Transit

Workshop Manual

Table of Contents

GROUP 1 General Information

Service Information

General Information 100-00
Identification Codes 100-01
Jacking and Lifting 100-02
Noise, Vibration and Harshness 100-04

GROUP 2 Chassis

Suspension

Suspension System - General Information 204-00
Front Suspension 204-01
Rear Suspension 204-02
Wheels and Tires 204-04

Driveline

Driveline System - General Information 205-00
Driveshaft 205-01
Rear Drive Axle/Differential 205-02A
Wheel Hubs and Bearings - Full Floating Axle 205-02B

Brake System

Brake System - General Information 206-00
Front Disc Brake 206-03
Rear Disc Brake 206-04
Parking Brake and Actuation 206-05A
Parking Brake and Actuation - Vehicles With: Parking Brake Assist 206-05B
Hydraulic Brake Actuation 206-06
Power Brake Actuation 206-07
Anti-Lock Control 206-09

Steering System

Steering System - General Information 211-00
Power Steering 211-02
Steering Linkage 211-03
Steering Column 211-04
Steering Column Switches 211-05

GROUP 3 Powertrain

Engine

Engine System - General Information 303-00
Engine - 2.4L Duratorq-TDCi (Puma) Diesel 303-01A
Engine - 2.3L Duratec-HE (MI4) 303-01B
Engine Cooling 303-03
Fuel Charging and Controls - 2.3L Duratec-HE (MI4) 303-04A
Fuel Charging and Controls - Turbocharger 303-04B
Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel 303-04C
Accessory Drive 303-05
Starting System 303-06
Glow Plug System - 2.4L Duratorq-TDCi (Puma) Diesel 303-07A
Engine Ignition - 2.3L Duratec-HE (MI4) 303-07B
Engine Emission Control 303-08
Intake Air Distribution and Filtering 303-12
Evaporative Emissions 303-13
Electronic Engine Controls 303-14

Manual Transmission/Transaxle, Clutch and Transfer Case
Manual Transmission/Transaxle and Clutch - General Information 308-00
Clutch - Vehicles With: MT-75 308-01
Clutch Controls - Vehicles With: MT-75 308-02
Manual Transmission/Transaxle - Vehicles With: MT-75 308-03
Manual Transmission/Transaxle External Controls - Vehicles With: MT-75 308-06

Exhaust System
Exhaust System 309-00

Fuel System
Fuel System - General Information 310-00
Fuel Tank and Lines 310-01
Acceleration Control - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel 310-02A
Acceleration Control - 2.3L Duratec-HE (MI4) 310-02B
Speed Control 310-03

GROUP 4 Electrical

Climate Control System
Climate Control System - General Information 412-00
Air Distribution and Filtering 412-01
Heating and Ventilation 412-02
Air Conditioning 412-03A
Auxiliary Climate Control 412-03B
Control Components 412-04

Instrumentation and Warning Systems
Instrument Cluster and Panel Illumination 413-00
Instrument Cluster 413-01
Horn 413-06
Warning Devices 413-09

Battery and Charging System
Charging System - General Information 414-00
Battery, Mounting and Cables 414-01
Generator and Regulator 414-02

Information and Entertainment Systems
Information and Entertainment System - General Information 415-00
Information and Entertainment System 415-01

Lighting
Exterior Lighting 417-01
Interior Lighting 417-02

Electrical Distribution
Module Communications Network 418-00
Module Configuration 418-01
Wiring Harnesses 418-02

Electronic Feature Group
Anti-Theft - Passive 419-01
Multifunction Electronic Modules 419-10

GROUP 5 Body and Paint

Body and Paint
Body System - General Information 501-00
Front End Body Panels 501-02
Body Closures 501-03
Interior Trim and Ornamentation 501-05
Exterior Trim and Ornamentation 501-08
Rear View Mirrors 501-09
Seating 501-10
Glass, Frames and Mechanisms 501-11
Instrument Panel and Console 501-12
Handles, Locks, Latches and Entry Systems 501-14
Wipers and Washers 501-16
Roof Opening Panel 501-17
Bumpers 501-19
Safety Belt System 501-20A
Supplemental Restraint System 501-20B
Body Repairs - General Information 501-25
Body Repairs - Vehicle Specific Information and Tolerance Checks 501-26
Front End Sheet Metal Repairs 501-27
Side Panel Sheet Metal Repairs 501-29

Rear End Sheet Metal Repairs 501-30
Paint - General Information 501-36

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Frame and Mounting
Uni-Body, Subframe and Mounting System 502-00

GROUP

1

General Information

SECTION TITLE PAGE

Service Information

General Information.....100-00
Identification Codes.....100-01
Jacking and Lifting.....100-02
Noise, Vibration and Harshness.....100-04

GROUP

2

Chassis

SECTION TITLE PAGE

Suspension
- Suspension System - General Information....204-00
- Front Suspension....204-01
- Rear Suspension....204-02
- Wheels and Tires....204-04

Driveline
- Driveline System - General Information....205-00
- Driveshaft....205-01
- Rear Drive Axle/Differential....205-02A
- Wheel Hubs and Bearings - Full Floating Axle....205-02B

Brake System
- Brake System - General Information....206-00
- Front Disc Brake....206-03
- Rear Disc Brake....206-04
- Parking Brake and Actuation....206-05A
- Parking Brake and ActuationVehicles With: Parking Brake Assist....206-05B
- Hydraulic Brake Actuation....206-06
- Power Brake Actuation....206-07
- Anti-Lock Control....206-09

Steering System
- Steering System - General Information....211-00
- Power Steering....211-02
- Steering Linkage....211-03
- Steering Column....211-04
- Steering Column Switches....211-05

GROUP

3

Powertrain

SECTION TITLE PAGE

Engine

Engine System - General Information....303-00
Engine2.4L Duratorq-TDCi (Puma) Diesel....303-01A
Engine2.3L Duratec-HE (MI4)....303-01B
Engine Cooling....303-03
Fuel Charging and Controls2.3L Duratec-HE (MI4)....303-04A
Fuel Charging and Controls - Turbocharger....303-04B
Fuel Charging and Controls2.4L Duratorq-TDCi (Puma) Diesel....303-04C
Accessory Drive....303-05
Starting System....303-06
Glow Plug System2.4L Duratorq-TDCi (Puma) Diesel....303-07A
Engine Ignition2.3L Duratec-HE (MI4)....303-07B
Engine Emission Control....303-08
Intake Air Distribution and Filtering....303-12
Evaporative Emissions....303-13
Electronic Engine Controls....303-14

Manual Transmission/Transaxle, Clutch and Transfer Case

Manual Transmission/Transaxle and Clutch - General Information....308-00
ClutchVehicles With: MT-75....308-01
Clutch ControlsVehicles With: MT-75....308-02
Manual Transmission/TransaxleVehicles With: MT-75....308-03
Manual Transmission/Transaxle External ControlsVehicles With: MT-75....308-06

Exhaust System

Exhaust System....309-00

Fuel System

Fuel System - General Information....310-00
Fuel Tank and Lines....310-01
Acceleration Control2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel....310-02A
Acceleration Control2.3L Duratec-HE (MI4)....310-02B
Speed Control....310-03

GROUP

4

Electrical

SECTION TITLE PAGE

Climate Control System
- Climate Control System - General Information....412-00
- Air Distribution and Filtering....412-01
- Heating and Ventilation....412-02
- Air Conditioning....412-03A
- Auxiliary Climate Control....412-03B
- Control Components....412-04

Instrumentation and Warning Systems
- Instrument Cluster and Panel Illumination....413-00
- Instrument Cluster....413-01
- Horn....413-06
- Warning Devices....413-09

Battery and Charging System
- Charging System - General Information....414-00
- Battery, Mounting and Cables....414-01
- Generator and Regulator....414-02

Information and Entertainment Systems
- Information and Entertainment System - General Information....415-00
- Information and Entertainment System....415-01

Lighting
- Exterior Lighting....417-01
- Interior Lighting....417-02

Electrical Distribution
- Module Communications Network....418-00
- Module Configuration....418-01
- Wiring Harnesses....418-02

Electronic Feature Group
- Anti-Theft - Passive....419-01
- Multifunction Electronic Modules....419-10

GROUP

5

Body and Paint

SECTION TITLE PAGE

Body and Paint

Body System - General Information....501-00
Front End Body Panels....501-02
Body Closures....501-03
Interior Trim and Ornamentation....501-05
Exterior Trim and Ornamentation....501-08
Rear View Mirrors....501-09
Seating....501-10
Glass, Frames and Mechanisms....501-11
Instrument Panel and Console....501-12
Handles, Locks, Latches and Entry Systems....501-14
Wipers and Washers....501-16
Roof Opening Panel....501-17
Bumpers....501-19
Safety Belt System....501-20A
Supplemental Restraint System....501-20B
Body Repairs - General Information....501-25
Body Repairs - Vehicle Specific Information and Tolerance Checks....501-26
Front End Sheet Metal Repairs....501-27
Side Panel Sheet Metal Repairs....501-29
Rear End Sheet Metal Repairs....501-30
Paint - General Information....501-36

Frame and Mounting

Uni-Body, Subframe and Mounting System....502-00

SECTION 100-00 General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

About This Manual..... 100-00-3
Introduction..... 100-00-3
Special Tools..... 100-00-3
Important Safety Instructions..... 100-00-3
Warnings, Cautions and Notes in This Manual..... 100-00-3
Overview Procedures..... 100-00-3
Trustmark Authoring Standards (TAS) Removal and Installation Procedures..... 100-00-4
How to Use This Manual..... 100-00-13
Health and Safety Precautions..... 100-00-15
Introduction..... 100-00-15
Acids and Alkalis..... 100-00-15
Air Bags..... 100-00-15
Air Conditioning Refrigerant..... 100-00-15
Adhesives and Sealers..... 100-00-16
Antifreeze..... 100-00-17
Asbestos..... 100-00-17
Battery Acids..... 100-00-17
Brake and Clutch Linings and Pads..... 100-00-17
Brake Fluids (Polyalkylene Glycols)..... 100-00-17
Brazing..... 100-00-17
Chemical Materials..... 100-00-17
Chlorofluorocarbons (CFC)..... 100-00-18
Clutch Fluids..... 100-00-18
Clutch Linings and Pads..... 100-00-18
Corrosion Protection Materials..... 100-00-18
Cutting..... 100-00-18
Dewaxing..... 100-00-19
Dusts..... 100-00-19
Electric Shock..... 100-00-19
Engine Oils..... 100-00-19
Exhaust Fumes..... 100-00-19
Fibre Insulation..... 100-00-19
Fire..... 100-00-19
First Aid..... 100-00-20
Fluoroelastomer..... 100-00-20
Foams - Polyurethane..... 100-00-20
Freon..... 100-00-20
Fuels..... 100-00-20
Gas Cylinders..... 100-00-21
Gases..... 100-00-21
Gaskets (Fluoroelastomer)..... 100-00-21
General Workshop Tools and Equipment..... 100-00-21
High Pressure Air, Lubrication and Oil Test Equipment..... 100-00-22
Halon..... 100-00-22

Legal Aspects 100-00-22
Lubricants and Greases 100-00-22
Transmission Fluids 100-00-22
Noise 100-00-23
Noise Insulation Materials 100-00-23
O-Rings (Fluoroelastomer) 100-00-23
Paints 100-00-23
Pressurized Equipment 100-00-24
Solder 100-00-24
Solvents 100-00-24
Sound Insulation 100-00-24
Suspended Loads 100-00-24
Transmission Brake Bands 100-00-25
Underseal 100-00-25
Viton 100-00-25
Welding 100-00-25
Warning Symbols on Vehicles 100-00-26
White Spirit 100-00-27
Standard Workshop Practices 100-00-28
Vehicle in Workshop 100-00-28
Alternative Fuel 100-00-28
Alternative Fuel — Do's 100-00-28
Alternative Fuel — Do Nots 100-00-28
Towing the Vehicle 100-00-29
Connecting a Slave Battery Using Jumper Cables 100-00-29
Component Cleaning 100-00-30
Calibration of Essential Measuring Equipment 100-00-30
Solvents, Sealants and Adhesives 100-00-31
Introduction 100-00-31
Road/Roller Testing 100-00-32
Pre-Test Checks 100-00-32
Starting the Engine 100-00-32
Road or Roller Testing 100-00-32
Brake Testing 100-00-33
Battery and Battery Charging Health and Safety Precautions 100-00-34
Engine Cooling System Health and Safety Precautions 100-00-35
Petrol Fuel System Health and Safety Precautions 100-00-36
Diesel Fuel System Health and Safety Precautions 100-00-37
Air Conditioning (A/C) System Health and Safety Precautions 100-00-38
Supplemental Restraint System (SRS) Health and Safety Precautions 100-00-39
Brake System Health and Safety Precautions 100-00-40

DESCRIPTION AND OPERATION

About This Manual

Introduction

This manual has been written in a format that is designed to meet the needs of technicians worldwide. The objective is to use common formats and include similar content in each manual.

This manual provides general descriptions for accomplishing diagnosis and testing, service and repair work with tested, effective techniques. Following them will help assure reliability.

Special Tools

The special tool(s) table provided at the beginning of each procedure shows all special tools required to carry out a repair. Where possible, illustrations are provided to assist in identifying the special tool required.

Important Safety Instructions

Appropriate service methods and correct repair procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual carrying out the work.

This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Anyone who departs from the instructions provided in this manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or components.

Warnings, Cautions and Notes in This Manual

WARNING:Warnings are used to indicate that failure to follow a procedure correctly may result in personal injury.

CAUTION:Cautions are used to indicate that failure to follow a procedure correctly may result in damage to the vehicle or equipment being used.

NOTE: Notes are used to provide additional essential information required to carry out a complete and satisfactory repair.

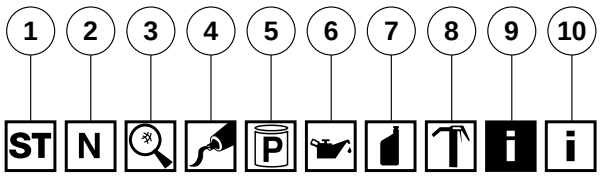
As you read through this manual, you will come across WARNINGS, CAUTIONS and NOTES.

A warning, caution or note is placed at the beginning of a series of steps if it applies to multiple steps. If the warning, caution or note only applies to one step, it is placed at the beginning of the specific step (after the step number).

Overview Procedures

Overview procedures contain an exploded view illustration(s). The numbered sequence within the illustration(s) indicate the order to be followed when removing/disassembling or when installing/assembling a component. Additional information, symbol(s) or a torque figure, may also be shown alongside the component.

There are ten symbols used to give additional information when removing/disassembling or when installing/assembling a component.



TIE42918

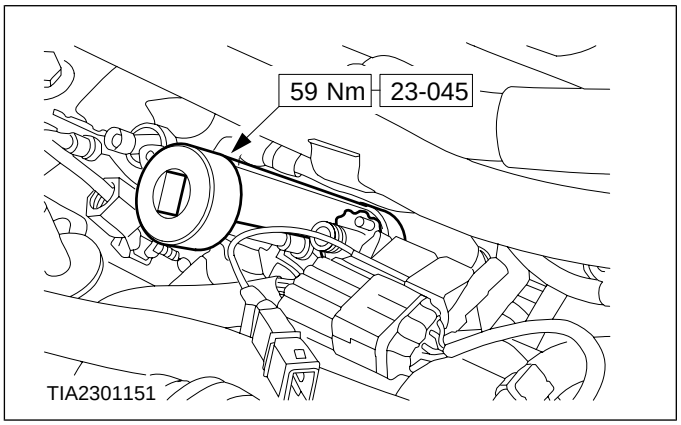
Item	Designation	Description
1	Special tool	A special tool is required for this component. There will also be a removal or installation symbol alongside the special tool symbol.
2	Install new component	Discard the old component and install a new component.
3	Inspect	Check the component for damage.

DESCRIPTION AND OPERATION

Item	Designation	Description
4	Apply sealant	Apply sealant to the component as specified in the mate-rials table.
5	Apply petroleum jelly	Apply petroleum jelly to the component as specified in the materials table.
6	Apply oil	Apply oil to the component as specified in the materials table.
7	Apply fluid	Apply fluid to the component as specified in the materials table.
8	Apply grease	Apply grease to the component as specified in the mate-rials table.
9	Removal or Disassembly detail	Go to the removal or disassembly detail for additional information to remove or disassemble a component
10	Installation or Assembly detail	Go to the installation or assembly detail for additional information to install or assemble a component

Special Tools and Torque Figures

Any requirement for special tools will picture the tool, showing it in use and with its tool number shown. Torque settings will be given at the relevant point in the procedure.



Trustmark Authoring Standards (TAS) Removal and Installation Procedures

NOTE:TAS style procedures can be identified by steps that have no accompanying step text and the magenta color of the electrical connectors and fasteners such as nuts, bolts, clamps or clips.

A TAS removal and installation procedure uses a sequence of color illustrations to indicate the order to be followed when removing/disassembling or installing/assembling a component.

Many of the TAS procedures will have the installation information within the removal steps. These procedures will have the following note at the beginning of the procedure:

NOTE: Removal steps in this procedure may contain installation details.

Items such as O-ring seals, gaskets, seals, self-locking nuts and bolts are to be discarded and new components installed unless otherwise stated within the procedure. Coated nuts or bolts are to be reused, unless damaged or otherwise stated within the procedure.

Specification procedures will contain all technical data that are not part of a repair procedure.

TAS Graphics

Colors used in the graphic are as follows:

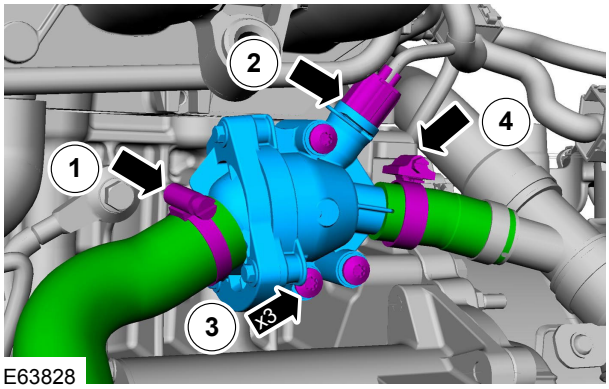
- Blue - Indicates the target item, item to be removed/installed or disassembled/assembled
- Green and Brown - Indicates a secondary item that needs to be detached, removed/installed or disassembled/assembled prior to the target item
- Magenta - Indicates electrical connectors and fasteners such as nuts, bolts, clamps or clips
- Pale Blue - is for the special tool(s) and general equipment

There may be multiple steps assigned to one illustration.

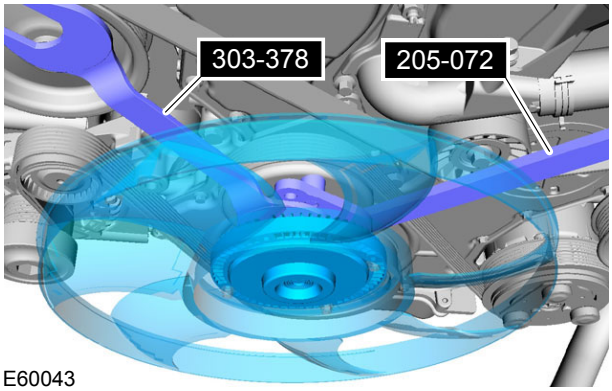
Numbered pointers are used to indicate the number of electrical connectors and fasteners such as nuts, bolts, clamps or clips.

Items in the illustration can be transparent or use cutouts to show hidden detail(s).

DESCRIPTION AND OPERATION



E63828

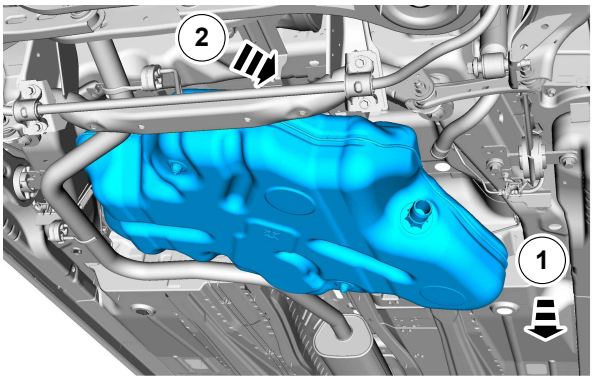


E60043

TAS Symbols

Symbols are used inside the graphics and in the text area to enhance the information display. The following paragraphs describe the various types and categories of symbols.

Prohibition symbols advise on prohibited actions to either avoid damage or health and safety related risks.



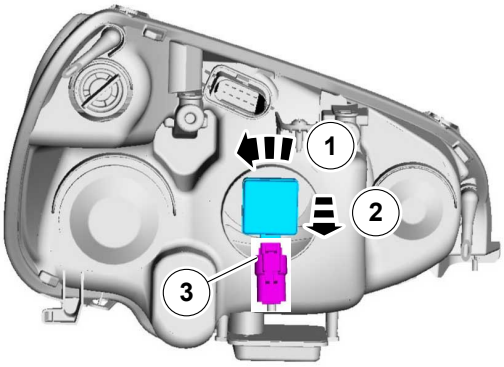
4. 



E85026

Health and Safety symbols recommend the use of particular protection equipment to avoid or at least reduce the risk or severity of possible injuries.

DESCRIPTION AND OPERATION

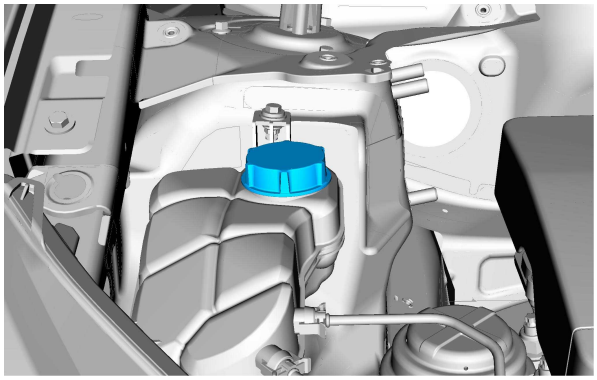


2. 



E85027

Warning symbols are used to indicate potential risks resulting from a certain component or area.



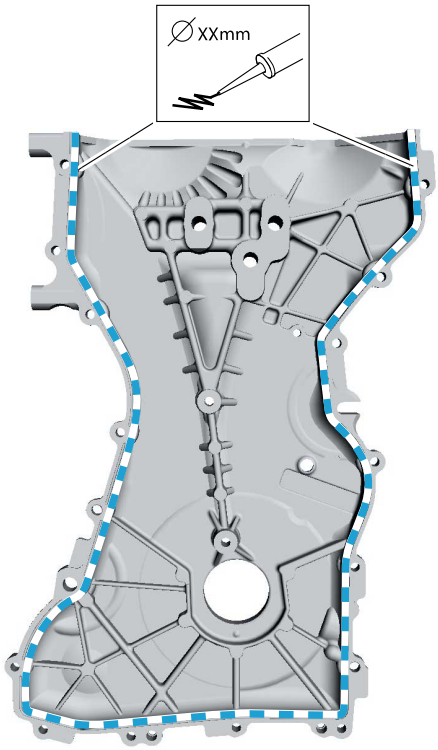
3. 

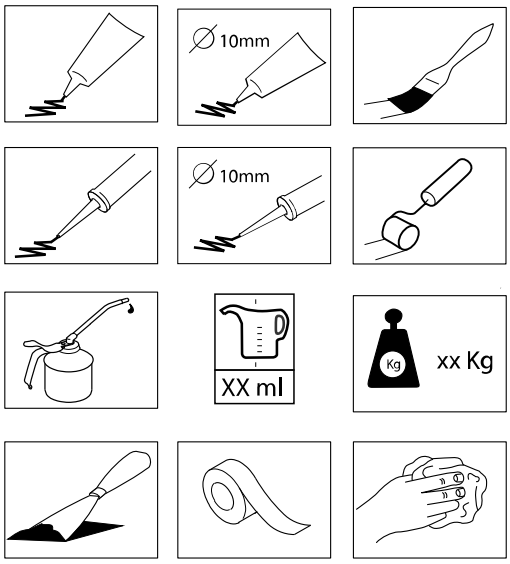


E85028

DESCRIPTION AND OPERATION

Instruction symbols are used to apply sealer, lubricant, weight, tape or cleaning detergent to a component.

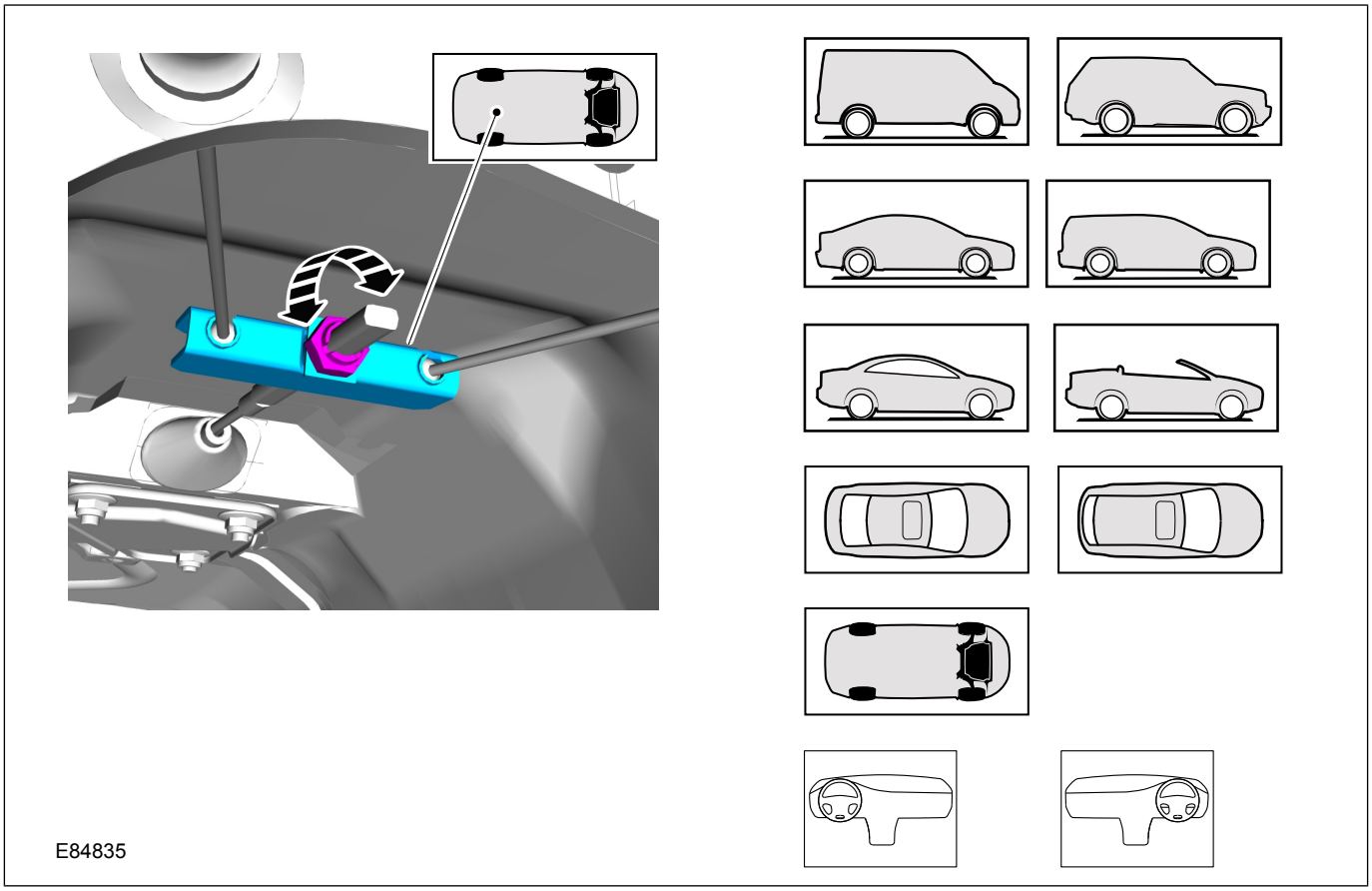




E84834

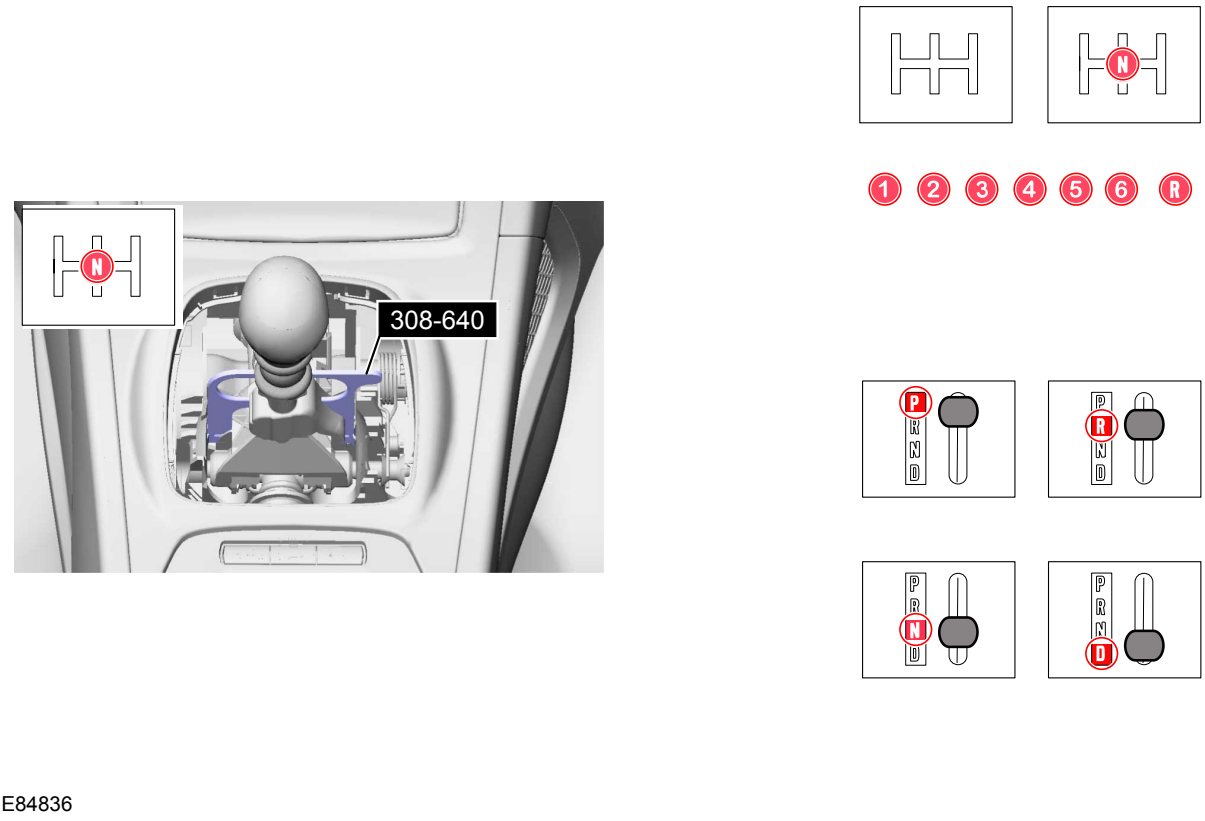
Location symbols are used to show the location of a component or system within the vehicle.

DESCRIPTION AND OPERATION



Gearshift lever or selector lever position symbols are used to show which gearshift lever or selector lever position is to be set.

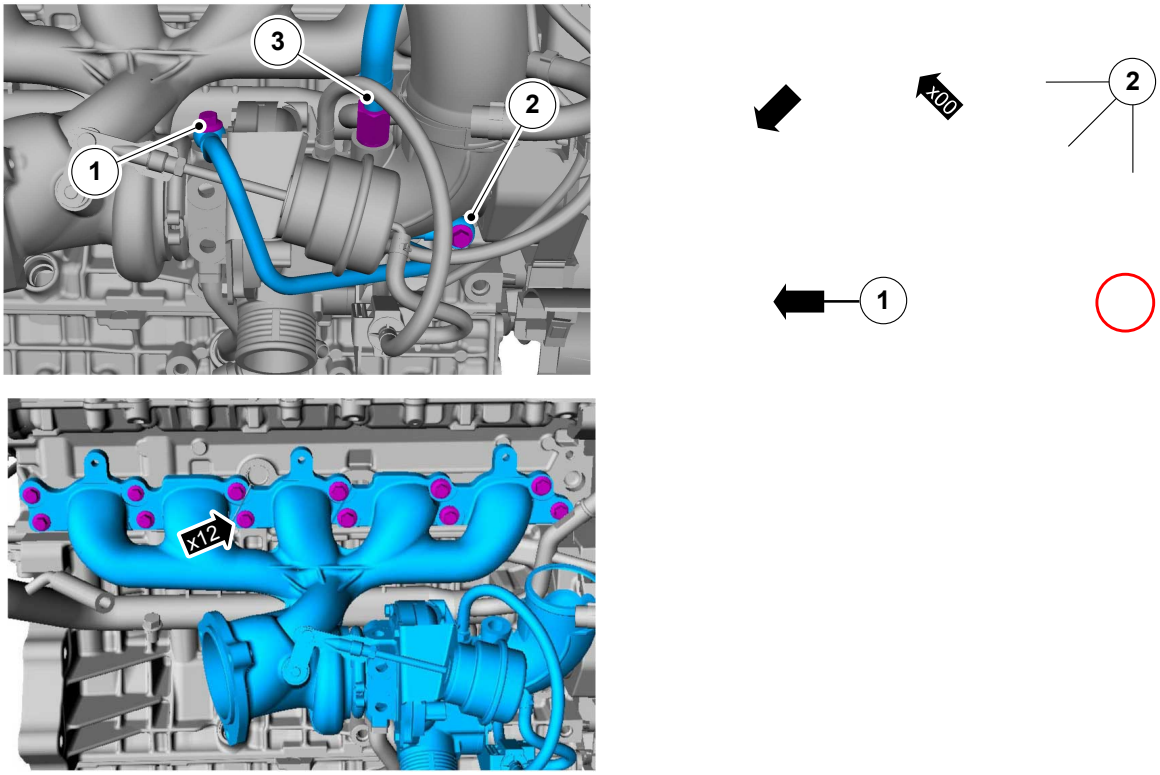
DESCRIPTION AND OPERATION



E84836

Pointer symbols are used to draw the attention to components and give special instructions such as a required sequence or number of components. The number of components is reflected by the value inside the luty arrow. A sequence number is located inside the circle. Numbers inside circles are also used to allocate special information such as tightening torques or chemicals to a particular component.

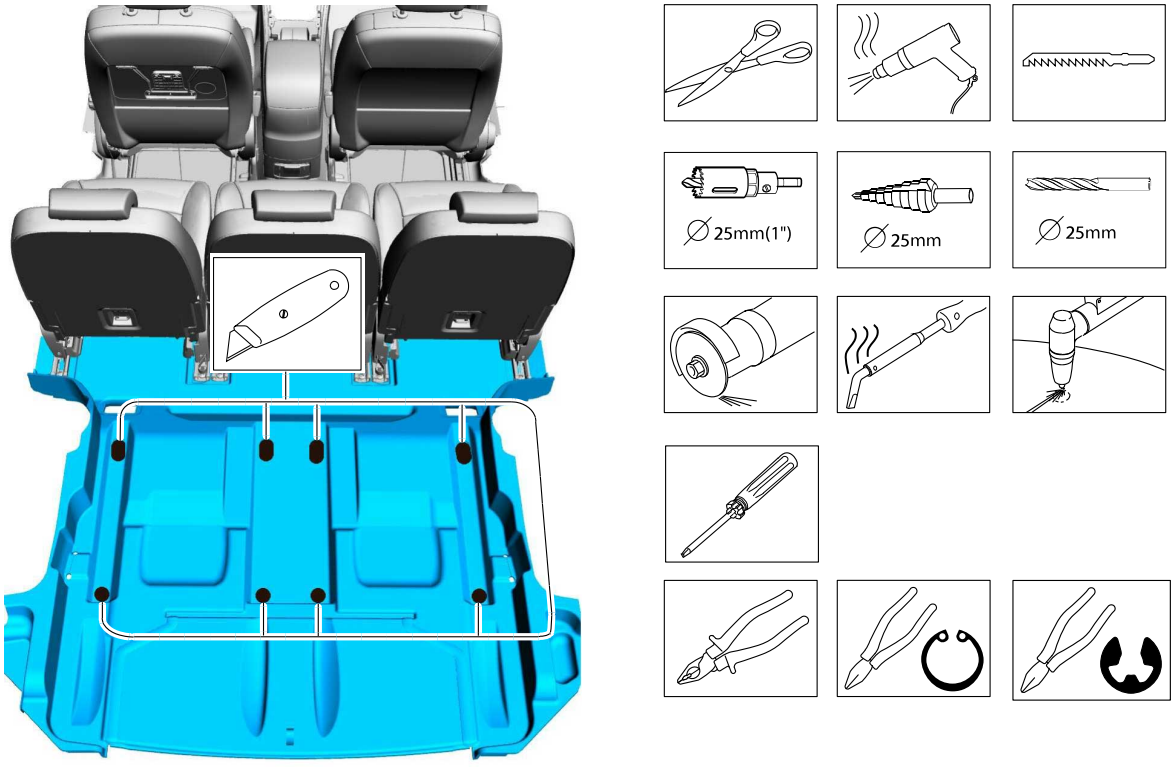
DESCRIPTION AND OPERATION



E84837

Movement arrows are used to show three dimensional or rotational movements. These movements can include specific values inside the symbol if required.

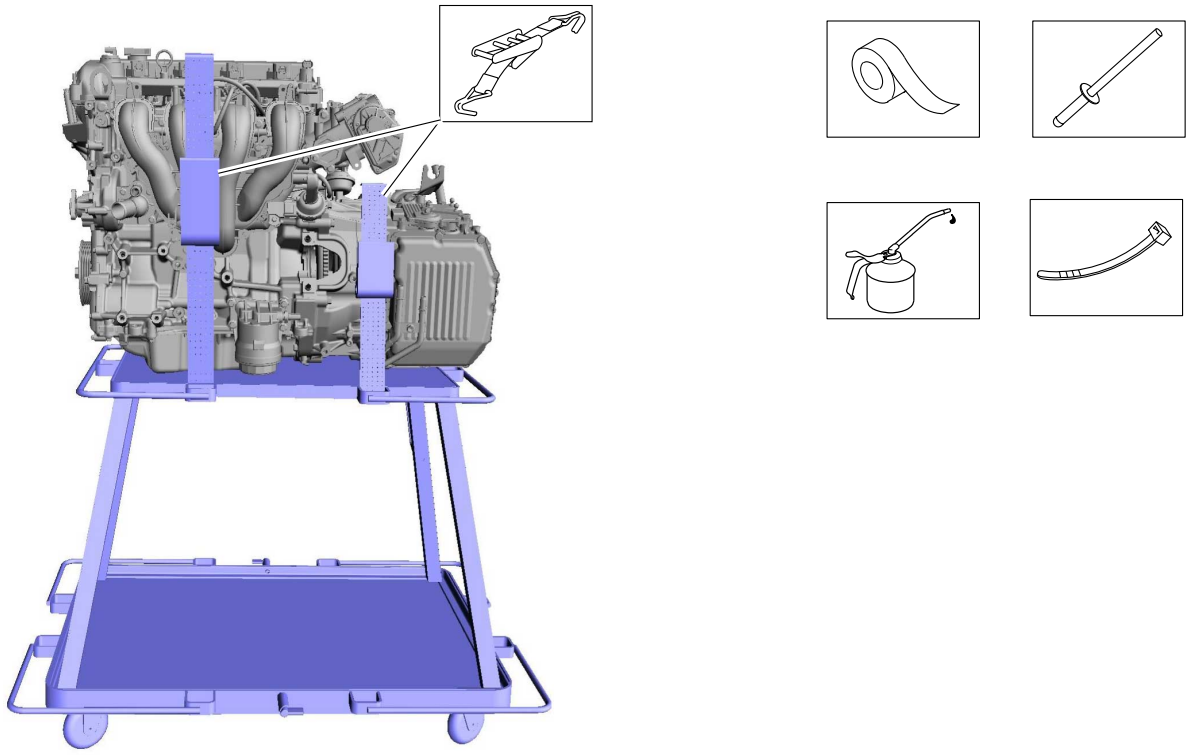
DESCRIPTION AND OPERATION



E84839

The following graphic illustrates a set of symbols that are used to provide detailed information on where to apply a material.

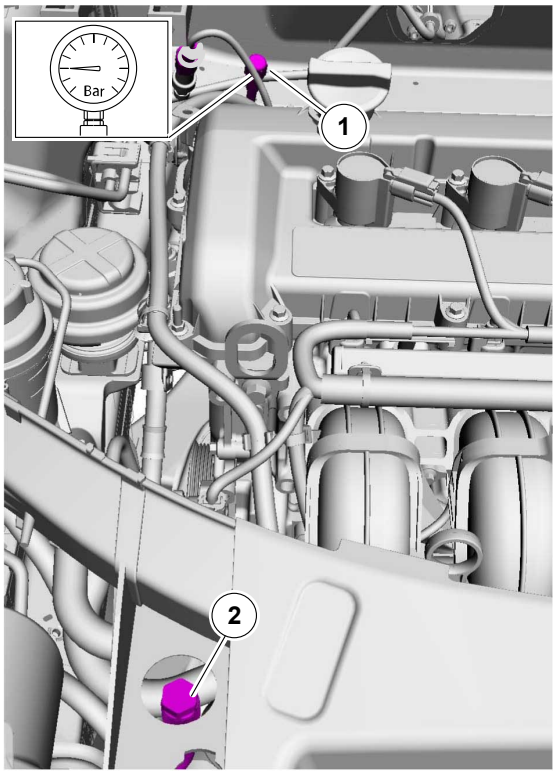
DESCRIPTION AND OPERATION



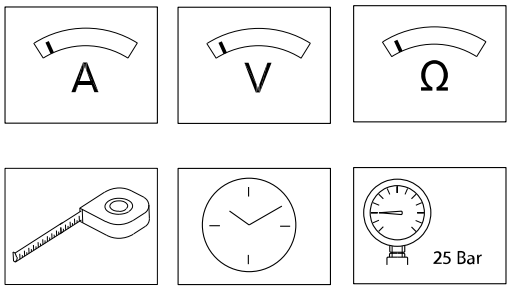
E84840

Measurement symbols provide detailed information on where to carry out a specific measurement. These symbols can include specific values if required.

DESCRIPTION AND OPERATION



E84841



Special Tools and Torque Figure(s)

Special tools will be shown with the tool number in the illustration. The special tool number(s), general equipment, material(s) and torque figure(s) used for the procedure step will be shown in the text column.

How to Use This Manual

This manual covers diagnosis and testing, service and repair procedures.

This manual is structured into groups and sections, with specific system sections collected together under their relevant group.

A group covers a specific portion of the vehicle. The manual is divided into five groups, General Information, Chassis, Powertrain, Electrical and Body and Paint. The number of the group is the first number of a section number.

Pages at the start of the manual list all sections available. Each section has a contents list detailing Specifications, Description and Operation, Diagnosis and Testing, In Vehicle Repairs, Disassembly and Assembly, Removal and Installation.

If components need to be removed or disassembled in sequence, the sequence will be identified numerically in a graphic and the corresponding text will be numbered accordingly.

All left and right-hand references to the vehicle are taken from a position sitting in the driver seat looking forward.

All left and right-hand references to the engine are taken from a position at the flywheel looking towards the front camshaft pulley.

Where appropriate, instructions will be given for the use of the diagnostic tool.

Inspection and Verification

Visual Inspection Charts, Symptom Charts and other information charts (such as diagnostic routines) or supplement test procedures with technical specifications will navigate the user to a specific test procedure.

Symptom Chart

The symptom chart indicates symptoms, sources and actions to address a condition.

DESCRIPTION AND OPERATION

Pinpoint Tests

For electrical systems, pinpoint test steps are used to identify the source of a concern in a logical, step-by-step manner. pinpoint tests have two columns: CONDITIONS and DETAILS/RESULTS/ACTIONS.

The CONDITIONS column is used exclusively for graphics and icons (with or without captions) and the DETAILS/RESULTS/ACTIONS column provides direction to another test step or specific corrective actions.

The boxed numbers indicate the order in which the described action is to be performed.

Component Tests

A component test is used when a component is tested in multiple pinpoint tests, or if a procedure is too complicated to be formatted within a single page of the pinpoint test.

Graphics

Test graphics show the measurement or test to be performed in a test step.

A representative tester graphic is used for voltmeters and ohmmeters.

If multiple measurements are made in a single graphic, the test leads are drawn with a solid line until the test lead splits to indicate the multiple measurements, at which point dashed lines are used.

Breakout box-type testers are represented by a double circle test pin. Test pins are labeled with the pin number.

DESCRIPTION AND OPERATION

Health and Safety Precautions

Introduction

Many of the procedures associated with vehicle maintenance and repair involve physical hazards or other risks to health. This subsection lists, alphabetically, some of these hazardous operations and the materials and equipment associated with them. Precautions necessary to avoid these hazards are identified.

The list is not exhaustive and all operations and procedures, and the handling of materials, should be carried out with health and safety in mind.

Before using any product the Materials Safety Data Sheet supplied by the manufacturer or supplier should be consulted.

Acids and Alkalis

See also Battery Acids.

For example caustic soda, sulphuric acid.

Used in batteries and cleaning materials.

Irritant and corrosive to the skin, eyes, nose and throat. Cause burns. Can destroy ordinary protective clothing.

Avoid splashes to the skin, eyes and clothing. Wear suitable protective impervious apron, gloves and goggles. Do not breath mists.

Make sure access to eye wash bottles, shower and soap are readily available for splashing accidents.

Display Eye Hazard sign.

Air Bags

See also Fire, Chemical Materials.

Highly flammable, explosive – observe No Smoking policy.

Used as a safety restraint system mounted in the steering wheel and passenger side of the instrument panel.

The inflator contains a high-energetic propellant which, when ignited, produces a VERY HOT GAS (2500°C).

The gas generant used in air bags is Sodium Azide. This material is hermetically sealed in the module and is completely consumed during deployment. No attempt should be made to open an air bag inflator as this will lead to the risk of exposure to Sodium Azide. If a gas generator is ruptured, full protective clothing should be worn when dealing with the spillage.

After normal deployment, gloves and safety goggles must be worn during the handling process.

Deployed air bags should be disposed of in a plastic bag in accordance with local regulations at an approved chemical waste site.

Following any direct contact with gas generant.

- wash affected areas thoroughly with water.
- seek medical assistance if necessary.

Air Bags - Do's

- Do store modules in an upright position.
- Do keep modules dry.
- Do carry modules with the cover side pointing away from the body.
- Do place modules with their cover side upwards.
- Do carefully inspect modules for damage.
- Do stand to one side when connecting modules.
- Do make sure all test equipment is properly calibrated and maintained.
- Do wash hands after handling deployed air bags.

Air Bags - Do Nots

- Do not store highly flammable material together with modules or gas generators.
- Do not store gas generators at temperatures exceeding 80°C.
- Do not store modules upside down.
- Do not attempt to open a gas generator housing.
- Do not expose gas generators to open flame or sources of heat.
- Do not place anything on top of a module cover.
- Do not use damaged modules.
- Do not touch a fired module or gas generator for at least 10 minutes.
- Do not use any electrical probes on the wiring circuit.

Air Conditioning Refrigerant

See also Chlorofluorocarbon, Chemical Materials

Highly flammable, combustible – observe No Smoking policy.

DESCRIPTION AND OPERATION

Skin contact may result in frostbite.

Instructions given by the manufacturer must be followed. Avoid naked lights, wear suitable protective gloves and goggles.

If refrigerant comes into contact with the skin or eyes, immediately rinse the affected areas with water. Eyes should also be rinsed with an appropriate irrigation solution and should not be rubbed. SEEK MEDICAL ASSISTANCE IF NECESSARY.

Air Conditioning Refrigerant - Do Nots

- Do not expose refrigerant bottles to sunlight or heat.
- Do not stand refrigerant bottles upright; when filling, hold them with the valve downwards.
- Do not expose refrigerant bottles to frost.
- Do not drop refrigerant bottles.
- Do not vent refrigerant to atmosphere under any circumstance.
- Do not mix refrigerants, for example R12 (Freon) and R134a.

Adhesives and Sealers

See also Fire, Chemical Materials.

Highly flammable, flammable, combustible – observe No Smoking policy.

Generally should be stored in No Smoking areas. Cleanliness and tidiness in use should be observed, for example disposable paper covering benches; should be dispensed from applicators where possible; containers, including secondary containers, should be labeled appropriately.

Solvent-based Adhesives/Sealers - See Solvents

Follow manufacturers instructions.

Water-based Adhesives/Sealers

Those based on polymer emulsions and rubber latexes may contain small amounts of volatile toxic and harmful chemicals. Skin and eye contact should be avoided and adequate ventilation provided during use.

Hot Melt Adhesives

In the solid state, they are safe. In the molten state they may cause burns and health hazards may arise from the inhalation of toxic fumes.

Use appropriate protective clothing and a thermostatically controlled heater with a thermal cut-out and adequate extraction.

Resin-based Adhesives/Sealers, for example Epoxide and Formaldehyde Resin-based

Mixing should be carried out in well ventilated areas, as harmful or toxic volatile chemicals may be released.

Skin contact with uncured resins and hardeners can result in irritation, dermatitis, and absorption of toxic or harmful chemicals through the skin. Splashes can damage the eyes.

Provide adequate ventilation and avoid skin and eye contact.

Anaerobic, Cyanoacrylate (super-glues) and other Acrylic Adhesives

Many are irritant, sensitizing or harmful to the skin and respiratory tract. Some are eye irritants.

Skin and eye contact should be avoided and the manufacturers instructions followed.

Cyanoacrylate adhesives (super-glues) MUST NOT contact the skin or eyes. If skin or eye tissue is bonded, cover with a clean moist pad and SEEK IMMEDIATE MEDICAL ATTENTION. Do not attempt to pull tissue apart. Use in well ventilated areas as vapors can cause irritation to the nose and eyes.

For two-pack systems see Resin-based and Isocyanate Adhesives/Sealers.

Isocyanate (Polyurethane) Adhesives/Sealers

See also Resin-based Adhesives.

Individuals suffering from asthma or respiratory allergies should not work with or near these materials as sensitivity reactions can occur.

Over exposure is irritating to the eyes and respiratory system. Excessive concentrations may produce effects on the nervous system including

DESCRIPTION AND OPERATION

drowsiness. In extreme cases, loss of consciousness may result. Long term exposure to vapor concentrations may result in adverse health effects.

Prolonged contact with the skin may have a defatting effect which may lead to skin irritation and in some cases, dermatitis.

Splashes entering the eye will cause discomfort and possible damage.

Any spraying should preferably be carried out in exhaust ventilated booths, removing vapors and spray droplets from the breathing zone.

Wear appropriate gloves, eye and respiratory protection.

Antifreeze

See also Fire, Solvents.

For example isopropanol, ethylene glycol, methanol.

Highly flammable, flammable, combustible.

Used in vehicle coolant systems, brake air pressure systems, screenwash solutions.

Vapors may be given off from coolant antifreeze (glycol) when heated. Avoid breathing these vapors.

Antifreeze may be absorbed through the skin in toxic or harmful quantities. Antifreeze, if swallowed, can be fatal and MEDICAL ATTENTION SHOULD BE SOUGHT IMMEDIATELY.

These products must not be used in any cooling or industrial water system that is connected or linked to general, food preparation or drinking water supplies.

Asbestos

See also Warning Symbols on Vehicles at the end of this subsection.

Breathing asbestos dust may cause lung damage or, in some cases, cancer.

Used in brake and clutch linings, transmission brake bands and gaskets.

The use of drum cleaning units, vacuum cleaning or damp wiping is preferred.

Asbestos dust waste should be dampened, placed in a sealed container and marked for safe disposal. If any cutting or drilling is attempted on materials containing asbestos the item should be dampened and only hand tools or low speed power tools used.

Battery Acids

See also Acids and Alkalis.

Gases released during charging are explosive. Never use naked flames or allow sparks near charging or recently charged batteries.

Make sure there is adequate ventilation.

Brake and Clutch Linings and Pads

See Asbestos.

Brake Fluids (Polyalkylene Glycols)

See also Fire.

Splashes to the skin and eyes are slightly irritating. Avoid skin and eye contact as far as possible. Inhalation vapor hazards do not arise at ambient temperatures because of the very low vapor pressure.

Brazing

See Welding.

Chemical Materials

See also Legal Aspects.

Chemical materials such as solvents, sealers, adhesives, paints, resin foams, battery acids, antifreeze, brake fluids, fuels, oils and grease should always be used with caution and stored and handled with care. They may be toxic, harmful, corrosive, irritant or highly flammable and give rise to hazardous fumes and dusts.

The effects of excessive exposure to chemicals may be immediate or delayed; briefly experienced or permanent; cumulative; superficial; life threatening; or may reduce life expectancy.

DESCRIPTION AND OPERATION

Chemical Materials - Do's

- Do carefully read and observe hazard and precaution warnings given on material containers (labels) and in any accompanying leaflets, posters or other instructions. Material health and safety data sheets can be obtained from manufacturers.
- Do remove chemical materials from the skin and clothing as soon as practicable after soiling. Change heavily soiled clothing and have it cleaned.
- Do organize work practices and protective clothing to avoid soiling of the skin and eyes; breathing vapors, aerosols, dusts or fumes; inadequate container labeling; fire and explosion hazards.
- Do wash before job breaks, before eating, smoking, drinking or using toilet facilities when handling chemical materials.
- Do keep work areas clean, uncluttered and free of spills.
- Do store chemical materials according to national and local regulations.
- Do keep chemical materials out of the reach of children.

Chemical Materials - Do Nots

- Do not mix chemical materials except under the manufacturers instructions; some chemicals can form other toxic or harmful chemicals, give off toxic or harmful fumes or become explosive when mixed together.
- Do not spray chemical materials, particularly those based on solvents, in confined spaces, for example when people are inside a vehicle.
- Do not apply heat or flame to chemical materials except under the manufacturers instructions. Some are highly flammable and some may release toxic or harmful fumes.
- Do not leave containers open. Fumes given off can build up to toxic, harmful or explosive concentrations. Some fumes are heavier than air and will accumulate in confined areas such as pits.
- Do not transfer chemical materials to unlabelled containers.
- Do not clean hands or clothing with chemicals. Chemicals, particularly solvents and fuels, will dry the skin and may cause irritation leading to dermatitis or be absorbed through the skin in toxic or harmful quantities.
- Do not use emptied containers for other materials except when they have been cleaned under supervised conditions.
- Do not sniff or smell chemical materials. Brief exposure to high concentrations of fumes can be toxic or harmful.

Chlorofluorocarbons (CFC)

There is concern in the scientific community that CFCs and Halons are depleting the upper ozone layer which filters out harmful ultraviolet radiation. Decreased filtration of ultraviolet radiation may result in increases in skin cancer, cataracts and immune system suppression in humans, as well as decreased productivity of crops and aquatic systems.

CFCs are used primarily as refrigerants in vehicle air conditioning systems and as aerosol propellants. Halons are used as fire extinguishants.

Clutch Fluids

See Brake fluids.

Clutch Linings and Pads

See Asbestos.

Corrosion Protection Materials

See also Solvents, Fire.

Highly flammable, flammable – observe No Smoking policy.

These materials are varied and the manufacturers instructions must be followed. They may contain solvents, resins or petroleum products. Skin and eye contact should be avoided. They should only be sprayed in conditions of adequate ventilation and not in confined spaces.

Cutting

See Welding.

DESCRIPTION AND OPERATION

Dewaxing

See Solvents and Fuels (Kerosene).

Dusts

Powder, dusts or clouds may be irritant, harmful or toxic. Avoid breathing dusts from powdery chemical materials or those arising from dry abrasion operations. Wear respiratory protection if ventilation is inadequate.

Fine dusts of combustible material can present an explosion hazard. Avoid explosive limits and sources of ignition.

Electric Shock

Electric shock can result from the use of faulty electrical equipment or from the misuse of equipment in good condition.

Make sure that electrical equipment is maintained in good condition and frequently tested. Faulty equipment should be labeled and preferably removed from the workstation.

Make sure that flexes, cables, plugs and sockets are not frayed, kinked, cut, cracked or otherwise damaged.

Make sure that electrical equipment and flexes do not come into contact with water.

Make sure that electrical equipment is protected by the correct rated fuse.

Never misuse electrical equipment and never use equipment that is in any way faulty. The results could be fatal.

Make sure that the cables of mobile electrical equipment cannot get trapped and damaged, such as in a vehicle hoist.

Make sure that the designated electrical workers are trained in basic First Aid.

In cases of electrocution:

- switch off the power supply before approaching the victim.
- if this is not possible push or drag the victim from the source of electricity using dry non-conductive material.
- commence resuscitation if trained to do so.
- SUMMON MEDICAL ASSISTANCE.

Engine Oils

See Lubricants and Grease.

Exhaust Fumes

These contain asphyxiating, harmful and toxic chemicals and particles such as carbon oxides, nitrogen oxides, aldehydes, lead and aromatic hydrocarbons. Engines should be run only under conditions of adequate exhaust extraction or general ventilation and not in confined spaces.

Gasoline (petrol) engine

There may not be adequate warning of odor or of irritation before toxic or harmful effects arise. These may be immediate or delayed.

Diesel engine

Soot, discomfort and irritation usually give adequate warning of hazardous fume concentrations.

Fibre Insulation

See also Dusts.

Used in noise and sound insulation.

The fibrous nature of surfaces and cut edges can cause skin irritation. This is usually a physical and not a chemical effect.

Precautions should be taken to avoid excessive skin contact through careful organization of work practices and the use of gloves.

Fire

See also Welding, Foams, Legal Aspects.

Many of the materials found on or associated with the repair of vehicles are highly flammable. Some give off toxic or harmful fumes if burnt.

Observe strict fire safety when storing and handling flammable materials or solvents, particularly near electrical equipment or welding processes.

Make sure, before using electrical or welding equipment, that there is no fire hazard present.

Have a suitable fire extinguisher available when using welding or heating equipment.

DESCRIPTION AND OPERATION

First Aid

Apart from meeting any legal requirements it is desirable for someone in the workshop to be trained in First Aid procedures.

Splashes in the eye should be flushed carefully with clean water for at least ten minutes.

Soiled skin should be washed with soap and water.

In case of cold burns, from alternative fuels, place affected area in cool to cold water.

Individuals affected by inhalation of gases and fumes should be removed to fresh air immediately. If effects persist, consult a doctor.

If liquids are swallowed inadvertently, consult a doctor giving him the information on the container or label. Do not induce vomiting unless this action is indicated on the label.

Fluoroelastomer

See Viton.

Foams - Polyurethane

See also Fire.

Used in sound and noise insulation. Cured foams used in seat and trim cushioning.

Follow manufacturers instructions.

Unreacted components are irritating and may be harmful to the skin and eyes. Wear gloves and goggles.

Individuals with chronic respiratory diseases, asthma, bronchial medical problems, or histories of allergic diseases should not work in or near uncured materials.

The components, vapors or spray mists can cause direct irritation, sensitivity reactions and may be toxic or harmful.

Vapors and spray mists must not be inhaled. These materials must be applied with adequate ventilation and respiratory protection. Do not remove the respirator immediately after spraying; wait until the vapors/mists have cleared.

Burning of the uncured components and the cured foams can generate toxic and harmful fumes. Smoking, naked flames or the use of electrical equipment during foaming operations and until vapors/mists have cleared should not be allowed. Any heat cutting of cured foams or partially cured foams should be conducted with extraction ventilation. See also the vehicle Body Repair Manual.

Freon

See Air Conditioning Refrigerant.

Fuels

See also, Fire, Legal Aspects, Chemicals and Solvents.

Avoid skin contact with fuel where possible. Should contact occur, wash the affected skin with soap and water.

Gasoline (Petrol)

Highly flammable - observe No Smoking policy.

Swallowing can result in mouth and throat irritation and absorption from the stomach can result in drowsiness and unconsciousness. Small amounts can be fatal to children. Aspiration of liquid into the lungs, through vomiting, is a very serious hazard.

Gasoline dries the skin and can cause irritation and dermatitis on prolonged or repeated contact. Liquid in the eye causes severe smarting.

Motor gasoline may contain appreciable quantities of benzene, which is toxic upon inhalation, and the concentration of gasoline vapors must be kept very low. High concentrations will cause eye, nose and throat irritation, nausea, headache, depression and symptoms of drunkenness. Very high concentrations will result in rapid loss of consciousness.

Make sure there is adequate ventilation when handling and using gasoline. Great care must be taken to avoid the serious consequences of inhalation in the event of vapor build up arising from spillages in confined spaces.

Special precautions apply to cleaning and maintenance operations on gasoline storage tanks.

Gasoline should not be used as a cleaning agent. It must not be siphoned by mouth. See First Aid.

Gas-oil (Diesel Fuel)

Combustible.

DESCRIPTION AND OPERATION

Gross or prolonged skin contact with high boiling point gas oils may also cause serious skin disorders including skin cancer.

Kerosene (Paraffin)

Used also as heating fuel, solvent and cleaning agent.

Flammable - observe No Smoking policy.

Irritation of the mouth and throat may result from swallowing. The main hazard from swallowing arises if liquid aspiration into the lungs occurs.

Liquid contact dries the skin and can cause irritation or dermatitis. Splashes in the eye may be slightly irritating.

In normal circumstances the low volatility does not give rise to harmful vapors. Exposure to mists and vapors from kerosene at elevated temperature should be avoided (mists may arise in dewaxing). Avoid skin and eye contact and make sure there is adequate ventilation.

Alternative Fuel

Highly flammable. Observe ``NO SMOKING'' signs.

Make sure there is adequate ventilation when working on alternative fuelled vehicles. Great care must be taken to avoid the serious consequences of inhalation in the event of vapor build up in confined spaces.

Inhalation in high concentrations may cause dizziness, headache, nausea and loss of co-ordination. Very high concentrations may result in loss of consciousness.

Contact with liquefied petroleum gas (LPG) or compressed natural gas (CNG) to the skin may cause cold burns and frost bite.

Long sleeved cotton overalls, steel toe capped safety boots and rubber neoprene gloves should be worn during removal and installation of LPG/CNG fuel system components.

LPG/CNG fuel leaks could cause a fire and be a hazard to health that can lead to personal injury, illness or even death.

If a leak is detected, under no circumstances attempt to seal the leak by tightening the union/connection until the fuel in the system or component is depressurized. Once tightened the system should be checked for integrity following the specified procedures.

If the fuel tank is to be removed for service or repair the fuel must be evacuated using dedicated equipment and following the specified procedures.

Gas Cylinders

See also Fire.

Gases such as oxygen, acetylene, argon and propane are normally stored in cylinders at pressures of up to 138 bar (2000 psi) and great care should be taken in handling these cylinders to avoid mechanical damage to them or to the valve gear attached. The contents of each cylinder should be clearly identified by appropriate markings.

Cylinders should be stored in well-ventilated enclosures, and protected from ice and snow, or direct sunlight. Fuel gases, for example acetylene and propane, should not be stored in close proximity to oxygen cylinders.

Care should be exercised to prevent leaks from gas cylinders and lines, and to avoid sources of ignition.

Only trained personnel should undertake work involving gas cylinders.

Gases

See Gas Cylinders.

Gaskets (Fluoroelastomer)

See Viton.

General Workshop Tools and Equipment

It is essential that all tools and equipment are maintained in good condition and that the correct safety equipment is used where required.

Never use tools or equipment for any purpose other than that for which they were designed. Never overload equipment such as hoists, jacks, axle and chassis stands or lifting slings. Damage caused by overloading is not always immediately apparent and may result in a fatal failure the next time that the equipment is used.

DESCRIPTION AND OPERATION

Do not use damaged or defective tools or equipment, particularly high-speed equipment such as grinding wheels. A damaged grinding wheel can disintegrate without warning and cause serious injury.

Wear suitable eye protection when using grinding, chiseling or sand blasting equipment.

Wear a suitable breathing mask when using abrasive blasting equipment, working with asbestos-based materials or using spraying equipment.

Make sure there is adequate ventilation to control dusts, mists and fumes.

High Pressure Air, Lubrication and Oil Test Equipment

See also Lubricants and Greases.

Always keep high-pressure equipment in good condition, and regularly maintained, particularly at joints and unions.

Never direct a high-pressure nozzle, for example diesel injector, at the skin as the fluid may penetrate to the underlying tissue, and cause serious injury.

Halon

See CFCs.

Legal Aspects

There are many laws and regulations relating to health and safety in the use and disposal of materials and equipment in a workshop.

For a safe working environment and to avoid environmental pollution, workshops should be familiar, in detail, with the many health and safety laws and regulations within their country, published by both national and local authorities.

Lubricants and Greases

Avoid all prolonged and repeated contact with mineral oils. All lubricants and greases may be irritating to the eyes and skin.

Transmission Fluids

Safety instructions

Certain Transmission and Power Steering fluids supplied to Ford may contain additives which have the potential to cause skin disease (dermatitis) to exposed persons. The dermatitis may be irritant or allergic in nature. Risks are higher where prolonged or repeated skin contact with a fluid may occur. These fluids are used for vehicle initial fill and service purposes. This sub-section is to:

- Inform Service personnel who may come into contact with these vehicle fluids (hazard communication).
- Summarise appropriate workplace control measures and personal protective equipment requirements.
- Draw attention to the existence of Material Safety Datasheets (MSDS's) for the fluids (available from Ford Customer Service Division). These MSDS's contain detailed information on hazards and appropriate controls.

Control measures

Workplace risk assessments made under national chemical control regulations should identify operations involving the fluids as potentially hazardous and specify workplace control and worker awareness measures. In such circumstances, the relevant Material Safety Datasheet (see the details specified below) which specifies hazards and control measures in detail should be made available for guidance.

Avoid unprotected skin contact with the fluids, and in particular, avoid prolonged or repeated skin contact. Work practices should be organised so as to minimise the potential for skin contact. This may include the use of drip trays, absorbents, correct fluid handling equipment (funnels etc), and workplace housekeeping measures such as the cleaning of contaminated surfaces.

Personnel engaged in operations where skin contact could occur (such as fluid draining or filling) should wear impervious gloves made from nitrile rubber, certified to a chemical protection standard, e.g. Europe Standard EN374. This glove type is widely available from reputable suppliers of gloves for chemical protection [including the manufacturers Ansell-Admont (Solvex Range), North Safety products (North Nitrile Latex Gloves range), and

DESCRIPTION AND OPERATION

Marigold Industrial (Blue Nitrile range)]. If gloves become torn or contaminated on the inside they should be replaced. Eye protection with safety glasses is appropriate. Use of an impervious apron and arm protectors may be necessary if more extensive exposure is possible. Use of skin barrier creams suitable for work with mineral oil products may offer some supplementary protection, but such barrier creams should not be used in place of protective clothing.

If accidental skin contact occurs with the fluids, wash the area thoroughly with soap or skin cleanser and water.

Accidental eye contact should be dealt with as per normal first aid practices, by flushing the eyes with an eye wash or clean cool water for 10 minutes, after which medical attention should be obtained.

Remove and launder clothing which becomes contaminated with the fluids. Do not place rags contaminated with fluid in clothing pockets.

Wash thoroughly after completing operations where skin exposure may have occurred.

It is important that personnel do not smoke, eat or drink whilst handling the fluids or affected transmissions. These measures are designed to limit the risk from accidental ingestion.

Label any decanted fluid properly/use an equivalent label to that on original product containers.

Clean up any spills promptly using an inert absorbent and wash down contaminated surfaces with detergent and water.

Dispose of any waste fluids safely as hazardous waste.

Safety Data Sheets

Safety Data Sheets, which detail specific material handling instructions and precautions are available from the respective national sales company, and via internet www.msds.ford.com.

Used Engine Oil

Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants, which may cause skin cancer. Adequate means of skin protection and washing facilities must be provided.

Do not employ used engine oils as lubricants or for any application where appreciable skin contact is likely to occur.

Environmental Precautions

Burning used engine oil in small space heaters or boilers can be recommended only for units of approved design. If in doubt check with the appropriate local authority and manufacturer of approved appliances.

Dispose of used oil and used oil filters through authorized waste disposal contractors or licensed waste disposal sites, or to the waste oil reclamation trade. If in doubt, contact the relevant local authority for advice on disposal facilities.

It is illegal to pour used oil on to the ground, down sewers or drains, or into watercourses.

Noise

Some operations may produce high noise levels, which could, in time, damage hearing. In these cases, suitable ear protection must be worn.

Noise Insulation Materials

See Foams, Fibre Insulation.

O-Rings (Fluoroelastomer)

See Viton.

Paints

See also Solvents, Chemical Materials.

Highly flammable, flammable - observe No Smoking policy

One Pack

Can contain harmful or toxic pigments, driers and other components as well as solvents. Spraying should be carried out only with adequate ventilation.

DESCRIPTION AND OPERATION

Two Pack

Can also contain harmful and toxic unreacted resins and resin hardening agents. The manufacturers instructions should be followed. See also Resin-based Adhesives and Isocyanate Adhesives and Sealers under Adhesives and Sealers.

Spraying should preferably be carried out in exhausted ventilated booths removing vapor and spray mists from the breathing zone. Individuals working in booths should wear appropriate respiratory protection. Those doing small-scale repair work in the open workshop should wear air-fed respirators.

Pressurized Equipment

See High Pressure Air, Lubrication and Oil Test Equipment.

Solder

Solders are mixtures of metals such that the melting point of the mixture is below that of the constituent metals (normally lead and tin). Solder application does not normally give rise to toxic lead fumes, provided a gas/air flame is used. Oxy-acetylene flames should not be used, as they are much hotter and will cause lead fumes to be produced.

Some fumes may be produced by the application of any flame to surfaces coated with grease, and inhalation of these should be avoided.

Removal of excess solder should be undertaken with care, to make sure that fine lead dust is not produced, which can give toxic effects if inhaled. Respiratory protection may be necessary.

Solder spillage and filings should be collected and removed promptly to prevent general air contamination by lead.

High standards of personal hygiene are necessary in order to avoid ingestion of lead or inhalation of solder dust from clothing.

Solvents

See also Chemical Materials, Fuels (Kerosene), Fire.

For example acetone, white spirit, toluene, xylene, trichloroethane.

Used in cleaning and dewaxing materials, paints, plastics, resins and thinners.

Some may be highly flammable or flammable.

Skin contact will degrease the skin and may result in irritation and dermatitis following repeated or prolonged contact. Some can be absorbed through the skin in toxic or harmful quantities.

Splashes in the eye may cause severe irritation and could lead to loss of vision.

Brief exposure of high concentrations of vapors or mists will cause eye and throat irritation, drowsiness, dizziness, headaches and, in the worst circumstances, unconsciousness.

Repeated or prolonged exposure to excessive but lower concentrations of vapors or mists, for which there might not be adequate warning indications, can cause more serious toxic or harmful effects.

Aspiration into the lungs, for example through vomiting, is the most serious consequence of swallowing.

Avoid splashes to the skin, eyes and clothing. Wear protective gloves, goggles and clothing if necessary.

Make sure there is good ventilation when in use, avoid breathing fumes, vapors and spray mists and keep containers tightly sealed. Do not use in confined spaces.

When spraying materials containing solvents, for example paints, adhesive, coatings, use extraction ventilation or personal respiratory protection in the absence of adequate general ventilation.

Do not apply heat or flame except under specific and detailed manufacturers instructions.

Sound Insulation

See Fibre Insulation, Foams.

Suspended Loads

CAUTION:Never improvise lifting tackle.

There is always a danger when loads are lifted or suspended. Never work under an unsupported, suspended or raised load, for example a suspended engine.

Always make sure that lifting equipment such as jacks, hoists, axle stands and slings are adequate and suitable for the job, in good condition and regularly maintained.

DESCRIPTION AND OPERATION

Transmission Brake Bands

See Asbestos.

Underseal

See Corrosion Protection.

Viton

In common with many other manufacturers vehicles, some components have O-rings, seals or gaskets, which contain a material known as `Viton'.

Viton is a fluoroelastomer, that is a synthetic rubber type material, which contains Fluorine. It is commonly used for O-rings, gaskets and seals of all types. Although Viton is the most well known fluoroelastomer, there are others, including Fluorel and Tecmoflon.

When used under design conditions fluoroelastomers are perfectly safe. If, however, they are exposed to temperatures in excess of 400°C, the material will not burn, but will decompose, and one of the products formed is hydrofluoric acid.

This acid is extremely corrosive and may be absorbed directly, through contact, into the general body system.

O-rings, seals or gaskets which have been exposed to very high temperatures will appear charred or as a black sticky substance.

DO NOT; under any circumstances touch them or the attached components.

Enquiries should be made to determine whether Viton or any other fluoroelastomer has been used in the affected O-ring, seal or gasket. If they are of natural rubber or nitrile there is no hazard. If in doubt, be cautious, as the material may be Viton or any fluoroelastomer.

If Viton or any other fluoroelastomers have been used, the affected area should be decontaminated before the commencement of work.

Disposable heavy duty plastic gloves should be worn at all times, and the affected area washed down using wire wool and a limewater (calcium hydroxide) solution to neutralize the acid before disposing of the decomposed Viton residue and final cleaning of the area. After use, the plastic gloves should be discarded carefully and safely.

Welding

See also Fire, Electric Shock, Gas Cylinders.

Welding processes include Resistance Welding (Spot Welding), Arc Welding and Gas Welding.

Resistance Welding

This process may cause particles of molten metal to be emitted at a high velocity, and the eyes and skin must be protected.

Arc Welding

This process emits a high level of ultra-violet radiation, which may cause arc-eye, and skin burns to the operator and to other persons nearby. Gas-shielded welding processes are particularly hazardous in this respect. Personal protection must be worn, and screens used to shield other people.

CONTACT LENS WEARERS ARE ADVISED TO REVERT TO ORDINARY SPECTACLES WHEN ARC WELDING as the arc spectrum is believed to emit microwaves which dry out the fluid between the lens and the eye. This may result in blindness when the lens is removed from the eye.

Metal spatter will also occur, and appropriate eye and skin protection is necessary.

The heat of the welding arc will produce fumes and gases from the metals being welded, the rods and from any applied coatings or contamination on the surfaces being worked on. These gases and fumes may be toxic and inhalation of these should be avoided. The use of extraction ventilation to remove the fumes from the working area may be necessary particularly in cases where the general ventilation is poor, or where considerable welding work is anticipated. In extreme cases or confined spaces where adequate ventilation cannot be provided, air-fed respirators may be necessary.

Gas Welding (and Cutting)

Oxy-acetylene torches may be used for welding and cutting, and special care must be taken to prevent leakage of these gases, with consequent risk of fire and explosion.

The process will produce metal spatter and eye and skin protection is necessary.

DESCRIPTION AND OPERATION

The flame is bright, and eye protection should be used, but the ultra-violet emission is much less than that from arc welding, and lighter filters may be used.

The process itself produces few toxic fumes, but such fumes and gases may be produced from coatings on the work, particularly during cutting away of damaged body parts, and inhalation of the fumes should be avoided.

In brazing, toxic fumes may be produced from the metals in the brazing rod, and a severe hazard may arise if brazing rods containing cadmium are used. In this event particular care must be taken to avoid inhalation of fumes and expert advice may be required.

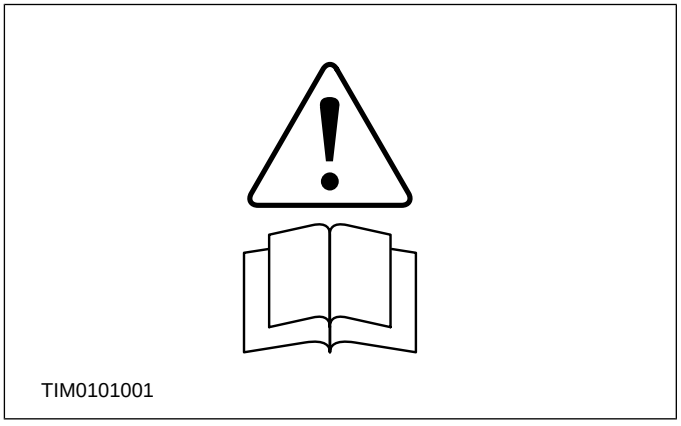
SPECIAL PRECAUTIONS MUST BE TAKEN BEFORE ANY WELDING OR CUTTING TAKES PLACE ON VESSELS, WHICH HAVE CONTAINED COMBUSTIBLE MATERIALS, FOR EXAMPLE BOILING OR STEAMING OUT OF FUEL TANKS.

Warning Symbols on Vehicles

Decals showing warning symbols will be found on various vehicle components.

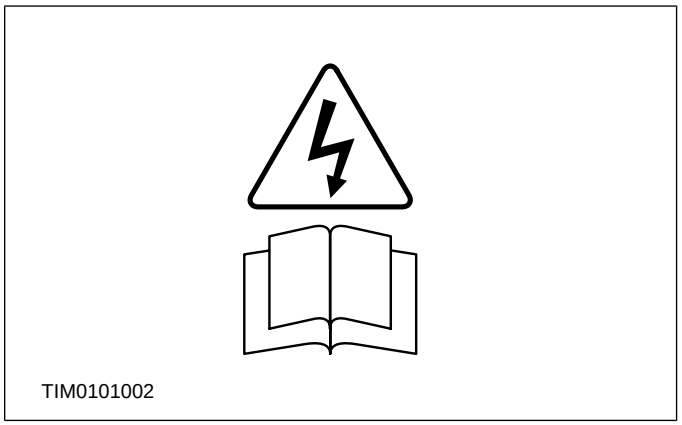
These decals must not be removed. The warnings are for the attention of owners/operators and persons carrying out service or repair operations on the vehicle.

The most commonly found decals are reproduced below together with an explanation of the warnings.



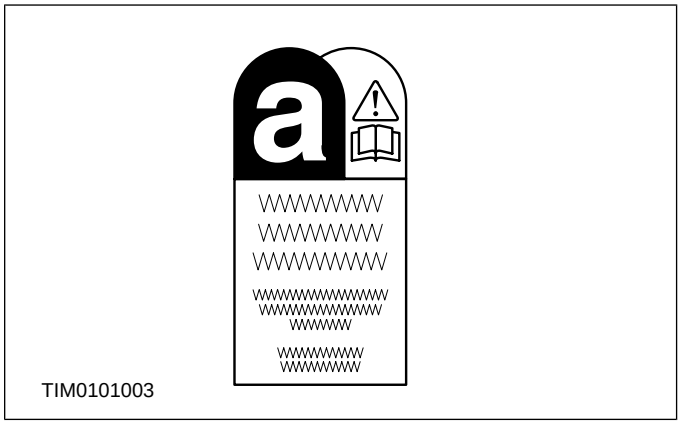
TIM0101001

1. Components or assemblies displaying the caution triangle and open book symbol advise consultation of the relevant section of the owner literature before touching or attempting adjustments of any kind.



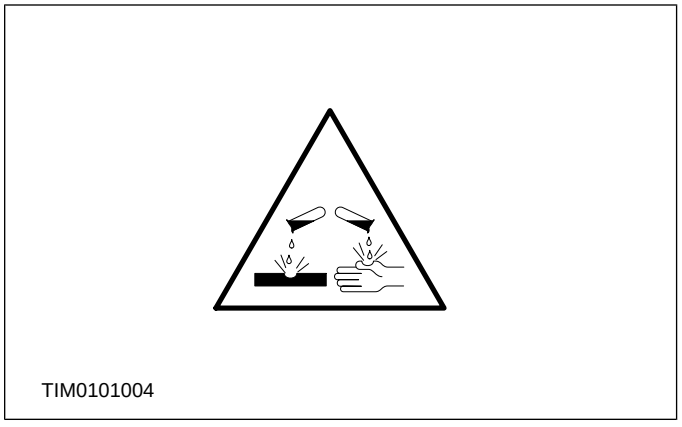
TIM0101002

2. Components or assemblies displaying the warning triangle with the `electrified' arrow and open book symbol give warning of inherent high voltages. Never touch these with the engine running or the ignition switched on. See Electric Shock in this subsection.



TIM0101003

3. Vehicles and replacement components which contain asbestos are identified by this symbol. See Asbestos in this subsection.



TIM0101004

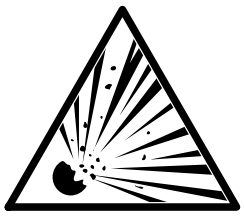
4. Components or assemblies displaying this symbol give warning that the component contains a corrosive substance. See Acids and Alkalis in this subsection.

DESCRIPTION AND OPERATION



TIM0101005

5. Displaying the caution circle with a deleted lighted match symbol, caution against the use of naked lights or flames within the immediate vicinity due to the presence of highly flammable or explosive liquids or vapors. See Fire in this subsection.



TIM0101006

6. Displaying this symbol (normally in conjunction with 5 above) warn of the presence of potentially explosive matter within the immediate vicinity.



TIM0101008

7. Displaying this symbol warn that children should not be allowed in the immediate vicinity unsupervised.

White Spirit

See Solvents.

DESCRIPTION AND OPERATION

Standard Workshop Practices

Vehicle in Workshop

When working on a vehicle in the workshop always make sure that:

- the parking brake is applied or the wheels are securely chocked to prevent the vehicle moving forwards or backwards.
- the key is removed from key operated hood locks before any work is carried out around the front of the vehicle.
- if the engine is to be run, there is adequate ventilation, or an extraction hose to remove exhaust fumes.
- there is adequate room to raise the vehicle and remove the wheels, if necessary.
- fender covers are always fitted if any work is to be carried out in the engine compartment.
- the battery is disconnected if working on the engine, underneath the vehicle, or if the vehicle is raised.

CAUTION:When electric arc welding on a vehicle, always disconnect the generator wiring to prevent the possibility of a surge of current causing damage to the internal components of the generator.

- if using welding equipment on the vehicle, a suitable fire extinguisher is readily available.

Alternative Fuel

WARNING:When servicing the fuel system always follow the recommended procedures. Failure to follow these instructions may result in personal injury.

If the odor of liquefied petroleum gas (LPG) or compressed natural gas (CNG) is present in the air in the workshop, warn all persons in the area to:

- extinguish all flames and lighted tobacco.
- shut off electrical and air powered equipment.
- evacuate the area.
- ventilate the area.
- contact the fire control authorities.
- remove the vehicle to a dedicated, ventilated area.

Alternative Fuel — Do's

- Do work on the vehicle in a designated area, that is well ventilated and with access restricted to qualified personnel only.
- Install new warning labels to their original locations.
- If possible always isolate the alternative fuel tank, and run the vehicle on the alternative fuel until it automatically switches to its normal fuel prior to taking the vehicle into the workshop service area.
- Only use tested and approved components and pipes when repairing or servicing LPG and CNG systems.

Alternative Fuel — Do Nots

- Do not vent off LPG fuel.
- Do not use shop air pressure to force LPG fuel from the fuel tank.
- Do not use paint drying ovens above 40°C for any alternative fuel vehicle. LPG and CNG fuel tanks must be removed from the vehicle prior to being put into paint drying ovens above 40°C.
- Do not modify the system or install new components that are not designed for gas vehicles.
- Do not evacuate fuel tanks unless there is repair that requires the removal of the fuel tank.
- Do not work on the fuel lines or system components unless the alternative fuel has been evacuated and the pressure in the system reduced to atmospheric or less.
- Do not use anything other than the specified leak detector fluid to trace fuel leaks.

Be aware of situations that may cause the LPG or CNG fuel system to vent off fuel, such as:

- extremely hot days.
- parking by a space heater.
- hoisting a vehicle up near a ceiling heater.

Only fully trained personnel, who are conversant with local standards, are to work on alternative fuel vehicles.

DESCRIPTION AND OPERATION

Towing the Vehicle

WARNING:When the vehicle is being towed, the ignition switch must be in position II (steering lock released and warning lamps illuminated). Only then will the steering, turn signal lamps, horn and stop lamps be operational. Failure to follow these instructions may result in personal injury.

NOTE: The removable towing eye (if equipped), has a left-hand thread and must be fully tightened before towing can commence.

When towing is necessary, the vehicle towing eyes should be used. The rope must be securely fastened to the towing eyes and must also be attached to the other vehicle such that the rope will not foul the bodywork.

When a vehicle with automatic transmission is towed, the gear selector must be in position N (Neutral). Never tow a vehicle with automatic transmission at a speed greater than 30 mph (50 km/h) or for a distance greater than 30 miles (50 km). If it is necessary to tow the vehicle a greater distance, the drive wheels must be lifted clear off the ground.

Alternatively the vehicle can be transported on a low loader or a trailer.

Connecting a Slave Battery Using Jumper Cables

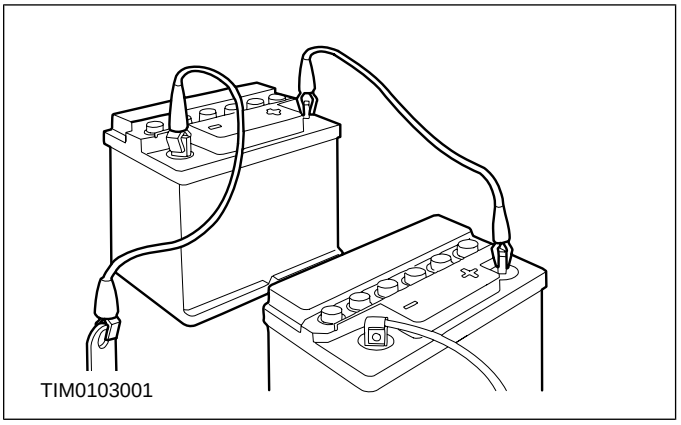
WARNING:If the slave battery has recently been charged and is gassing, cover the vent plugs or covers with a damp cloth to reduce the risk of explosion should arcing occur when connecting the jumper cables. Failure to follow these instructions may result in personal injury.

CAUTIONS:

A discharged battery condition may have been caused by an electrical short circuit. If this condition exists there will be an apparently live circuit on the vehicle even when all normal circuits are switched off. This can cause arcing when the jumper cables are connected.

While it is not recommended that the vehicle is jump started, it is recognized that this may occasionally be the only practical way to mobilize a vehicle. In such an instance, the discharged battery must be recharged immediately after jump starting to avoid permanent damage.

- Always make sure that the jumper cables are adequate for the task. Heavy duty cables must be used.
- Always make sure that the slave battery is of the same voltage as the vehicle battery. The batteries must be connected in parallel.
- Always make sure that switched electric circuits are switched off before connecting jumper cables. This reduces the risk of arcing occurring when the final connection is made.


TIM0103001

WARNING:Make sure that the ends of the jumper cables do not touch each other or ground against the vehicle body at any time while the cables are attached to the battery. A fully charged battery, if shorted through jumper cables, can discharge at a rate well above 1000 amps causing violent arcing and very rapid heating of the jumper cables and terminals, and can even cause the battery to explode. Failure to follow these instructions may result in personal injury.

Always connect the jumper cables in the following sequence:

- Slave battery positive first and then vehicle battery positive.
- Slave battery negative next and then vehicle ground at least 12 inches (300 mm) from the battery terminal, for example engine lifting eye.

Always reduce the engine speed to idle before disconnecting the jumper cables.

Before removing the jumper cables from the vehicle that had the discharged battery, switch on the heater blower (high) or the heated rear window, to reduce the voltage peak when the cables are removed.

DESCRIPTION AND OPERATION

Always disconnect the jumper cables in the reverse order to the connecting sequence and do not short the ends of the cables.

Do not rely on the generator to restore a discharged battery. For a generator to recharge a battery, it would take in excess of eight hours continuous driving with no additional loads placed on the battery.

Component Cleaning

To prevent the ingress of dirt, accumulations of loose dirt and greasy deposits should be removed before disconnecting or dismantling components or assemblies.

Components should be thoroughly cleaned before inspection prior to reassembly.

Cleaning Methods:

- Dry cleaning.
- Removal of loose dirt with soft or cable brushes.
- Scraping dirt off with a piece of metal or wood.
- Wiping off with a rag.

WARNING:Wear eye protection when cleaning vehicle components with compressed air, a steam cleaner or a power washer. Failure to follow this instruction may result in personal injury.

CAUTIONS:

Compressed air is sometimes 'wet' so use with caution, especially on hydraulic systems.

To prevent damage to the electrical connectors in the engine compartment, do not use a steam cleaner or a power washer to clean the engine compartment.

- Blowing dirt off with compressed air.
- Removal of dry dust using vacuum equipment. This method must always be used to remove friction lining material dust (asbestos particles).
- Steam cleaning.

WARNING:Most solvents require careful handling and some are harmful. Refer to Health and Safety Precautions and to the manufacturers literature for the relevant safety precautions. Failure to follow these instructions may result in personal injury.

Various solvents are available which are suitable for component cleaning. Some components, such as brake hydraulic parts and electrical assemblies should be cleaned only with recommended solvents — refer to Solvents, Sealers and Adhesives or to the section of the manual relevant to the component.

Calibration of Essential Measuring Equipment

WARNING:Equipment, which requires regular calibration, must be calibrated in accordance with the manufacturers instructions. Failure to follow this instruction may result in personal injury or damage to components.

It is of fundamental importance that certain essential equipment, for example torque wrenches, multimeters, exhaust gas analyzers or rolling roads, are regularly calibrated in accordance with the manufacturers instructions.

DESCRIPTION AND OPERATION

Solvents, Sealants and Adhesives

Introduction

WARNING:Always handle all solvents, sealers and adhesives with extreme care. Some contain chemicals or give off fumes which can be dangerous to health. Always follow the manufacturers instructions. If in doubt about any substance, particularly a solvent, DO NOT use it.

CAUTION:If in doubt about the suitability of any proprietary solvent or sealer for a particular application, contact the manufacturer of the product for information regarding storage, handling and application.

The Health and Safety Precautions subsection refers to some commonly used chemicals and materials, hazards associated with their use, and safety measures to be taken.

DESCRIPTION AND OPERATION

Road/Roller Testing

Road or roller testing may be carried out for various reasons and a procedure detailing pre-test checks, engine starting and stopping, pre-driving checks, on-test checks and final checks to be completed on completion of the test is given below.

Unless complete vehicle performance is being checked, the full road test procedure need not be carried out. Instead, those items particularly relevant to the system(s) being checked can be extracted.

Pre-Test Checks

WARNING:If the brake system hydraulic fluid level is low, pedal travel is excessive or a hydraulic leak is found, do not attempt to road test the vehicle until the reason for the low fluid level, excessive pedal travel or hydraulic leak is found and rectified.

It is suggested that pre-test checks and functional tests of those systems and circuits which affect the safe and legal operations of the vehicle, such as brakes, lights and steering, should always be carried out before the road or roller test.

With the ignition switched off, check:

- the engine oil level.
- the engine coolant level.
- the tires, for correct pressure, compatible types and tread patterns, and wear within limits.
- that there is sufficient fuel in the tank to complete the test.
- all around the engine, transmission and under the vehicle for oil, coolant, hydraulic and fuel leaks. Make a note of any apparent leaks and wipe off the surrounding areas to make it easier to identify the extent of the leak on completion of the test.

Starting the Engine

NOTE: On initial drive away from cold and within the first 1.5 km (1 mile), do not depress the accelerator pedal beyond half travel until the vehicle has attained a minimum speed of 25 km/h (15 miles/h). Never operate at high engine speed or with the accelerator pedal at full travel whilst the engine is cold.

With the ignition switched off, check:

- that the parking brake is applied.
- that the gear lever is in the neutral position.
- that all instrument gauges (except fuel gauge) read zero.

With the ignition switched on, check:

- that the ignition controlled warning lamps are illuminated.
- that the engine temperature gauge registers a reading compatible with the engine temperature.
- that the fuel gauge registers a reading appropriate to the fuel level in the tank.
- the operation of the parking brake warning lamp and fluid level warning indicator.

Road or Roller Testing

CAUTION:If road testing, check the brake operation while still traveling at low speed before continuing with the test. If the brakes pull to one side, or appear to be otherwise faulty, do not continue with the road test until the fault has been found and rectified.

During the road or roller test, check:

- that the clutch pedal operation is not stiff or heavy.
- that the initial gear engagement is smooth and there is no evidence of clutch drag.
- that the parking brake control operates smoothly and releases quickly and completely.
- that the clutch takes up the drive smoothly, without slip or judder.
- that gear changing is smooth with no abnormal noises or vibrations from the transmission.
- the engine power output is satisfactory, full power is achieved, acceleration is smooth and pedal operation is not stiff or heavy, and engine speed returns to idle correctly.
- there is no excessive or abnormally colored smoke from the engine under normal driving, heavy load or overrun conditions.
- that steering operation, including power steering (if equipped), is smooth, accurate, not excessively heavy or with excessive free play or vibration.
- that the steering does not pull to one side and self centers smoothly after cornering.

DESCRIPTION AND OPERATION

- that the speedometer, coolant temperature gauge and tachometer (if equipped) register the correct readings and operate correctly.
- that the switches and controls operate smoothly and positively, warning and indicator lamps operate correctly and the direction indicator control self cancels when the steering is returned to the straight ahead position.
- that the heating and ventilation systems operate correctly and effectively.
- the brake operation and efficiency.

Brake Testing

WARNING:When brake testing, avoid breathing the fumes from hot brakes, this may contain asbestos dust which is hazardous to health. Failure to follow this instruction may result in personal injury.

For additional information, refer to:Health and Safety Precautions (100-00 General Information, Description and Operation).

CAUTIONS:

Avoid brake testing on busy roads where it may cause inconvenience or danger to other road users.

Brake testing which includes heavy brake applications should not be carried out with new brake pads/discs or linings/drums until the components have bedded-in. New brake friction components will not reach full efficiency until the bedding-in process is complete.

Test the brakes at several speeds within the normal operating range using both light and heavy pedal pressure. Note any tendency to snatch, pull or drag, and any undue delay in application or release.

Allow the vehicle to coast and note any tendency to pull to one side, or evidence that the brakes are binding.

After stopping the vehicle (not immediately after a period of heavy braking), carefully check the brake temperature. A brake disc or brake drum that feels hot or is appreciably hotter than the others, indicates that the brake is binding.

After completion of the test, check for:

- oil, coolant, hydraulic, air and fuel leaks.
- abnormal temperature of any moving components or assemblies, for example wheel hubs, transmission and axle, which might indicate over tightness or lack of lubrication.

DESCRIPTION AND OPERATION

Battery and Battery Charging Health and Safety Precautions

WARNINGS:

Batteries contain sulphuric acid, avoid contact with skin, eyes or clothing. Wear safety goggles when working near the battery to protect against possible splashing of the acid solution. In cases of acid contact with the skin or eyes, flush immediately with water for a minimum of 15 minutes and seek prompt medical attention. If swallowed, seek immediate medical attention.

Batteries normally produce explosive gases. Do not allow naked flames, sparks or lighted substances to come near the battery.

When charging the battery shield your face and wear safety goggles. Provide adequate ventilation.

CAUTION:Boost charging with excessive current or voltage above 16 volts will damage the battery.

DESCRIPTION AND OPERATION

Engine Cooling System Health and Safety Precautions

WARNINGS:

Extreme care must be exercised when handling hot fluids. Always wash off spilled fluids from exposed skin immediately.

Vapors may be given off from antifreeze when heated. Avoid breathing these vapors.

Antifreeze may be absorbed through the skin in toxic or harmful quantities. If taken internally, drink water and induce vomiting. Seek medical attention immediately.

Antifreeze must not be used in any cooling or industrial water system that is connected or linked to general water supplies.

DESCRIPTION AND OPERATION

Petrol Fuel System Health and Safety Precautions

WARNINGS:

Extreme care must be exercised when handling hot fluids. Always wash off spilled fluids from exposed skin immediately.

Highly flammable mixtures are always present and may ignite when working on fuel systems. Do not allow naked flames, sparks or lighted substances to come near fuel related components.

There may not be adequate warning of odor or of irritation before toxic or harmful effects arise. These may be immediate or delayed.

Swallowing can result in mouth and throat irritation and absorption from the stomach can result in drowsiness and unconsciousness. Small amounts can be fatal to children. Aspiration of liquid into the lungs, through vomiting, is a very serious hazard.

Gasoline dries the skin and can cause irritation and dermatitis on prolonged or repeated contact. Liquid in the eye causes severe smarting.

Motor gasoline may contain appreciable quantities of benzene, which is toxic upon inhalation, and the concentration of gasoline vapors must be kept very low. High concentrations will cause eye, nose and throat irritation, nausea, headache, depression and symptoms of drunkenness. Very high concentrations will result in rapid loss of consciousness.

Make sure there is adequate ventilation when handling and using gasoline. Great care must be taken to avoid the serious consequences of inhalation in the event of vapor build up arising from spillages in confined spaces.

Special procedures apply to cleaning and maintenance operations on gasoline storage tanks.

Gasoline should not be used as a cleaning agent. It must not be siphoned by mouth. See First Aid.

CAUTIONS:

Fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is essential that absolute cleanliness is observed when working with these components.

Make sure that the workshop area in which the vehicle is being worked on is as clean and as dust free as possible.

DESCRIPTION AND OPERATION

Diesel Fuel System Health and Safety Precautions

WARNINGS:

Extreme care must be exercised when handling hot fluids. Always wash off spilled fluids from exposed skin immediately.

Combustible.

Gross or prolonged skin contact with high boiling point gas oils may also cause serious skin disorders including skin cancer.

CAUTIONS:

Fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is essential that absolute cleanliness is observed when working with these components.

Make sure that the workshop area in which the vehicle is being worked on is as clean and as dust free as possible.

NOTE: Soot, discomfort and irritation usually give adequate warning of hazardous fume concentrations.

DESCRIPTION AND OPERATION

Air Conditioning (A/C) System Health and Safety Precautions

WARNINGS:

Only qualified technicians are allowed to work on air conditioning (A/C) systems.

Air conditioning (A/C) system components can become particularly hot or cold.

When handling refrigerants, always wear protective goggles and gloves made of fluoroelastomer. Leather or fabric gloves are not suitable.

Make sure that the air conditioning (A/C) system is at ambient temperature before carrying out any repair.

If liquid refrigerant comes into contact with the skin, it produces severe frostbite. Immediately rinse the affected areas with water for 15 minutes. Seek medical attention.

If refrigerant comes into contact with the eyes, immediately rinse the eyes with plenty of water for 15 minutes. Seek medical attention.

If refrigerant comes into contact with naked flames or hot surfaces, it produces toxic gases (fluorine and phosgene). The toxic gases formed are readily recognizable by their pungent smell at tiny concentrations.

Refrigerant is flammable and explosive.

Make sure that the local regulations regarding work on air conditioning (A/C) systems are adhered to.

Make sure that refrigerant bottles are not exposed to temperatures greater than 45°C.

Make sure that refrigerant bottles are closed properly.

Toxic gases generated when refrigerant is heated are hazardous to health. The gases have an irritating smell and can cause lung damage. The symptoms can continue for a long time after having been in contact with the gases. The gases can cause lung damage even if the amount of gas in the air is too small to smell.

Gaseous refrigerant has a higher density than air. There is a danger of suffocation when working close to the ground or in workshop pits.

Provide adequate ventilation when handling refrigerant.

Never release refrigerant into the atmosphere.

Only use special tools, equipment and lubricants that are approved for the type of refrigerant being used.

The pressurized container in the servicing unit must never be over-filled. The refrigerant must have sufficient room to expand if the temperature rises.

Always follow the manufacturer's instructions for the correct servicing unit operating procedure.

CAUTIONS:

Do not mix refrigerant oils for different types of refrigerant.

Never mix different types of refrigerant or equipment intended for them.

Only use refrigerant in gas form when filling the system through the low-pressure connection.

Only use refrigerant in liquid form when filling the system through the high-pressure connection.

Refrigerant attacks certain plastics. Only use seals suitable for refrigerant.

If the air conditioning (A/C) compressor is damaged, the fixed orifice tube can become blocked with metal particles.

Any sort of blockage in the refrigerant circuit will damage the air conditioning (A/C) compressor irreparably.

If the air conditioning (A/C) system has been opened for a period greater than 2 hours, a new receiver drier must be installed and the evacuating time to be increased by a minimum of 2 hours.

NOTE: New air conditioning (A/C) compressors are delivered prefilled.

NOTE: Refrigerant oil in new air conditioning (A/C) compressors can contain Teflon, visible as white particles, which will not harm the system.

DESCRIPTION AND OPERATION

Supplemental Restraint System (SRS) Health and Safety Precautions

WARNINGS:

Undeployed pyrotechnic supplemental restraint system (SRS) components must not be deployed in the vehicle.

Never carry out any electrical measurement on disconnected, undeployed supplemental restraint system (SRS) pyrotechnic components.

Pyrotechnic components must not be disassembled.

Pyrotechnic components are not interchangeable between vehicles.

Always carry a live air bag module away from the body with the air bag or trim cover pointing upwards.

Live air bag modules must be placed in a suitable cage when removed from the vehicle. The air bag or trim cover must be facing upwards.

CAUTIONS:

Supplemental restraint system (SRS) components must not be subjected to temperatures higher than 110°C.

Never install aftermarket accessories to the vehicle on or adjacent to the supplemental restraint system (SRS) module.

DESCRIPTION AND OPERATION

Brake System Health and Safety Precautions

WARNING:Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid comes into contact with the eyes, flush the eyes with cold running water for 15 minutes. Seek medical attention if irritation persists. If taken internally, drink water and induce vomiting. Seek medical attention immediately.

CAUTION:If brake fluid is spilled on the paintwork, the affected area must be immediately washed down with cold water.

SECTION 100-01 Identification Codes

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Identification Codes..... 100-01-2
Vehicle Identification Number..... 100-01-3
Vehicle Certification Label (Typical) or VIN Plate..... 100-01-6

DESCRIPTION AND OPERATION

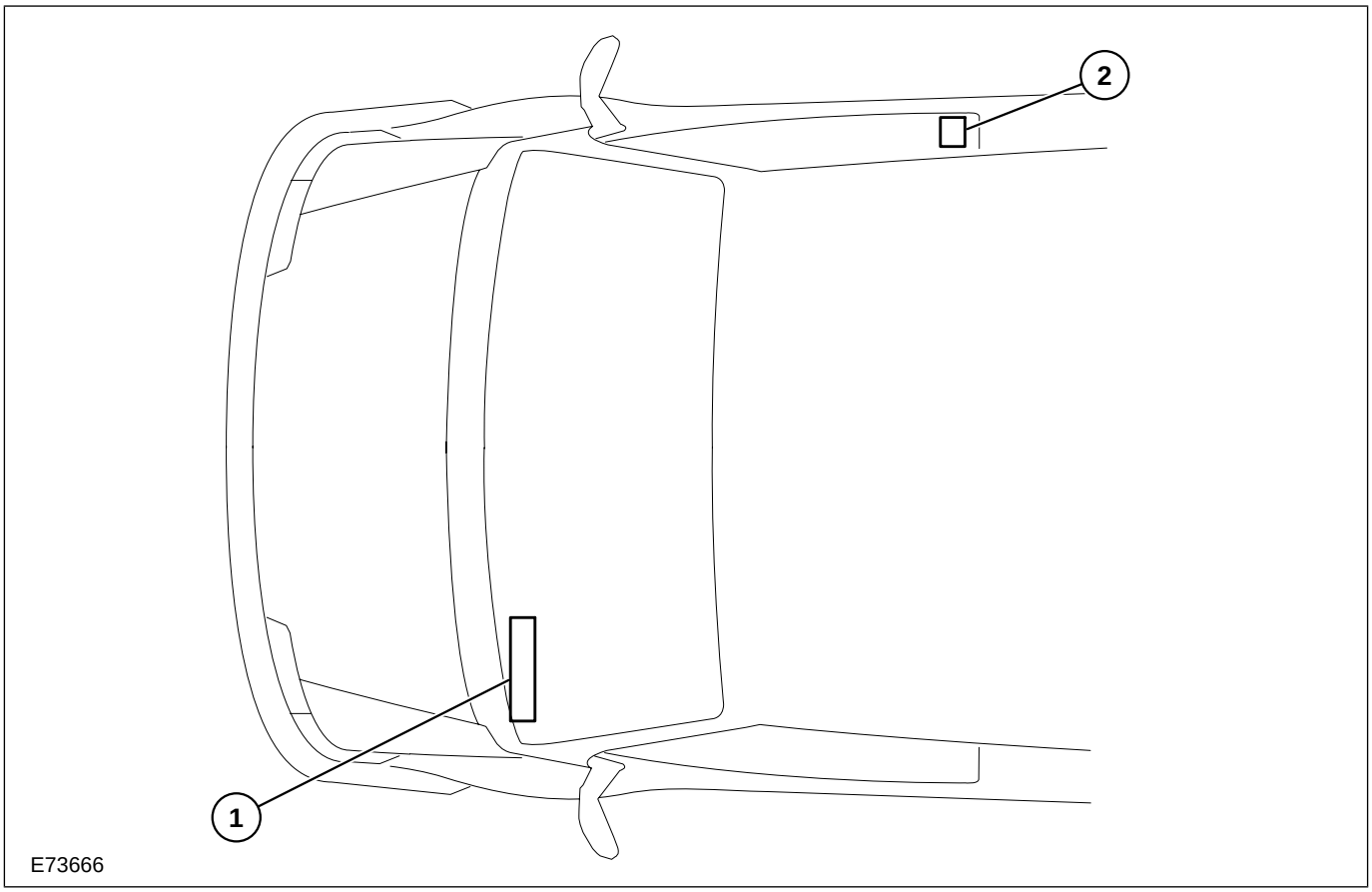
Identification Codes

NOTE: The vehicle identification number (VIN) can be identified by an asterisk (*) at its start and finish.

The VIN for registration purposes is stamped onto the body on the front right-hand side wheel arch.

The VIN is also stamped on the VIN plate. The VIN plate is located on the passenger side B-pillar.

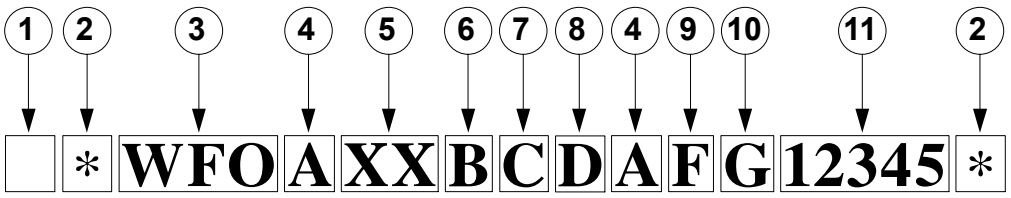
The visible VIN (label) is located on the instrument panel close to the windshield glass on the left-hand side of the vehicle and is visible from the outside.



Item	Description
1	Visible VIN
2	VIN plate

DESCRIPTION AND OPERATION

Vehicle Identification Number



E0013277

Item	Description
1	VIN Position 1 — Not Used
2	VIN Position 2 and 20 — Constant *
3	VIN Position 3, 4 and 5 — World Manufacturer Identifier
4	VIN Position 6 and 12 — Model Variant
5	VIN Position 7 and 8 — Constant XX
6	VIN Position 9 — Product Source Company
7	VIN Position 10 — Assembly Plant

Item	Description
8	VIN Position 11 — Model range
9	VIN Position 13 — Year of Manufacture
10	VIN Position 14 — Month of Manufacture
11	VIN Position 15-19 — Vehicle Sequence Number

Item 1 - VIN Position 1

Not used.

Item 2 - VIN Positions 2 and 20

Constant *.

Item 3 - VIN Position 3, 4 and 5 — World Manufacturer Identifier

Code	World Manufacturer
WF0	Ford Werke AG Germany

Item 4 - VIN Position 6 and 12 — Model Variant

Code	Model Variant
B	Bus (M1)
D	Bus (M2)

DESCRIPTION AND OPERATION

Code	Model Variant
F	Chassis single cab
N	Chassis double cab
S	Kombi (M1)
X	Van
Z	Kombi Van — (M1)
1	Kombi (N1) — Turkey only
3	Kombi Van (N1) — Turkey only

Item 5 - VIN Positions 7 and 8

Constant X.

Item 6 - VIN Positions 9 — Product Source Company

Code	Product Source Company
B	Ford of Britain own assembly
C	Ford of Britain affiliated company assembly
D	Ford of Britain dealer assembly
E	Ford of Germany affiliated company assembly
F	Ford of Germany dealer assembly
G	Ford of Germany own assembly
H	Knock down assembly
T	Turkey

Item 7 - VIN Position 10 — Assembly Plant

Code	Assembly Plant
B	Genk
D	Southampton
G	Poland
J	Istanbul
P	Portugal
T	Izmit

Item 8 - VIN Position 11 — Model Range

Code	Model Range
F	Transit

Item 9 - VIN Position 13 — Year of Manufacture

Code	Year of Manufacture
6	2006
7	2007

DESCRIPTION AND OPERATION

Code	Year of Manufacture
8	2008
9	2009
A	2010

Item 10 - VIN Position 14 — Month of Manufacture

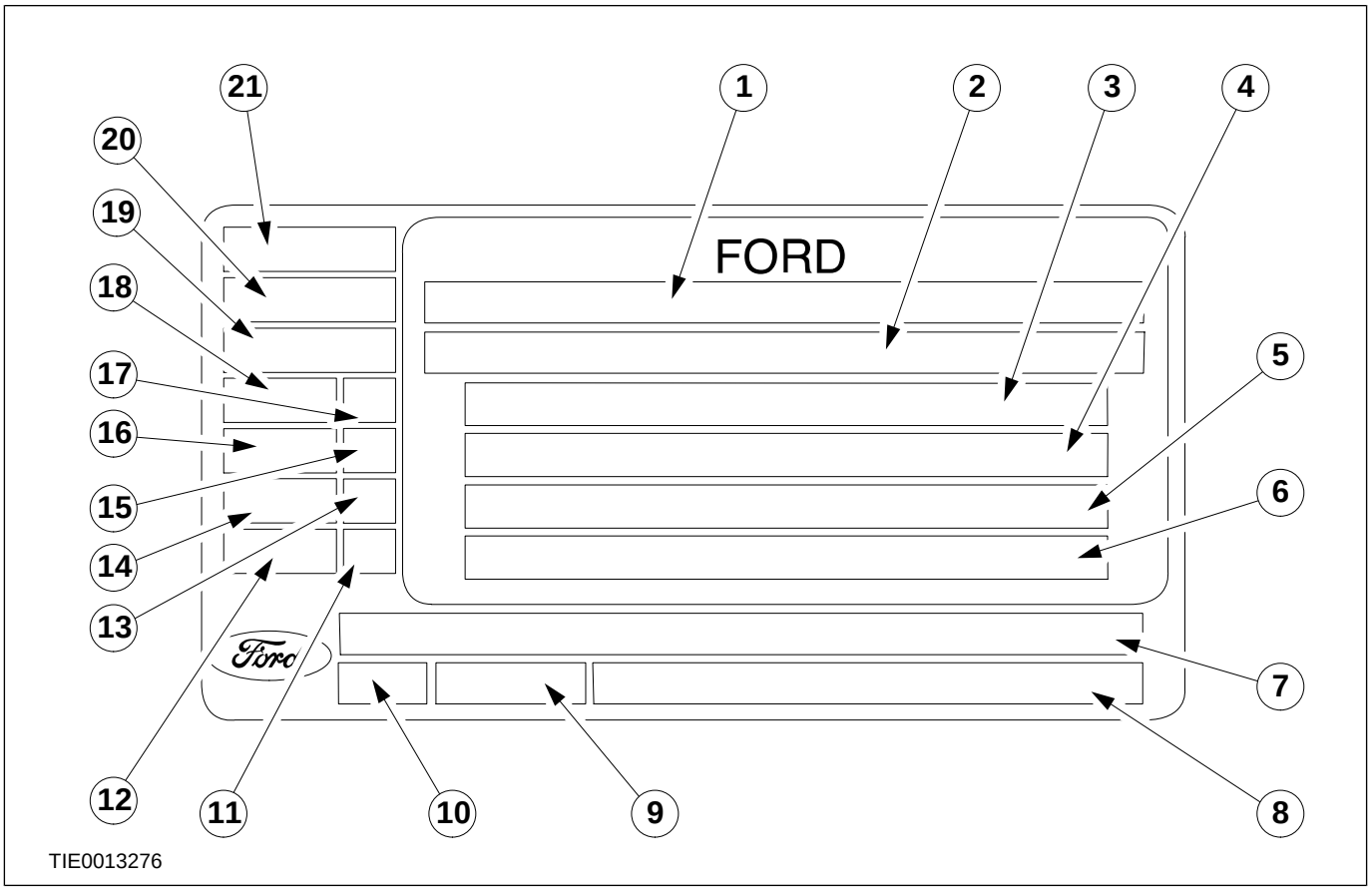
Month	2006	2007	2008	2009	2010
January	L	C	B	J	L
February	Y	K	R	U	Y
March	S	D	A	M	S
April	T	E	G	P	T
May	J	L	C	B	J
June	U	Y	K	R	U
July	M	S	D	A	M
August	P	T	E	G	P
September	B	J	L	C	B
October	R	U	Y	K	R
November	A	M	S	D	A
December	G	P	T	E	G

Item 11 - VIN Position 15 to 19 — Vehicle Sequence Number

Five digit number.

DESCRIPTION AND OPERATION

Vehicle Certification Label (Typical) or VIN Plate



Item	Part Number	Description
1	-	Type approval code
2	-	Vehicle identification number (VIN)
3	-	Gross vehicle mass (GVM)
4	-	Gross train mass (GTM)
5	-	Maximum permissible front axle mass
6	-	Maximum permissible rear axle mass
7	-	Vehicle dimensions
8	-	Model type codes
9	-	Wheelbase
10	-	Rear axle/axle ratio
11	-	Used by SVO only
12	-	Transmission identification
13	-	Door combination
14	-	Suspension

Item	Part Number	Description
15	-	Hand of drive
16	-	Body color codes
17	-	Brakes
18	-	Interior trim codes
19	-	Smoke values
20	-	Engine type codes
21		Blank

Item 1: Type Approval Code

A unique code required by legislation in certain territories.

Item 2: Vehicle Identification Number (VIN)

Vehicle identification number.

DESCRIPTION AND OPERATION

Item 3: Gross Vehicle Mass

Indicates maximum legal laden mass, in territories where this is required.

Item 4: Gross Train Mass

Indicates the maximum combined mass of vehicle and trailer or caravan.

Item 5: Maximum Permissible Front Axle Mass

Maximum permissible loading on the front wheels of the vehicle.

Item 6: Maximum Permissible Rear Axle Mass

Maximum permissible loading on the rear wheels of the vehicle.

Item 7: Vehicle Dimensions

Dimensions of the vehicle in mm.

Item 8: Model Type Codes

Model type code usage.

Digit 1 - Vehicle

Digit 1	Vehicle
F	Transit

Digit 2 - Body

Digit 2	Body
A	Van (N1/N2)
B	Passenger car (Bus M1)
C	Bus (M2)
D	Passenger car (Kombi M1)
M	Chassis single cab (N1/N2)
N	Chassis double cab (N1/N2)
S	Passenger car (Kombi van M1)
Z	Passenger car (Kombi special M1)

Digit 3 - Wheelbase/Drive

Digit 3	Wheelbase/Drive
A	Short wheelbase 2933/3137 mm rear wheel drive
B	Medium wheelbase 3300/3504 mm rear wheel drive
C	Long wheelbase 3750/3954 mm rear wheel drive
D	Long wheelbase 3750/3954 mm rear wheel drive extended frame
E	Short wheelbase 2933/3137 mm front wheel drive
F	Medium wheelbase 3300/3504 mm front wheel drive
G	Long wheelbase 3750/3954 mm front wheel drive
H	Long wheelbase 3750/3954 mm front wheel drive extended frame

DESCRIPTION AND OPERATION

Digit 4 - Model Year

Digit 4	Model Year
6	2006.5

Digits 5 to 8 - Engine Variant

Digits 5 to 8	Engine variant
G Z F A	Engine code north - south
G Z F B	Engine code north - south
H F F A	Engine code north - south
H 9 F B	Engine code north - south
J X F A	Engine code north - south
P H F A	Engine code north - south
P 8 F A	Engine code east - west
Q V F A	Engine code east - west
Q W F A	Engine code east - west
Q W F B	Engine code east - west
R B F A	Engine code north - south
R C F A	Engine code north - south

Digit 9 - Steered Axle

Digit 9	Steered axle
1	-
2	-

Digit 10

Not used.

Digit 11 - Variant and Digit 17 - Gross Vehicle Mass in Kg

Digit 11		Digit 17			
		A	B	C	D
A	260 Short wheelbase	2600	2400	2000	2350
B	280 Short wheelbase	2800	2500	3000	–
C	300 Short wheelbase	3000	–	–	–
D	330 Medium wheelbase	3300	–	–	–
E	350 Medium wheelbase Single rear wheel	3500	3550	3490	3850
F	350 Medium wheelbase Twin rear wheel	3500	3550	3490	3850
G	430 Medium wheelbase Twin rear wheel	4250	3490	3550	4100

DESCRIPTION AND OPERATION

Digit 11		Digit 17			
		A	B	C	D
H	350 Long wheelbase Single rear wheel, High front axle	3500	3550	3490	3850
J	350 Long wheelbase Twin rear wheel, High front axle	3500	3550	3490	3850
K	430 Long wheelbase Twin rear wheel, High front axle	4250	3490	3550	4100
L	350 Long wheelbase Single rear wheel, High rear axle	3500	3550	3490	3850
M	350 Long wheelbase Twin rear wheel, High front axle, High rear axle	3500	3550	3490	3850

Digit 11 - Variant and Digit 17 - Gross Vehicle Mass in Kg (continued)

Digit 10		Digit 11				
		E	F	G	H	J
A	260 Short wheelbase	2500	–	–	–	–
B	280 Short wheelbase	–	–	–	–	–
C	300 Short wheelbase	–	–	–	–	–
D	330 Short wheelbase	–	–	–	–	–
E	350 Medium wheelbase Single rear wheel	–	–	–	–	–
F	350 Medium wheelbase Twin rear wheel	–	–	–	–	–
G	430 Medium wheelbase Twin rear wheel	3500	3850	–	–	–
H	350 Long wheelbase Single rear wheel, High front axle	–	–	–	–	–
J	350 Long wheelbase Twin rear wheel, High front axle	–	–	–	–	–
K	430 Long wheelbase Twin rear wheel, High front axle	3500	3850	–	–	–
L	350 Long wheelbase Single rear wheel, High rear axle	–	–	–	–	–
M	350 Long wheelbase Twin rear wheel, High front axle, High rear axle	–	–	–	–	–

Digit 12 - Seats

Digit 12	Description
1 – 9	Maximum number of seats M1/N1/M2/N2 vehicles
A	11 seats maximum M2 vehicles

DESCRIPTION AND OPERATION

Digit 12	Description
B	12 seats maximum M2 vehicles
C	13 seats maximum M2 vehicles
D	14 seats maximum M2 vehicles
E	15 seats maximum M2 vehicles
F	16 seats maximum M2 vehicles
G	18 seats maximum M2 vehicles

Digit 13 - Transmission

Digit 13	Description
A	5-speed manual transmission (VXT75)
B	5-speed manual transmission (MT75)
C	6-Speed Manual Transmission (MT82)

Digit 14 - Final Drive

Digit 14	Ratio
A	4.23
B	4.54
C	3.73
D	4.27
E	4.78
F	5.11
G	5.44
H	5.88
J	4.23 with reduced GTM
K	4.54 with reduced GTM
L	3.73 with reduced GTM
M	4.27 with reduced GTM

Digit 15

Not used.

Digit 16

Not used.

Item 9: Wheelbase

Wheelbase
Measured in mm

DESCRIPTION AND OPERATION

Item 10: Rear Axle/Axle Ratio

Code	Ratio
A	T51 /5.44 rear wheel drive
B	T51 /5.88 rear wheel drive
C	T53 /3.73 rear wheel drive
D	T53 4.27 rear wheel drive
E	T53/4.78 rear wheel drive
F	T53/5.11 rear wheel drive
G	T53/5.44 rear wheel drive
H	T53 /5.88 rear wheel drive
T	4.23 front wheel drive
U	4.54 front wheel drive
W	T51 /3.73 rear wheel drive
X	T51 /4.27 rear wheel drive
Y	T51 /4.78 rear wheel drive
Z	T51 /5.11 rear wheel drive

Item 11

Used by SVO only.

Item 12: Transmission/Transaxle Identification

Code	Transmission
M6	6-speed manual transmission (MT82) (5.44)
V2	5-speed manual transmission (VXT75) (3.80)
W2	5-speed manual transmission (MT75) (4.20)

Item 13: Door Combination

Code	Roof			Front Doors Hinged	Side Loading Doors		
	Low	Mid	High		LH sliding	RH sliding	RH sliding LH sliding
A	x			x			
B	x			x			
C		x		x			

DESCRIPTION AND OPERATION

Code	Roof			Front Doors Hinged	Side Loading Doors		
	Low	Mid	High		LH sliding	RH sliding	RH sliding LH sliding
D	x			x	x		
E	x			x	x		
F		x		x	x		
G	x			x		x	
H	x			x		x	
J		x		x		x	
K	x			x			x
L	x			x			x
M		x		x			x
N			x	x	x		
P			x	x		x	
Q			x	x			x

Item 13: Door Combination (continued)

Code	Rear Loading Doors			
	Double Hinged Low	Double Hinged Medium	Tailgate	Double Hinged High
A	x			
B			x	
C		x		
D	x			
E			x	
F		x		
G	x			
H			x	
J		x		
K	x			
L			x	
M		x		
N				x
P				x
Q				x

DESCRIPTION AND OPERATION

Item 14: Suspension

Code	Rear Springs and Shock Absorber
AA	Standard
1L	Heavy duty suspension
B1	Soft ride suspension
03	High center of gravity vehicle
B3	Soft ride suspension and high center of gravity vehicle

Item 15: Hand of Drive

Code	Drive
L	Left-hand drive
R	Right-hand drive

Item 16: Body Color Codes

Code	Body Color
BD	Safron yellow
EC	Pepper red
KD	Dark blue
KL	Dark true blue
ND	Colorado red
PC	Jewel green
UM	Magnum grey
ZJ	Moondust silver
3B	Tonic
3D	Blue ambition
-	Frozen white
-	Sublime

Item 17: Brakes

Code	Brake System
B	Booster with dual line diagonal split brake system, with anti-lock brakes (ABS)
C	Booster with dual line diagonal split brake system, without anti-lock brakes (ABS), with rear drum
H	Booster with dual line diagonal split brake system, without anti-lock brakes (ABS)

DESCRIPTION AND OPERATION

Item 18: Interior Trim

Code	Seat Trim	Description	Door trim	Color
5KA	York weave	Low back individual passenger	Cordwain	Lichen
5KB	Tomy woven	Low back individual passenger	Cordwain	Lichen
5KC	York weave	Low back dual passenger	Cordwain	Lichen
5KD	Tomy woven	Low back dual passenger	Cordwain	Lichen
5MD	Velour	Low back individual passenger	Cordwain	Lichen
5ME	Velour	Low back dual passenger	Cordwain	Lichen
5MF	Leather	Low back individual passenger	Cordwain	Lichen
5MG	Leather	Low back dual passenger	Cordwain	Lichen

Item 19: Smoke Values

Smoke Value	Engine Code	Engine	Emissions
1.31	P 8 F A	2.2L 85PS	Stage IV
1.44	Q V F A	2.2L 110PS	Stage IV
1.64	Q W F A	2.2L 130PS	Stage IV
1.62	P H F A	2.4L 100PS	Stage IV
1.56	J X F A	2.4L 115PS	Stage IV
1.49	H 9 F B	2.4L 140PS	Stage IV

Item 20: Engine Type Codes

Code	Engine	Catalytic Converter	kW	Transmission / Transaxle	Emission
GZFA	2.3L 146PS	Y	107	M	Stage IV
GZFB	2.3L 146PS	Y	107	M	Stage III
HFFA	2.4L 120PS	N	88	M	Stage I
H9FB	2.4L 140PS	Y	103	M	Stage IV
JXFA	2.4L 115PS	Y	85	M	Stage IV
PHFA	2.4L 100PS	Y	74	M	Stage IV
P8FA	2.2L 85PS	Y	63	M	Stage IV
QVFA	2.2L 150PS	Y	81	M	Stage IV
QWFA	2.2L 130PS	Y	96	M	Stage IV
QWFB	2.2L 130PS	N	96	M	Stage I
RBFA	2.4L 100PS	N	74	M	Stage I
RCFA	2.4L 130PS	N	96	M	Stage I

SECTION 100-02 Jacking and Lifting

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Jacking..... 100-02-2
Lifting..... 100-02-4

DESCRIPTION AND OPERATION

Jacking

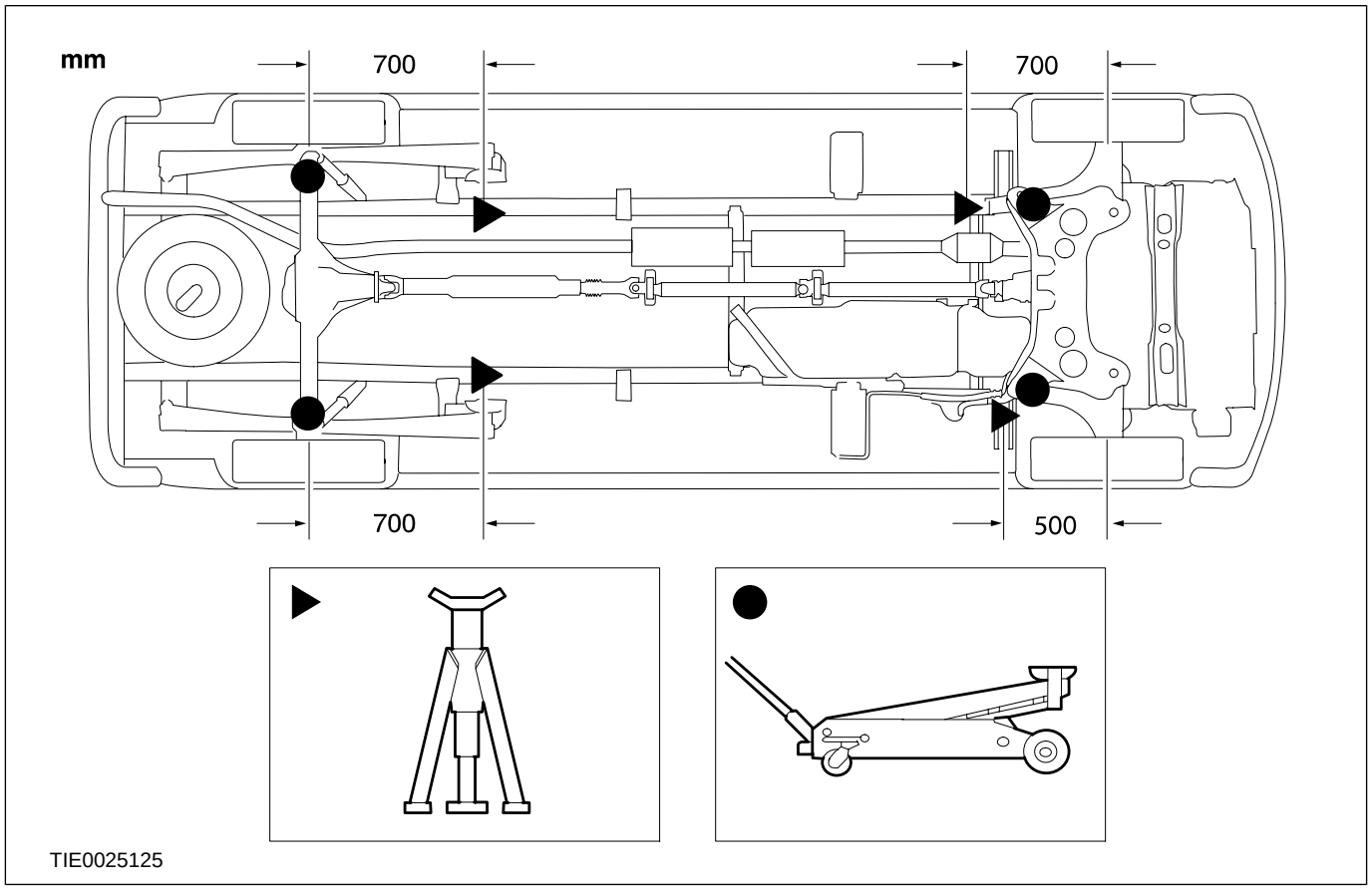
All Vehicles

WARNING:Always position the vehicle on a hard level surface. If the vehicle must be jacked up on a soft surface use load spreading blocks under the jack. Always chock the wheel diagonally opposite the jacking point. Failure to follow these instructions may result in personal injury.

CAUTION:It is important that only the correct jacking and support locations are used at all times.

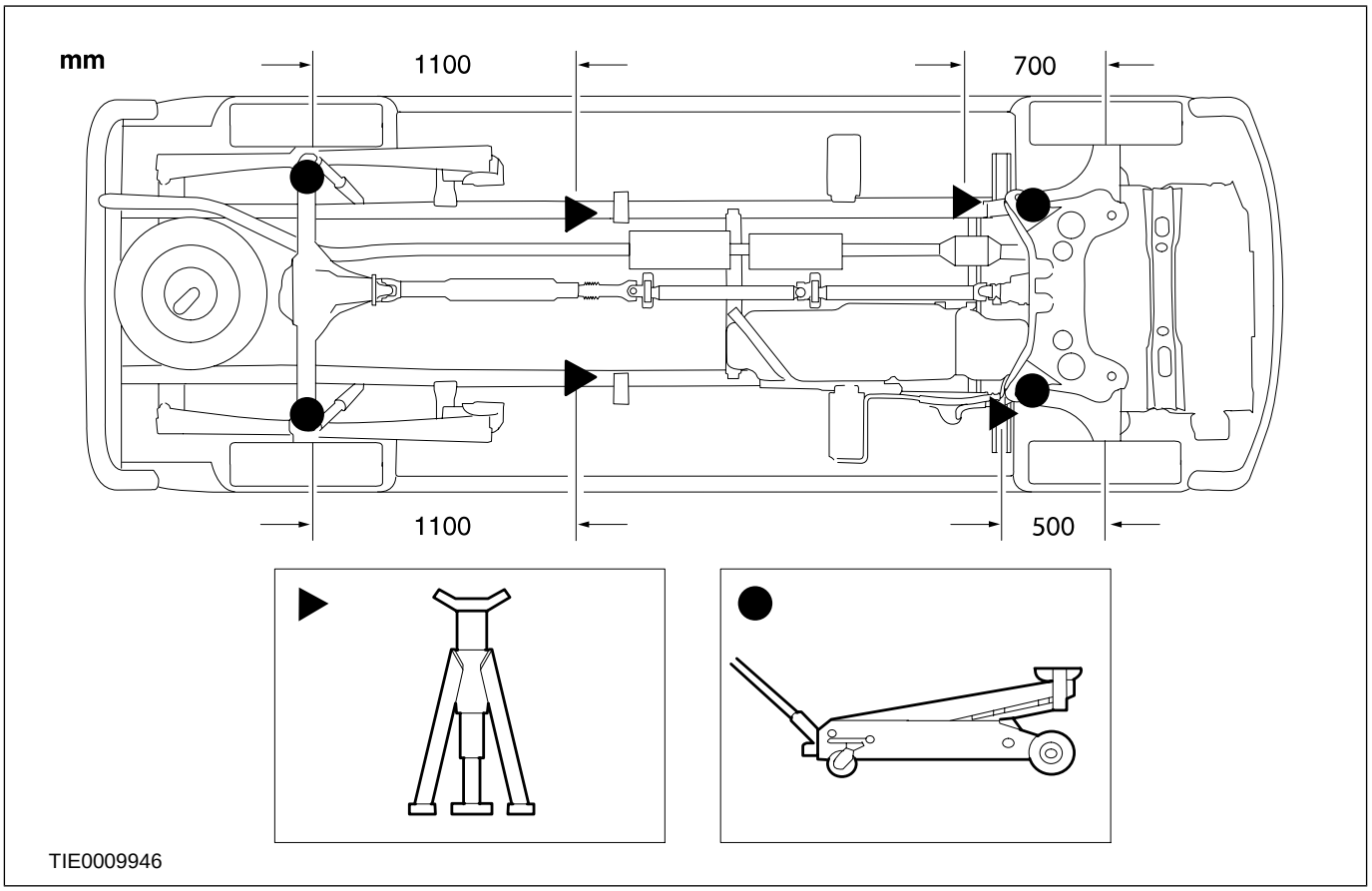
NOTE: When using the vehicle jack, refer to the owner guide for correct operating instructions.

Van, Bus and Kombi (Short Wheelbase [SWB], Medium Wheelbase [MWB], Long Wheelbase [LWB] and Extended Length)



Chassis Single Cab, Extended Frame Chassis Single Cab, Chassis Double Cab and Extended Frame Chassis Double Cab

DESCRIPTION AND OPERATION



DESCRIPTION AND OPERATION

Lifting

All Vehicles

WARNING:When lifting the vehicle with a two post lift for the removal of the engine/transmission or rear axle, make sure the vehicle is secured to the lift using vehicle retention straps to prevent tilting. Failure to follow these instructions may result in personal injury.

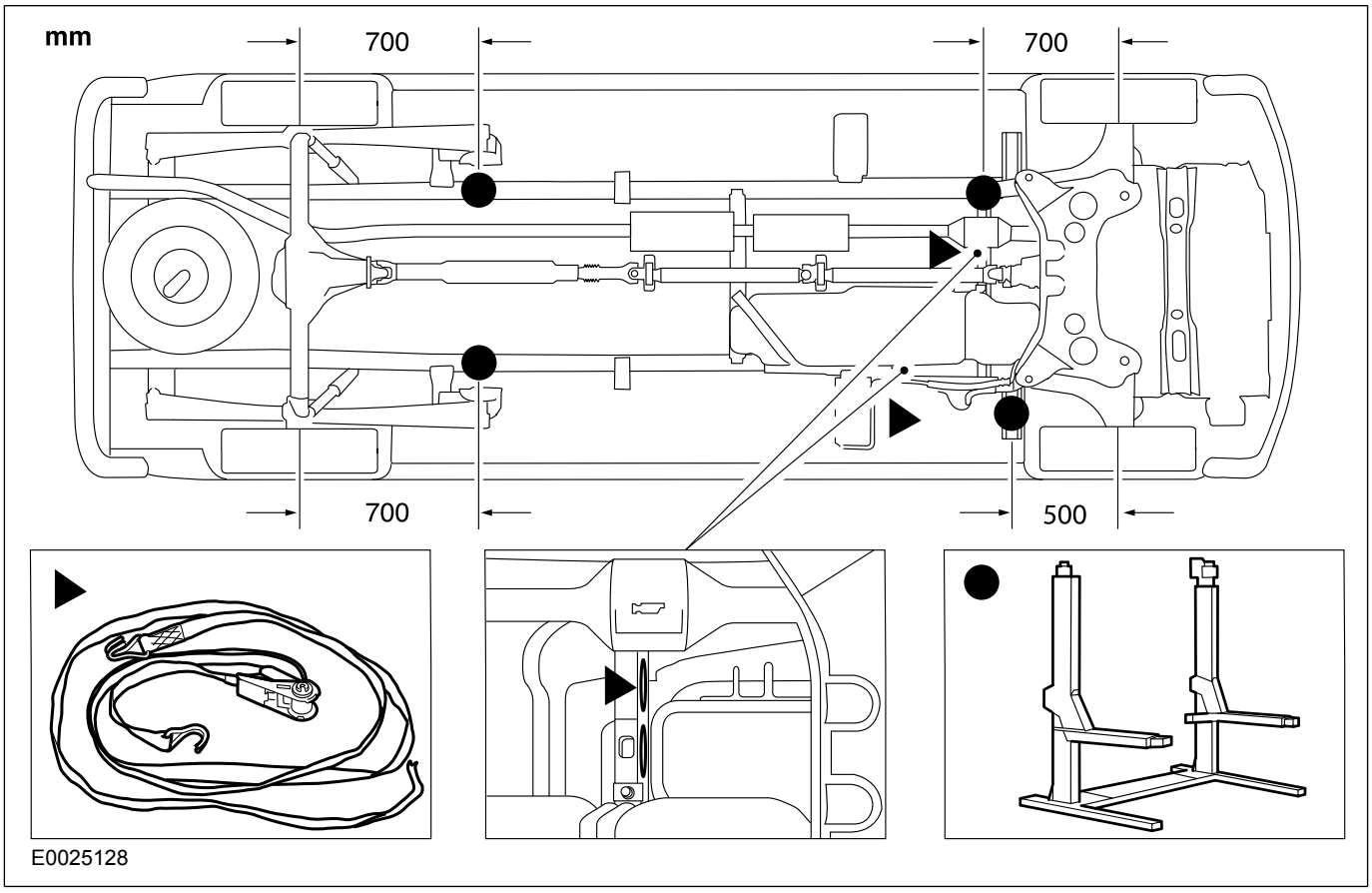
CAUTIONS:

When lifting the vehicle with a two post lift, vehicle lift arm adapters must be used under the lifting points.

When lifting the vehicle with a two post lift, the maximum kerb weight must not be exceeded.

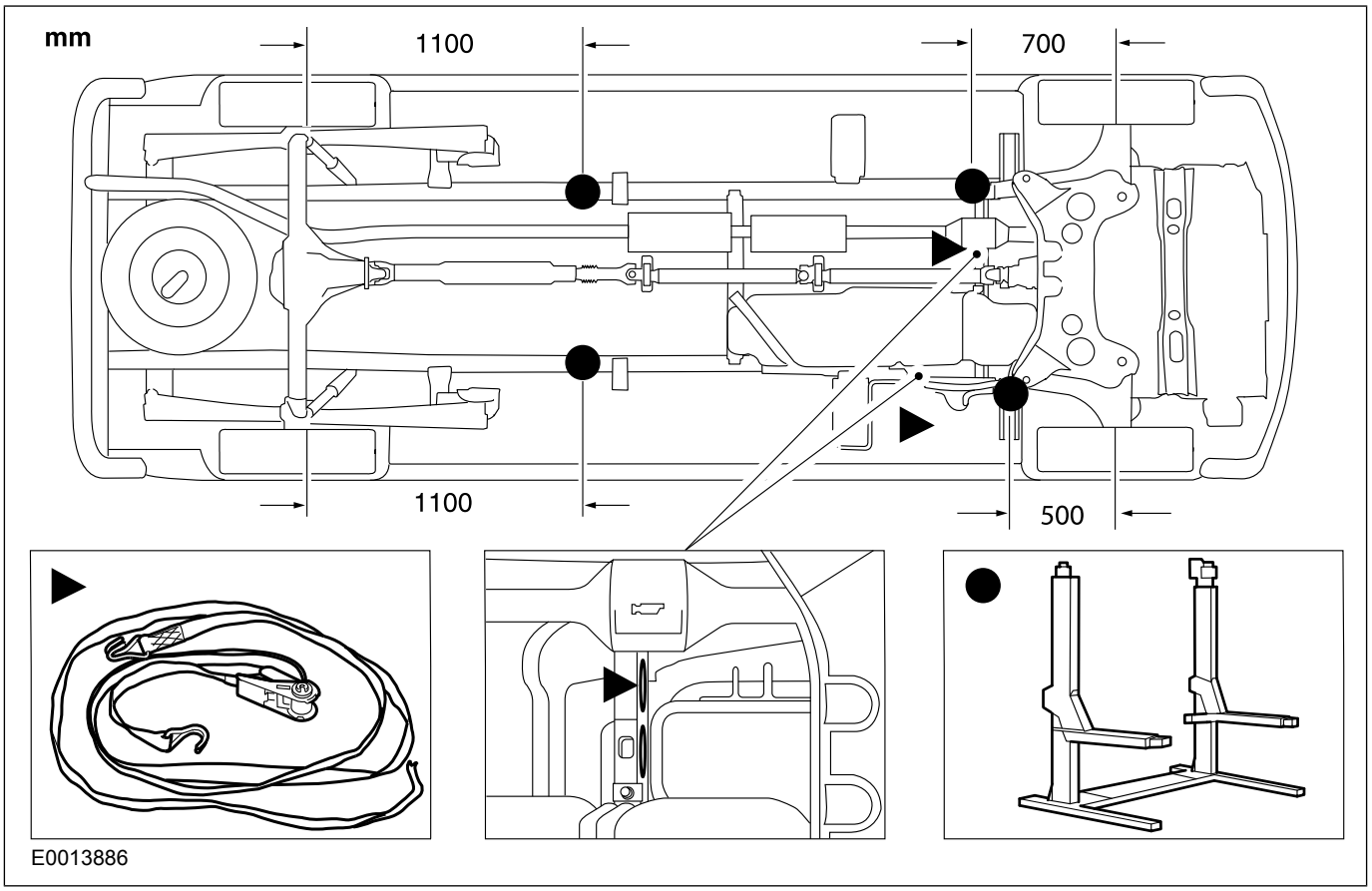
It is important that only the correct lifting and support locations are used at all times.

Van, Bus and Kombi (Short Wheelbase [SWB], Medium Wheelbase [MWB], Long Wheelbase [LWB] and Extended Length)



Chassis Single Cab, Extended Length Chassis Single Cab, Chassis Double Cab and Extended Length Chassis Double Cab.

DESCRIPTION AND OPERATION



SECTION 100-04 Noise, Vibration and Harshness

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Noise, Vibration and Harshness (NVH)..... 100-04-2
Inspection and Verification..... 100-04-2
Noise Diagnostic Procedure..... 100-04-2
Road Test..... 100-04-3
Road Test Quick Checks..... 100-04-3
Road Conditions..... 100-04-4
Vehicle Preparation..... 100-04-4
Power Steering Conditions..... 100-04-4
Power Steering Operation Noise Check..... 100-04-4
Symptom Chart..... 100-04-7
Pinpoint Tests..... 100-04-14

GENERAL PROCEDURES

Exhaust System Neutralizing..... (25 001 0) 100-04-21

DIAGNOSIS AND TESTING

Noise, Vibration and Harshness (NVH)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the concern is not visually evident, verify the symptom and REFER to the Symptom Chart.

How to Use this Diagnostic Procedure Section

- Noise, vibration and harshness (NVH) concerns have become more important as vehicles have become more sensitive to these vibrations. This section is designed to aid in identifying these concerns.
- The section provides diagnostic procedures based on symptom. If the condition occurs at high speed, for instance, the most likely place to start is under Shake and Vibration While Driving.
- The road test procedure will tell how to sort the conditions into categories and how to tell a vibration from a shake.
- A series of Road Test Quick Checks are provided to make sure that a cause is either pinpointed or eliminated.
- Name the condition, proceed to the appropriate section and locate the correct diagnosis. When the condition is identified, the job is partly done.
- Follow the diagnostic procedure as outlined.
- Quick Checks are described within the step, while more involved tests and adjustments are outlined in General Procedures.
- Always follow each step exactly and make notes to recall important findings later.

Customer Interview

The road test and customer interview (if available) provide information that will help identify the concern and will provide direction to the correct starting point for diagnosis.

Identify the Condition

NVH usually occur in four areas:

- tires
- engine accessories
- suspension
- driveline

It is important, therefore, that an NVH concern be isolated into its specific area(s) as soon as possible. The easiest and quickest way to do this is to carry out the Road Test as outlined. To assist in the diagnosis and testing procedure(s), use a suitable approved NVH diagnosis tester.

Noise Diagnostic Procedure

Non-Axle Noise

The five most common sources of non-axle noise are exhaust, tires, roof racks, trim panels and transmission.

Therefore, make sure that none of the following conditions are the cause of the noise before proceeding with a driveline teardown and diagnosis.

- In certain conditions, the pitch of the exhaust may sound very much like gear noise. At other times, it can be mistaken for a wheel bearing rumble.
- Tires, especially snow tires, can have a high pitched tread whine or roar, similar to gear noise. Radial tires may have this characteristic. Also, any non-standard tire with an unusual tread construction may emit a roar or whine noise.
- Trim panels can also cause whistling or whining noise.
- Clunk may be a metallic noise heard when the automatic transaxle is engaged in "R" (REVERSE) or "D" (DRIVE) or it may occur when the throttle is applied or released. It is caused by backlash somewhere in the driveline.
- Bearing rumble sounds like marbles being tumbled. This condition is usually caused by a damaged wheel bearing.

DIAGNOSIS AND TESTING

Noise Conditions

- Gear noise is typically a howling or whining due to gear damage or incorrect bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.
- Chuckle is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 64 km/h (40 mph) and can usually be heard all the way to a stop. The frequency varies with vehicle speed.
- Knock is very similar to chuckle, though it may be louder and occurs on acceleration or deceleration. The teardown will disclose what has to be corrected.

Clicking, popping or grinding noises may be caused by the following:

- worn, damaged or incorrectly installed wheel bearing, suspension or brake component.

Check and rule out tires, exhaust and trim items before disassembling the transmission to diagnose and correct gear noise.

The noises described under Road Test usually have specific causes that can be diagnosed by observation as the unit is disassembled. The initial clues are the type of noise heard on the road test and driving conditions.

Vibration Conditions

Vibration at highway speeds may be caused by the following:

- out-of-balance front or rear wheels.
- out-of-round tires.

Shudder or vibration during acceleration may be caused by the following:

- damaged powertrain/drivetrain mounts.
- excessively high constant velocity (CV) joint operating angles caused by incorrect ride height. Check ride height, verify correct spring rate and check items under inoperative conditions.

Road Test

A gear-driven unit will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions, as on a newly paved asphalt road. The slight noise is in no way detrimental and must be considered normal.

The road test and customer interview (if available) provide information needed to identify the condition and give direction to the correct starting point for diagnosis.

1. Make notes throughout the diagnosis routine. Make sure to write down even the smallest bit of information, because it may turn out to be the most important.
2. Do not touch anything until a road test and a thorough visual inspection of the vehicle have been carried out. Leave the tire pressures and vehicle load just where they were when the condition was first observed. Adjusting tire pressures, vehicle load or making other adjustments may reduce the condition(s) intensity to a point where it cannot be identified clearly. It may also inject something new into the system, preventing correct diagnosis.
3. Make a visual inspection as part of the preliminary diagnosis routine, writing down anything that does not look right. Note tire pressures, but do not adjust them yet. Note leaking fluids, loose nuts and bolts, or bright spots where components may be rubbing against each other. Check the load space for unusual loads.
4. Road test the vehicle and define the condition by reproducing it several times during the road test.
5. Carry out the Road Test Quick Checks as soon as the condition is reproduced. This will identify the correct diagnostic procedure. Carry out the Road Test Quick Checks more than once to verify they are providing a valid result. Remember, the Road Test Quick Checks may not tell where the concern is, but they will tell where it is not.

Road Test Quick Checks

1. 24-80 km/h (15-50 mph): with light acceleration, a moaning noise is heard and possibly a vibration felt in the front floor panel. It is usually worse at a particular engine speed and at a particular throttle setting during acceleration at that speed. It may also produce a moaning sound, depending on what component is causing it. REFER to Tip-in Moan in the Driveline Noise and Vibration Symptom Chart.

DIAGNOSIS AND TESTING

2. Acceleration/Deceleration: With slow acceleration and deceleration, a shake is sometimes noticed in the steering wheel/column, seats, front floor panel, front door trim panel or front end sheet metal. It is a low frequency vibration (around 9-15 cycles per second). It may or may not be increased by applying the brakes lightly. REFER to Idle Boom/Shake/Vibration in the Driveline Noise and Vibration Symptom Chart.
3. High Speed: A vibration is felt in the front floor panel or seats with no visible shake, but with an accompanying sound or rumble, buzz, hum, drone or booming noise. Coast with the clutch pedal depressed (manual transmission) or shift control selector lever in "N" (NEUTRAL) (automatic transmission) and engine idling. If vibration is still evident, it may be related to wheels, tires, front brake discs, wheel hubs or front wheel bearings. REFER to Shake and Vibration While Driving in the Driveline Noise and Vibration Symptom Chart.
4. Engine rpm Sensitive: A vibration is felt whenever the engine reaches a particular rpm. It will disappear in neutral coasts. The vibration can be duplicated by operating the engine at the problem rpm while the vehicle is stationary. It can be caused by any component, from the accessory drive belt to the clutch or torque converter which turns at engine speed when the vehicle is stopped. REFER to Shake and Vibration While Driving in the Driveline Noise and Vibration Symptom Chart.
5. Noise and Vibration While Turning: Clicking, popping or grinding noises may be due to the following:

- worn, damaged or incorrectly installed front wheel bearing.
- damaged powertrain/drivetrain mounts.

Road Conditions

An experienced technician will always establish a route that will be used for all NVH diagnosis road tests. The road selected should be reasonably smooth, level and free of undulations (unless a particular condition needs to be identified). A smooth asphalt road that allows driving over a range of speeds is best. Gravel or bumpy roads are unsuitable because of the additional road noise produced. Once the route is established and consistently used, the road noise variable is eliminated from the test results.

NOTE: Some concerns may be apparent only on smooth asphalt roads.

If a customer complains of a noise or vibration on a particular road and only on a particular road, the source of the concern may be the road surface. If possible, try to test the vehicle on the same type of road.

Vehicle Preparation

Carry out a thorough visual inspection of the vehicle before carrying out the road test. Note anything which is unusual. Do not repair or adjust any condition until the road test is carried out, unless the vehicle is inoperative or the condition could pose a hazard to the technician. After verifying that the condition has been corrected, make sure all components removed have been installed.

Power Steering Conditions

Check for the noise in the following conditions to verify the customer concern.

- Check for the noise in several temperature conditions.
- Is the noise from when the vehicle was new?
- Can the noise be repeated constantly or is it random?
- Check the condition of the vehicle age, mileage and service record.
- Interview the customer to find the operating condition in which the noise will occur. Test the vehicle based on the detail(s) from the customer interview.
- Follow the power steering operation noise condition tables below, to find which condition the noise will occur.

Power Steering Operation Noise Check

Step 1: Check for NVH concerns from non-steering components, which may sound like noises coming from the steering system.

DIAGNOSIS AND TESTING

Power assisted steering operating condition			
Parking		Driving	
Steering central/slightly off center	Steering at a steering lock stop	Driving straight ahead	Cornering condition
REFER to NVH concerns from other components column A	REFER to NVH concerns from other components column B	REFER to NVH concerns from other components column C	REFER to NVH concerns from other components column D

NVH concerns from other components

NVH concerns from other condition (column A to D)					
Noise	**Driving Condition**	**A**	**B**	**C**	**D**
Pedal box knocking	Drive off, stop driving and slow cornering over uneven roads	X	X	O	X
Stabilizer bar link knocking	Drive off, driving and cornering	X	O	O	X
Engine support insulator knocking	Drive off, driving, acceleration and deceleration	X		X	
Air conditioning knocking	Engine on, activate switch for air conditioning	X	X	O	O
Suspension knocking (Subframe, Springs)	Drive off, driving, cornering, acceleration and deceleration	X		O	X
Constant velocity (CV) joint knocking	Drive off, driving, cornering, acceleration and deceleration	X	O		X
Washer bottle	Deceleration, acceleration and single impact	O		X	
Loose suspension bolts	All driving conditions	O		O	X
Instrument panel rattle/squeak	All driving conditions. Engine rpm dependant	X	X	X	X

- X = Noise will most likely occur in this operating condition.
- O = Noise can possibly occur in this operating condition.
- Blank = Noise is unlikely to occur in this operating condition.

Step 2: Check for steering system NVH concerns according to operation condition described at the customer interview.

Power assisted steering operating condition					
Parking		Driving		Vehicle stationary with engine off	
Steering central/ slightly off center	Steering at a steering lock stop	Steering central/slightly off center	Steering at a steering lock stop	Steering central/ slightly off centre	Steering at a steering lock stop

DIAGNOSIS AND TESTING

Power assisted steering operating condition					
Parking		Driving		Vehicle stationary with engine off	
REFER to steering system NVH concerns column A	REFER to steering system NVH concerns column B	REFER to steering system NVH concerns column C	REFER to steering system NVH concerns column D	REFER to steering system NVH concerns column E	REFER to steering system NVH concerns column F

Steering system NVH concerns

Steering System operation condition (column A to F)							
Noise	**Driving condition**	**A**	**B**	**C**	**D**	**E**	**F**
Moan	Parking between lock stops, at engine idle and also increased engine speed	X	O				
Whine	Driving, high engine rpm. Must be present from new	O	O	X	X		
Hiss	a) Parking between lock stops. Must be present from new	X	X	O	O		
	b) Holding steering wheel against lock stops. Must be present from new		X				
Lock stop impact knock	a) Parking at lock stop. Must be present from new		X				X
Mechanical knock (power assisted steering (PAS) off)	b) Parking between lock stops, engine OFF. Must be present from new					X	
Mechanical Knock (PAS on)	c) Parking between lock stops, engine ON (ball joint knock)	X					
Hammer knock	d) Parking into lock stop and release (vehicle with hydraulic power assisted steering (HPAS) only, not for vehicles with electro-hydraulic power assisted steering (EHPAS))		X				
Hydraulic knock (clonk)	e) Driving, cobble stones, rough road (clonk). Must be present from new			O	X		
Column knock	f) Parking, driving. cobble stones and rough roads	X	X	O	X	X	X
Column rattle	Mainly driving on rough roads	O		X	X	O	
Toc-toc	Steering left and right at high frequency. Must be present from new	X					
Grinding	When turning steering wheel	X			O	X	
Zip	At engine start, low temperatures below -10°C only	X	O				

- X = Noise will most likely occur in this operating condition.
- O = Noise can possibly occur in this operating condition.
- Blank = Noise is unlikely to occur in this operating condition.

DIAGNOSIS AND TESTING

Step 3: According to each identified operating condition (Column A, B, C, D, E, F), check each possible Steering System NVH concern with the detail symptom charts below.

Before conducting a vehicle test to identify a NVH concern carry out the following checks.

1. Check the tire pressures and adjust to specification, as necessary.
2. Make sure the steering system fluid is correct, the system is free of leaks and is operating correctly.
3. Make sure the vehicle steering system temperature is the same as described at the customer interview.
4. All evaluations must take place in a relatively quiet location.
5. The heating - air conditioning (A/C) fan and radio must be turned off during evaluations and the windows closed.

Symptom Chart

Power Steering Moan Noise

Test Condition

Listen for steering moan noise with the vehicle parked, transmission in neutral and all windows closed in the following test conditions.

1. Engine speed at idle with no steering action.
2. Engine speed at idle with slow 90 degrees per second turning of the steering wheel.
3. Engine speed at 1250 +/- 50 rpm with no steering action.
4. Engine speed at 1250 +/- 50 rpm with slow 90 degrees per second turning of the steering wheel.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
Power steering system moan noise – A continuous low pitched humming noise occurs when the steering wheel is turned and the steering system is loaded. Noise frequency changes with engine rpm changes. Particularly annoying at lower engine speed.	Power steering lines.	• CHECK the routing of the power steering lines. • CHECK the power steering line clamps are secure. • CHECK the power steering lines for clearance from the vehicle body, front axle cross-member and steering gear.
	Incorrect power steering fluid.	FLUSH the power steering system. REFER to:(211-00) Power Steering System Flushing - 1.8L Duratec-HE (MI4)/1.8L Duratec-SCi (MI4)/2.0L Duratec-HE (MI4) (General Procedures), Power Steering System Flushing - 3.0L Duratec-SE (VE6)/2.5L Duratec-VE (VE6)/3.0L Duratec-ST (VE6) (General Procedures), Power Steering System Flushing - 2.0L Duratorq-Di/TDDi (Puma) Diesel/2.0L Duratorq-TDCi (Puma) Diesel/2.2L Duratorq-TDCi (Puma) Diesel (General Procedures).
	Power steering pump.	Pressure pulses from the power steering pump. Certain amount of noise level acceptable, not a safety critical item.

Power Steering Whine Noise

Test Condition

Listen for steering whine noise with the vehicle parked, transmission in neutral and all windows closed in the following test conditions.

1. Engine speed at 1800 +/- 50 rpm with no steering action.
2. Engine speed at 1800 +/- 50 rpm with slow 90 degrees turning of the steering wheel.
3. Engine speed at 3000 +/- 50 rpm with no steering action.
4. Engine speed at 3000 +/- 50 rpm with slow 90 degrees turning of the steering wheel.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
Power steering system whine noise – a high pitched buzzing sound like an electric motor or drill. Whine occurs at the higher engine rpm, 1500 - 5000 rpm, frequency does not change if system is loaded or not loaded.	Power steering fluid aeration.	BLEED the power steering system. REFER to:Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).
	Incorrect power steering fluid.	FLUSH the power steering system. REFER to:(211-00) Power Steering System Flushing - 1.8L Duratec-HE (MI4)/1.8L Duratec-SCi (MI4)/2.0L Duratec-HE (MI4) (General Procedures), Power Steering System Flushing - 3.0L Duratec-SE (VE6)/2.5L Duratec-VE (VE6)/3.0L Duratec-ST (VE6) (General Procedures), Power Steering System Flushing - 2.0L Duratorq-Di/TDDi (Puma) Diesel/2.0L Duratorq-TDCi (Puma) Diesel/2.2L Duratorq-TDCi (Puma) Diesel (General Procedures).
	Overheated power steering fluid.	FLUSH the power steering system. REFER to:(211-00) Power Steering System Flushing - 1.8L Duratec-HE (MI4)/1.8L Duratec-SCi (MI4)/2.0L Duratec-HE (MI4) (General Procedures), Power Steering System Flushing - 3.0L Duratec-SE (VE6)/2.5L Duratec-VE (VE6)/3.0L Duratec-ST (VE6) (General Procedures), Power Steering System Flushing - 2.0L Duratorq-Di/TDDi (Puma) Diesel/2.0L Duratorq-TDCi (Puma) Diesel/2.2L Duratorq-TDCi (Puma) Diesel (General Procedures).
	Hydraulic operating condition of the power steering pump.	Certain amount of noise level acceptable, not a safety critical item.

DIAGNOSIS AND TESTING

Power Steering Hiss Noise

Test Condition

Listen for steering hiss noise with the vehicle parked, transmission in neutral and all windows closed in the following test conditions.

Symptom	Possible Sources	Action
NOTE: Engine speed at idle turning the steering wheel slowly lock to lock. Power steering system hiss noise – a high frequency, continuous rush or swish noise like escaping air from a balloon. Hiss occurs while turning between the steering lock stops, all steering angles. Noise does not change with engine rpm and is worse at high operating temperatures.	Floor seal.	CHECK the installation and potential damage of the floor seal.
	Power steering gear valve design.	Certain amount of noise level acceptable, not a safety critical item.
	Power steering system hydraulic design.	Certain amount of noise level acceptable, not a safety critical item.
NOTE: Engine speed at idle holding the steering wheel against a steering lock for three seconds. Do not hold for more than five seconds. Power steering system hiss noise – a continuous noise like escaping air occurs while holding the steering against a steering lock stop.	Power steering pump pressure relief valve.	Certain amount of noise level acceptable, not a safety critical item.

Power Steering Lock Stop Impact Knock Noise

Test Condition

Listen for steering knock noise with the engine speed at idle in the following test conditions (noise also apparent with engine off).

1. Turn the steering wheel to the left-hand and right-hand steering locks and listen for the impact noise.

Symptom	Possible Sources	Action
Power steering system knock noise – a heavy loud sound like a knock on a door that occurs in parking condition when hitting the lock stop.	Power steering gear mechanical noise, metal to metal at end of steering travel.	Certain amount of noise level acceptable, not a safety critical item.

Power Steering Mechanical Knock Noise (PAS off)

Test Condition

Listen for steering knock noise with the engine off in the following test conditions (no power assist).

1. Turn the steering wheel 90 degrees to the right, hold and then quickly release.
2. Turn the steering wheel 90 degrees to the left, hold and then quickly release.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
Power steering system knock noise – a heavy loud repeating sound like a knock on a door that occurs in several driving and steering conditions.	Power steering system knock noise – a damped, metallic knock noise which only occurs at steering condition with engine off (very high efforts).	Certain amount of noise level acceptable, not a safety critical item.
	Tolerances in the steering gear components.	Certain amount of noise level acceptable, not a safety critical item.

Power Steering Mechanical Knock Noise (PAS on)

Test Condition

Listen for steering knock noise with the engine speed at idle in the following test conditions (power assist).

1. Turn the steering wheel to a steering lock and return to center quickly.
2. Turn the steering wheel 90 degrees to the left and then 90 degrees to the right quickly.

Symptom	Possible Sources	Action
Power steering system knock noise – clear knock noise from steering gear linkage area.	Worn tie-rod ball joints (inner and outer ball joints).	REFER to Steering System. REFER to:Steering System (211-00, Diagnosis and Testing).

Power Steering Hammer Knock (Hydraulic) Noise

Test Condition

Listen for steering knock noise with the engine speed at idle in the following test conditions (for vehicles with hydraulic power assisted steering only, not electro-hydraulic power steering).

1. Turn the steering wheel to a steering lock position and return quickly.

Symptom	Possible Sources	Action
Power steering system knock noise – loud, metallic sound if hitting the suspension cross-member with a hammer (sounds like metallic noise but is created by pressure impulse in gear and return line).	Hydraulic noise created by pressure impulses.	Certain amount of noise level acceptable, not a safety critical item.

Power Steering Hydraulic Knock/Clonk Noise

Test Condition

Listen for steering knock/clonk noise in the following test conditions with the windows closed.

1. Drive over cobbled roads at low speed 10-30 km/h (6-20 mph) with and without turning.
2. Drive over straight tar strips road rails or 25 mm tall harshness strips at low speed 10-30 km/h (6-20 mph) both driving straight and with moderate turning.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
Power steering system knock/ clonk noise – sounds almost identical to column knock that occurs when driving and cornering over cobbled stones or rough roads. Noise may appear to emanate from a location closer to the floor than that for column knock (Sounds like metallic noise but is created by pressure impulse in gear and return line – similar to a sound like quickly turning off a water tap).	Power steering return lines.	Certain amount of noise level acceptable, not a safety critical item.
	High power assist gain of power steering gear valve (steering gear design - no quality issue).	Certain amount of noise level acceptable, not a safety critical item.
	High power steering pump flow rate (by design).	Certain amount of noise level acceptable, not a safety critical item.

Power Steering Column Knock Noise

Test Condition

Listen for steering knock noise in the following test conditions with windows closed.

1. Drive over cobbled stones at low speed 16-40 km/h (10-25 mph) with and without steering input carefully listening for knock sounds.
2. Drive over straight tar strips, road rails or 25 mm tall harshness strips at low speed 16-40 km/h (10-25 mph) both driving straight and with moderate cornering.

Symptom	Possible Sources	Action
Power steering system column knock noise – a loose sounding rattle or vibration coming from the column. Noticeable by hearing and touch.	Steering column or steering column shaft.	CHECK the steering column retaining bolts and attachments to the steering column and secure if necessary. REFER to:Specifications (211-04, Specifications).
		Check steering column and intermediate shaft for free play or loose components. REFER to:Steering System (211-00, Diagnosis and Testing).

Power Steering Toc-Toc Noise

Test Condition

Listen for steering toc-toc noise with the engine speed at idle and the vehicle parked, automatic transmission in "P" (PARK) or manual transmission in neutral and the windows closed.

1. Turn the steering wheel from left to right abruptly changing direction.
2. Drive the vehicle for low speed parking manoeuvres constantly changing steering direction.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
Power steering system toc-toc noise – a metallic noise created when changing direction of steering wheel rotation during parking manoeuvre or at stand-still.	Steering gear (design tolerance in steering rack).	Certain amount of noise level acceptable, not a safety critical item.

Power Steering Grinding Noise

Test Condition

Listen for steering grinding noise with the engine speed at idle and the vehicle parked, automatic transmission in "P" (PARK) or manual transmission in neutral and the windows closed.

1. Slowly turn the steering wheel from lock to lock.
2. Tilt and extend the steering column in various positions and slowly turn the steering wheel from lock to lock.

Symptom	Possible Sources	Action
Power steering system grinding noise – an abrasive noise (like sand paper rubbing against wood) occurs between moving components such as steering wheel and the steering column shroud.	Steering wheel to shroud interference.	Certain amount of noise level acceptable, not a safety critical item.
	Steering column bearing.	Certain amount of noise level acceptable, not a safety critical item.
	Foreign material in contact with the steering column shaft.	CHECK if floor covering is obstructing the steering gear pinion.
		CHECK the installation of the floor seal.
	Clockspring.	CHECK the clockspring and secure if necessary. REFER to:Clockspring (501-20B, Removal and Installation).

Power Steering Zip Noise

Symptom	Possible Sources	Action
Power steering system zip noise – occurs when hydraulic fluid does not flow freely through the power steering pump supply hose from steering fluid reservoir to power steering pump causing cavitation at the pump. Zip is primarily a cold weather start-up phenomenon (below -10°C).	High viscosity of power steering fluid at low temperature.	Certain amount of noise level acceptable, not a safety critical item.
	Aeration of the power steering fluid.	BLEED the power steering system. REFER to:Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).

DIAGNOSIS AND TESTING

Driveline Noise and Vibration

Symptom	Possible Sources	Action
Shake and vibration while driving	• Wheel end vibration. • Engine/transmission.	GO to Pinpoint Test A.
Tip-in moan	• Air cleaner. • Power assisted steering. • Powertrain. • Powertrain/drivetrain mounts. • Exhaust system.	GO to Pinpoint Test B.
Idle boom/shake/vibration/ shudder	• Cable(s)/hose(s). • Powertrain/drivetrain mounts. • Exhaust system. • Belt/pulleys.	GO to Pinpoint Test C.

Suspension Noise and Vibration

Symptom	Possible Sources	Action
Wheel end vibration analysis	• Suspension. • Wheel bearings.	GO to Pinpoint Test D.
Non-axle noise	• Trim panels. • Air conditioning (A/C) system. • Accessories.	GO to Pinpoint Test E.

Pinpoint Tests

NOTE: These Pinpoint Tests are designed to take the technician through a step-by-step diagnosis procedure to determine the cause of a condition. It may not always be necessary to follow the chart to its conclusion. Carry out only the pinpoint test steps necessary to correct the condition. Then check the operation of the system to make sure the condition has been corrected.

After verifying that the condition has been corrected, make sure all components removed have been installed.

PINPOINT TEST A : SHAKE AND VIBRATION WHILE DRIVING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: NEUTRAL COAST	
	1 Carry out the neutral coast test. • Does the vibration disappear during the neutral coast test? → **Yes** GO to A2. → **No** GO to Pinpoint Test D.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A2: CHECK THE POWERTRAIN/DRIVETRAIN MOUNTS	
	1 Carry out the powertrain/drivetrain mount neutralizing procedure • Are the mounts OK? → **Yes** Vehicle condition corrected. ROAD TEST as necessary. → **No** INSTALL new powertrain/drivetrain mounts as necessary. ROAD TEST as necessary.

PINPOINT TEST B : TIP-IN MOAN

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK THE AIR CLEANER	
	1 Check the condition of the air cleaner mounts, inlet tube, outlet tube, resonators and all other components associated with the air induction system for correct installation and tightness of all connections. • Are the components OK? → **Yes** GO to B2. → **No** REPAIR or INSTALL new components as necessary. ROAD TEST as necessary.
B2: CHECK THE EXHAUST SYSTEM	
	1 Carry out the exhaust system neutralizing procedure. REFER to:Exhaust System Neutralizing (100-04, General Procedures). • Is the exhaust system OK? → **Yes** GO to B3. → **No** REPAIR as necessary. ROAD TEST as necessary.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B3: CHECK THE POWER STEERING	
	1 Remove the accessory drive belt and test for tip-in moan. REFER to:(303-05 Accessory Drive) Accessory Drive Belt - 1.8L Duratec-HE (MI4)/1.8L Duratec-SCi (MI4)/2.0L Duratec-HE (MI4) (Removal and Installation), Accessory Drive Belt - 3.0L Duratec-SE (VE6)/2.5L Duratec-VE (VE6)/3.0L Duratec-ST (VE6) (Removal and Installation), Accessory Drive Belt - 2.0L Duratorq-Di/TDDi (Puma) Diesel/2.0L Duratorq-TDCi (Puma) Diesel/2.2L Duratorq-TDCi (Puma) Diesel (Removal and Installation). • Is the tip-in moan OK? → **Yes** REPAIR the power steering as necessary. REFER to:Steering System (211-00 Steering System - General Information, Diagnosis and Testing). → **No** GO to B4.
B4: CHECK THE POWERTRAIN/DRIVETRAIN MOUNTS	
	1 Carry out the powertrain/drivetrain mount neutralizing procedure • Are the powertrain/drivetrain mounts OK? → **Yes** Vehicle condition corrected. ROAD TEST as necessary. → **No** INSTALL new powertrain/drivetrain mounts as necessary. ROAD TEST as necessary.

DIAGNOSIS AND TESTING

PINPOINT TEST C : IDLE BOOM/SHAKE/VIBRATION/SHUDDER

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CHECK THE CABLE/HOSES	
	1 Check the engine compartment for any component that may have a touch condition between the engine and body or chassis. For example: control cable, air conditioning (A/C) hoses, acceleration cable. • Are the components OK? → **Yes** GO to C2. → **No** REPAIR or INSTALL new components as necessary. ROAD TEST as necessary.
C2: CHECK THE ENGINE COOLING RADIATOR	
	1 Check the engine cooling radiator mountings and bushings for security and condition. Check the radiator installation for any component that may have a touch condition. • Is the installation and bushings OK? → **Yes** GO to C3. → **No** REPAIR or INSTALL new components as necessary. ROAD TEST as necessary.
C3: CHECK THE EXHAUST SYSTEM	
	1 Carry out the exhaust system neutralizing procedure. REFER to:Exhaust System Neutralizing (100-04, General Procedures). • Is the exhaust system OK? → **Yes** GO to C4. → **No** REPAIR as necessary. ROAD TEST as necessary.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C4: CHECK THE POWERTRAIN/DRIVETRAIN MOUNTS	
	1 Carry out the powertrain/drivetrain mount neutralizing procedure • Are the powertrain/drivetrain mounts OK? → **Yes** Vehicle condition corrected. ROAD TEST as necessary. → **No** INSTALL new powertrain/drivetrain mounts as necessary. ROAD TEST as necessary.

PINPOINT TEST D : WHEEL END VIBRATION ANALYSIS

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: INSPECT THE WHEELS AND TIRES	
	1 Inspect the wheels and tires. REFER to:Wheels and Tires (204-04 Wheels and Tires, Diagnosis and Testing). • Are the wheels and tires OK? → **Yes** GO to D2. → **No** INSTALL new wheels or tires as necessary. REFER to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation). ROAD TEST as necessary.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D2: INSPECT THE WHEEL BEARINGS	
	1 Inspect the wheel bearings. REFER to:Wheel Bearing Inspection (204-00 Suspension System - General Information, General Procedures). • Are the wheel bearings OK? → **Yes** GO to D3. → **No** INSTALL new wheel bearings as necessary. REFER to: Wheel Bearing (204-01 Front Suspension, Removal and Installation), Wheel Bearing - 2.0L Duratorq-Di/TDDi (Puma) Diesel/2.0L Duratorq-TDCi (Puma) Diesel, Vehicles With: 5-Speed Automatic Transaxle (5F31J) (204-01 Front Suspension, Removal and Installation), Wheel Hub (204-02 Rear Suspension, Removal and Installation). ROAD TEST as necessary.
D3: INSPECT THE WHEEL AND TIRE RUNOUT	
	1 Inspect the wheel and tire runout. • Is the wheel and tire runout OK? → **Yes** Balance the wheels and tires. Refer to the wheel balance equipment manufacturer's instructions. ROAD TEST as necessary. → **No** INSTALL new wheels or tires as necessary. REFER to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation). ROAD TEST as necessary.

DIAGNOSIS AND TESTING

PINPOINT TEST E : NON-AXLE NOISE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: INSPECT THE VEHICLE TRIM	
	1 Check the radiator grille and trim panels to see if they are the source of the noise. • Are the vehicle trim components causing the noise? → **Yes** INSTALL new trim components or REPAIR as necessary. ROAD TEST as necessary. → **No** GO to E2.
E2: CHECK THE AIR CONDITIONING (A/C) SYSTEM FOR NOISE	
	1 Ignition switch in position III.
	2 Ignition switch in position II.
	3 Check the A/C system components for noise by turning the A/C system on and off. • Is the A/C system causing the noise? → **Yes** INSPECT the A/C system. REFER to:(412-00 Climate Control System - General Information) Climate Control System (Diagnosis and Testing), Climate Control System (Diagnosis and Testing). ROAD TEST as necessary. → **No** GO to E3.
E3: CHECK NON-FACTORY FITTED ACCESSORIES	
	1 Check any non-factory installed accessories for being the source of the noise. For example: touch condition body-to-frame, antennas, deflectors and fog lights. • Are the accessories the cause of the noise? → **Yes** ADJUST, REPAIR, or INSTALL new accessories or fasteners as required. ROAD TEST as necessary. → **No** VERIFY the customer concern.

GENERAL PROCEDURES

Exhaust System Neutralizing (25 001 0)

1. **Loosen the muffler inlet pipe and resonator pipe to exhaust manifold fasteners at the flanges and the muffler inlet connection.**
2. **Place a stand to support the muffler parallel to the vehicle frame with the muffler pipe bracket free of stress.**
3. **Tighten the muffler connection.**
4. **Position the exhaust pipes to the manifolds and tighten. Make sure that the catalytic converter and heat shield do not contact the frame rails.**
5. **With the complete exhaust system tight (and cooled) the rear hanger insulator should be angled forward, to allow the system to expand rearward when heated during normal running.**

SECTION 204-00 Suspension System - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 204-00-2

DIAGNOSIS AND TESTING

Suspension System 204-00-3
Inspection and Verification 204-00-3
Pinpoint Tests 204-00-7
Component Tests 204-00-13

GENERAL PROCEDURES

Front Toe Adjustment ..... (14 117 0) 204-00-15
Wheel Bearing Inspection 204-00-16

SPECIFICATIONS

Front Wheel Alignment (at curb weight) - FWD

Description	Nominal and Tolerance Range
Caster angle (Decimal degrees)	3.72° ± 0.5°
Camber angle (Decimal degrees)	-0.32° ± 0.5°
Total toe (Decimal degrees)	0.06° Toe-in ± 0.25°

Front Wheel Alignment (at curb weight) - RWD

Description	Nominal and Tolerance Range
Caster angle (Decimal degrees)	3.57° ± 0.5°
Camber angle (Decimal degrees)	-0.02° ± 0.5°
Total toe (Decimal degrees)	0.06° Toe-in ± 0.25°

Rear Wheel Alignment (at curb weight) - FWD

Description	Nominal and Tolerance Range
Camber angle (Decimal degrees)	1.00° ± 0.15°
Total toe (Decimal degrees)	0.10° Toe-in ± 0.05°

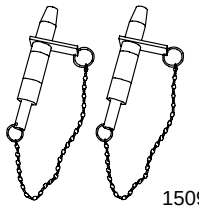
Torque Specifications

Item	Nm	lb-ft	lb-in
Tie-rod end locknut	80	59	-

DIAGNOSIS AND TESTING

Suspension System

Special Tool(s)

 15097A	Alignment Pins, Subframe 205-316 (15-097A)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical damage.

Visual Inspection Chart

Mechanical
– Tire pressure(s) – Wheels and tires – Wheel knuckles – Tie-rod ends – Front suspension lower arm ball joints – Front suspension lower arm bushings – Front strut and spring assemblies – Front and rear stabilizer bar and connecting links – Rear springs – Rear shock absorbers – Rear suspension beam axle and bushings

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• Drift left or right	• Vehicle attitude incorrect (front or rear is high or low).	• CHECK for abnormal loading, spring sag or non-standard springs.
	• Steering gear or linkage worn or damaged.	• CHECK the steering system. REFER to:Steering System (211-00 Steering System - General Information, Diagnosis and Testing).
	• Brake system.	• CHECK the brake system. REFER to:Brake System - Vehicles Built Up To: 04/2006 (206-00 Brake System - General Information, Diagnosis and Testing).
	• Incorrect wheel alignment.	• ADJUST the wheel alignment. REFER to:(204-00 Suspension System - General Information) Specifications (Specifications), Front Toe Adjustment (General Procedures).
	• Incorrect front crossmember alignment.	• Using the special tool, CHECK the front crossmember alignment.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Worn front wheel bearings.	• CHECK the wheel bearings. REFER to:Wheel Bearing Inspection (204-00 Suspension System - General Information, General Procedures).
	• Wheels and tires.	• GO to Pinpoint Test A.
• Steering wheel off-center	• Vehicle attitude incorrect (front or rear is high or low).	• CHECK for abnormal loading, spring sag or non-standard springs.
	• Steering gear or linkage worn or damaged.	• CHECK the steering system. REFER to:Steering System (211-00 Steering System - General Information, Diagnosis and Testing).
	• Lower arm ball joint.	• CARRY OUT the Ball Joint Component Test in this section.
	• Incorrect wheel alignment.	• ADJUST the wheel alignment. REFER to:(204-00 Suspension System - General Information) Specifications (Specifications), Front Toe Adjustment (General Procedures).
• Tracks incorrectly	• Incorrect front suspension toe castor or camber angles.	• CHECK the wheel alignment. REFER to:(204-00 Suspension System - General Information) Specifications (Specifications), Front Toe Adjustment (General Procedures). INSTALL new suspension components as necessary.
	• Front or rear suspension damage.	• CHECK and INSTALL new suspension components as necessary.
• Rough ride	• Front strut and spring assemblies.	• CARRY OUT the Strut or Shock Absorber Testing component test in this procedure. • CHECK and INSTALL new suspension components as necessary. REFER to:Front Strut and Spring Assembly (204-01 Front Suspension, Disassembly and Assembly).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Front or rear stabilizer bar, connecting links or bushings.	• CHECK and INSTALL new suspension components as necessary. REFER to: Stabilizer Bar - Vehicles With: Solid Stabilizer Bar Link (204-01 Front Suspension, Removal and Installation), Front Stabilizer Bar (204-01 Front Suspension, Removal and Installation), Rear Stabilizer Bar (204-02 Rear Suspension, Removal and Installation).
	• Front suspension lower arm bushings.	• INSTALL new lower arm bushings. REFER to:Lower Arm Bushing (204-01 Front Suspension, Removal and Installation).
	• Rear suspension bushings.	• CHECK and INSTALL new components as necessary.
	• Rear shock absorbers.	• CARRY OUT the Strut or Shock Absorber Testing component test in this procedure. • CHECK and INSTALL new suspension components as necessary.
• Excessive noise	• Front strut and spring assembly or rear shock absorber and spring upper mounting bolts or nuts loose or broken.	• GO to Pinpoint Test B.
	• Shock absorbers leaking	• GO to Pinpoint Test B.
	• Shock absorber performance incorrect	• GO to Pinpoint Test B.
	• Stabilizer bar components	• GO to Pinpoint Test B.
	• Strut and spring assembly and springs	• GO to Pinpoint Tes tB.
	• Springs moving on spring upper or lower seats	• GO to Pinpoint Test B.
	• Suspension bushings	• GO to Pinpoint Test B.
	• Lower arm ball joint	• GO to Pinpoint Test B.
	• Worn front wheel bearings	• GO to Pinpoint Test B.
	• Wheels and tires	• GO to Pinpoint Test B.
• Incorrect tire wear	• Front or rear suspension damage.	• CHECK and INSTALL new suspension components as necessary.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Incorrect wheel alignment.	• CHECK the wheel alignment. REFER to:(204-00 Suspension System - General Information) Specifications (Specifications), Front Toe Adjustment (General Procedures).
• Vibration	• Damaged or worn front wheel bearings.	• CHECK the front wheel bearings. REFER to:Wheel Bearing Inspection (204-00 Suspension System - General Information, General Procedures).
	• Wheels and tires.	• CHECK the tires. BALANCE or INSTALL new tires as necessary.
	• Incorrect wheel alignment.	• ADJUST the wheel alignment. REFER to:(204-00 Suspension System - General Information) Specifications (Specifications), Front Toe Adjustment (General Procedures).
	• Steering gear or linkage worn or damaged.	• CHECK the steering system. REFER to:Steering System (211-00 Steering System - General Information, Diagnosis and Testing).
	• Front strut and spring assemblies.	• CARRY OUT the Strut or Shock Absorber Testing component test in this procedure. • CHECK and INSTALL new suspension components as necessary. REFER to:(204-01 Front Suspension) Driver Side Strut and Spring Assembly (Removal and Installation), Passenger Side Strut and Spring Assembly (Removal and Installation).
	• Damaged front suspension lower arm(s).	• INSTALL a new lower arm(s). REFER to:Lower Arm (204-01 Front Suspension, Removal and Installation).

DIAGNOSIS AND TESTING

Pinpoint Tests

PINPOINT TEST A : DRIFT LEFT OR RIGHT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:To avoid personal injury due to the loss of vehicle control, the inspection should be carried out by two people to maintain safe driving conditions. Adequate grip should always be maintained on the steering wheel. Failure to follow these instructions may result in personal injury.	
NOTE: The following conditions must be met when evaluating the vehicle.	
NOTE: The tire swapping procedures are for bi-directional rotating tires only.	
A1: SWAP THE FRONT WHEEL AND TIRE ASSEMBLIES	
	1 Raise and support the vehicle. REFER to:(100-02 Jacking and Lifting) Jacking (Description and Operation), Lifting (Description and Operation). • Swap the front left-hand wheel and tire assembly with the front right-hand wheel and tire assembly. • Road test the vehicle. • Does the vehicle drift? → **Yes** GO to A2. → **No** The concern has been corrected.
A2: SWAP THE REAR WHEEL AND TIRE ASSEMBLIES	
	1 Raise and support the vehicle. REFER to:(100-02 Jacking and Lifting) Jacking (Description and Operation), Lifting (Description and Operation). • Swap the rear left-hand wheel and tire assembly with the rear right-hand wheel and tire assembly. • Road test the vehicle. • Does the vehicle drift? → **Yes** GO to A3. → **No** The concern has been corrected.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A3: SWAP THE LEFT-HAND WHEEL AND TIRE ASSEMBLIES	
	1 Raise and support the vehicle. REFER to:(100-02 Jacking and Lifting) Jacking (Description and Operation), Lifting (Description and Operation). • Swap the front left-hand wheel and tire assembly with the rear left-hand wheel and tire assembly. • Road test the vehicle. • Does the vehicle drift? → **Yes** GO to A4. → **No** The concern has been corrected.
A4: SWAP THE RIGHT-HAND WHEEL AND TIRE ASSEMBLIES	
	1 Raise and support the vehicle. REFER to:(100-02 Jacking and Lifting) Jacking (Description and Operation), Lifting (Description and Operation). • Swap the front right-hand wheel and tire assembly with the rear right-hand wheel and tire assembly. • Road test the vehicle. • Does the vehicle drift? → **Yes** GO to A5. → **No** The concern has been corrected.
A5: SWAP THE FRONT LEFT-HAND WHEEL AND TIRE ASSEMBLY	
	1 Raise and support the vehicle. REFER to:(100-02 Jacking and Lifting) Jacking (Description and Operation), Lifting (Description and Operation). • Swap the front left-hand wheel and tire assembly with the rear right-hand wheel and tire assembly. • Road test the vehicle. • Does the vehicle drift? → **Yes** GO to A6. → **No** The concern has been corrected.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A6: SWAP THE FRONT RIGHT-HAND WHEEL AND TIRE ASSEMBLY	
	1 Raise and support the vehicle. REFER to:(100-02 Jacking and Lifting) Jacking (Description and Operation), Lifting (Description and Operation). • Swap the front right-hand wheel and tire assembly with the rear left-hand wheel and tire assembly. • Road test the vehicle. • Does the vehicle drift? → **Yes** GO to A7. → **No** The concern has been corrected.
A7: INSTALL NEW TIRES	
NOTE: Install new tires only once.	
	1 Install new tires to the four road wheels. • Road test the vehicle. • Does the vehicle drift? → **Yes** Verify possible sources. Refer to the Symptom Chart. → **No** The concern has been corrected.

PINPOINT TEST B : EXCESSIVE NOISE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: INSPECT ALL STRUT AND SPRING ASSEMBLY AND SHOCK ABSORBER MOUNTING BOLTS AND NUTS	
	1 Inspect the strut and spring assembly and shock absorber mounting bolts and nuts. • Are the mounting bolts or nuts loose or broken? → **Yes** TIGHTEN or INSTALL new mounting bolts and nuts. REFER to: Specifications (204-01 Front Suspension, Specifications), Specifications (204-02 Rear Suspension, Specifications). → **No** GO to B2.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B2: INSPECT THE STRUT AND SPRING ASSEMBLIES AND SHOCK ABSORBERS FOR LEAKS	
	NOTE: Make sure that the oil is not from another source. 1 Inspect the strut and spring assemblies and shock absorbers for signs of oil weepage or leaks. Refer to weepage and leakage conditions in the Strut or Shock Absorber Testing component test in this procedure. • Are the struts or shock absorbers leaking? → **Yes** INSTALL new struts or shock absorbers as necessary. REFER to:(204-01 Front Suspension) Driver Side Strut and Spring Assembly (Removal and Installation), Passenger Side Strut and Spring Assembly (Removal and Installation). → **No** GO to B3.
B3: INSPECT THE SPRINGS AND STABILIZER BAR(S)	
	1 Inspect the springs and stabilizer bar(s) for damage. • Are the springs or stabilizer bar(s) damaged? → **Yes** INSTALL new springs or stabilzer bar(s). REFER to: Stabilizer Bar - Vehicles With: Solid Stabilizer Bar Link (204-01 Front Suspension, Removal and Installation), Front Stabilizer Bar (204-01 Front Suspension, Removal and Installation), Driver Side Strut and Spring Assembly (204-01 Front Suspension, Removal and Installation), Passenger Side Strut and Spring Assembly (204-01 Front Suspension, Removal and Installation), Rear Stabilizer Bar (204-02 Rear Suspension, Removal and Installation), Spring (204-02 Rear Suspension, Removal and Installation). → **No** GO to B4.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B4: INSPECT THE SUSPENSION BUSHINGS	
	1 Inspect the suspension bushings for excessive wear or damage. • Are the bushings worn or damaged? → **Yes** INSTALL new components as necessary. REFER to: Stabilizer Bar - Vehicles With: Solid Stabilizer Bar Link (204-01 Front Suspension, Removal and Installation), Front Stabilizer Bar (204-01 Front Suspension, Removal and Installation), Lower Arm Bushing (204-01 Front Suspension, Removal and Installation), Driver Side Strut and Spring Assembly (204-01 Front Suspension, Removal and Installation), Passenger Side Strut and Spring Assembly (204-01 Front Suspension, Removal and Installation), Rear Stabilizer Bar (204-02 Rear Suspension, Removal and Installation). → **No** GO to B5.
B5: INSPECT THE SUSPENSION LOWER ARM BALL JOINTS	
	1 Carry out the Ball Joint Inspection component test in this procedure. • Is the lower arm ball joint or gaiter damaged? → **Yes** INSTALL a new lower arm. REFER to:Lower Arm (204-01 Front Suspension, Removal and Installation). → **No** GO to B6.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B6: INSPECT THE WHEEL BEARINGS	
	1 Check the wheel bearings. REFER to:Wheel Bearing Inspection (204-00 Suspension System - General Information, General Procedures). • Are the wheel bearings damaged? → **Yes** INSTALL a new wheel bearing(s). REFER to:Front Wheel Bearing (204-01 Front Suspension, Removal and Installation). → **No** GO to B7.
B7: INSPECT THE WHEELS AND TIRES	
	1 Check the tires for uneven wear. • Is there uneven tire wear? → **Yes** REFER to the symptom chart. → **No** GO to B8.
B8: INSPECT THE STRUT AND SPRING ASSEMBLY AND REAR SUSPENSION SPRING INTERFACE	
	1 Loosen the strut and spring assemblies and rear spring mounting bolts and nuts. Tighten the mounting bolts and nuts. REFER to: Specifications (204-01 Front Suspension, Specifications), Specifications (204-02 Rear Suspension, Specifications). – Carry out a road test. REFER to:Road/Roller Testing (100-00 General Information, Description and Operation). • Is the concern still evident? → **Yes** GO to B9. → **No** Vehicle condition corrected.
B9: INSPECT THE STRUT AND SPRING ASSEMBLIES, REAR SPRING AND SHOCK ABSORBER COMPONENTS	
	1 Check that the spring is correctly located on the spring seat and has not moved.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disassemble the strut and spring and assembly and inspect the individual components. REFER to:Front Strut and Spring Assembly (204-01 Front Suspension, Disassembly and Assembly).
	3 Inspect the shock absorber top mount for wear or damage.
	4 Carry out the Strut or Shock Absorber Testing component test in this procedure. • Are any of the strut and spring assemblies or shock absorber components damaged? → **Yes** INSTALL new components as necessary. REFER to: Driver Side Strut and Spring Assembly (204-01 Front Suspension, Removal and Installation), Passenger Side Strut and Spring Assembly (204-01 Front Suspension, Removal and Installation), Spring (204-02 Rear Suspension, Removal and Installation). → **No** REINSTALL the strut and spring assemblies, rear spring or shock absorbers. GO to B10.
B10: CARRY OUT A ROAD TEST	
	1 Carry out a road test. REFER to:Road/Roller Testing (100-00 General Information, Description and Operation). • Is the concern still evident? → **Yes** REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing). → **No** Vehicle condition corrected.

Component Tests

Raise and support the vehicle. REFER to:(100-02 Jacking and Lifting)

Jacking (Description and Operation),
Lifting (Description and Operation).

Ball Joint Inspection

1. Firmly grasp the outer end of the suspension lower arm and try to move it up and down, watching and feeling for any movement. Free movement will usually be accompanied by an audible "click". There should be no free movement.

DIAGNOSIS AND TESTING

2. If there is any free movement, install a new lower arm ball joint. REFER to:(204-01 Front Suspension)

   Lower Arm Ball Joint - RWD (Removal and Installation),
   Lower Arm Ball Joint - FWD (Removal and Installation).
3. If a new lower arm ball joint is installed it will be necessary to check and adjust the front wheel alignment. REFER to:

   Specifications (204-01 Front Suspension, Specifications),
   Front Toe Adjustment (204-00 Suspension System - General Information, General Procedures).

Strut or Shock Absorber Inspection

NOTE: Inspect the struts or shock absorber for signs of oil weepage or leaks. Make sure that the oil is not from another source.

Weepage:

- deposits a thin film of oil on the strut and spring assembly or shock absorber.
- is normally noticed due to a collection of dust on the strut and spring assembly or shock absorber.
- occurs during the normal running-in period of 4800 - 8050 km. After this period no new signs of oil should be visible.
- does not require new struts or shock absorbers to be installed.

Leakage:

- covers the entire strut and spring assembly or shock absorber with oil.
- will drip oil onto the surrounding suspension components.
- requires new struts or shock absorbers to be installed.

Strut or Shock Absorber Testing

NOTE: Struts or shock absorbers must be tested in the vertical position.

1. Remove both strut and spring assemblies or shock absorbers. The piston rods should extend.
   - Disassemble the strut and spring assemblies.

     REFER to:Front Strut and Spring Assembly (204-01 Front Suspension, Disassembly and Assembly).
2. Compress the piston rods. Both piston rods should offer the same resistance when compressing.
3. Compress and release the piston rods. The piston rods should extent equally.
4. Compress and pull the piston rod in the vertical position. Feel if the resistance force at the point of direction change-over is perceptible without a lag. If a lag is perceptible it is an indication of damper valve damage and new struts or shock absorbers must be installed. REFER to:(204-01 Front Suspension)

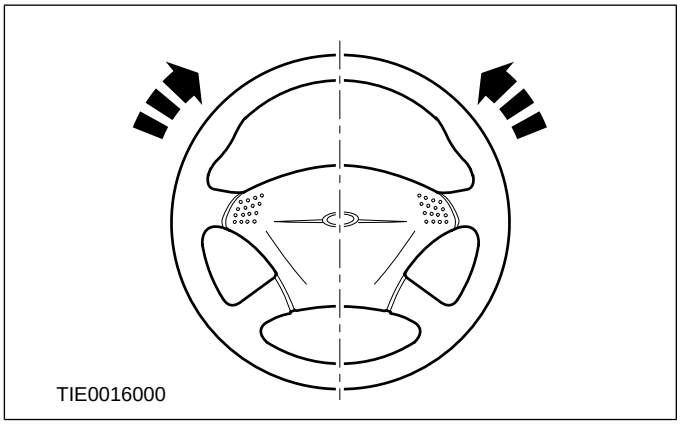
   Driver Side Strut and Spring Assembly (Removal and Installation),
   Passenger Side Strut and Spring Assembly (Removal and Installation).

GENERAL PROCEDURES

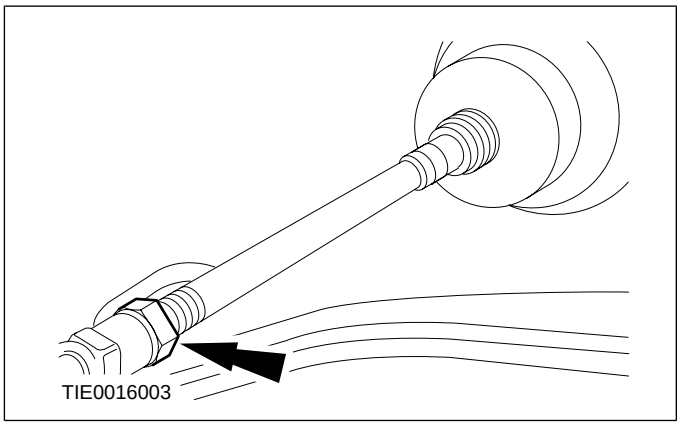
Front Toe Adjustment (14 117 0)

NOTE: Make sure that the vehicle is standing on a level surface.

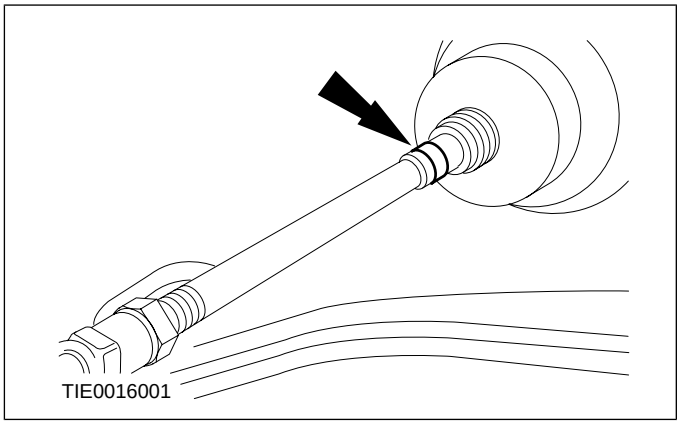
1. **Centralize the steering and lock it in position.**



2. **Loosen the tie-rod end locknuts.**

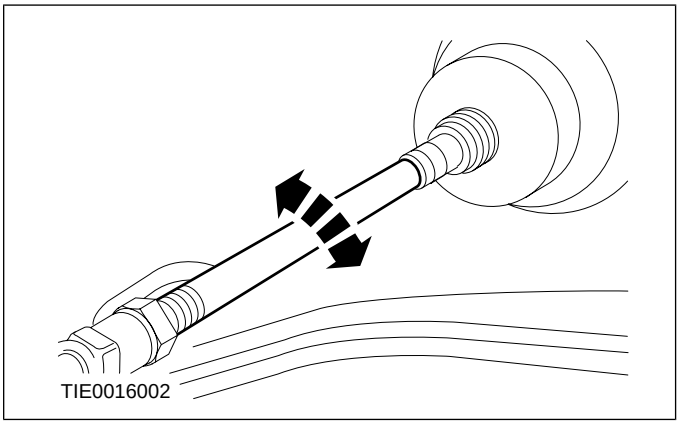


3. **Remove the steering gear boot outer clamps.**



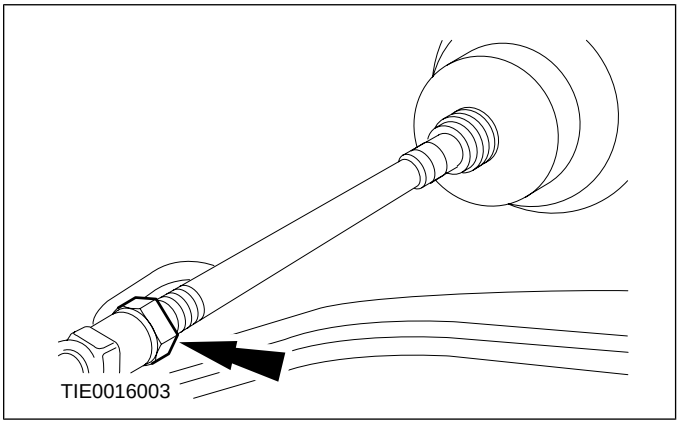
4. **Rotate the tie-rods an equal amount in either a clockwise or a counterclockwise direction to adjust the toe setting.**

   For additional information, refer to:Specifications (204-00 Suspension System - General Information, Specifications).

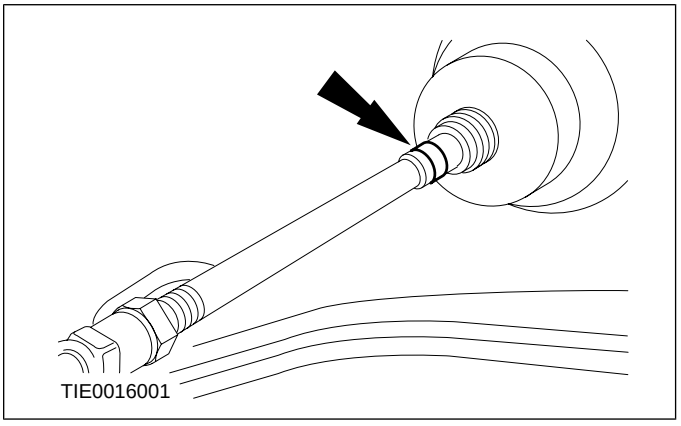


5. **Tighten the tie-rod end locknuts.**

   For additional information, refer to:Tie Rod End (211-03 Steering Linkage, Removal and Installation).



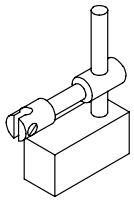
6. **Install the steering gear boot outer clamps.**



GENERAL PROCEDURES

Wheel Bearing Inspection

Special Tool(s)

 15008	Holding Fixture, Dial Indicator Gauge 205-044 (15-008)

General Equipment

Dial indicator gauge

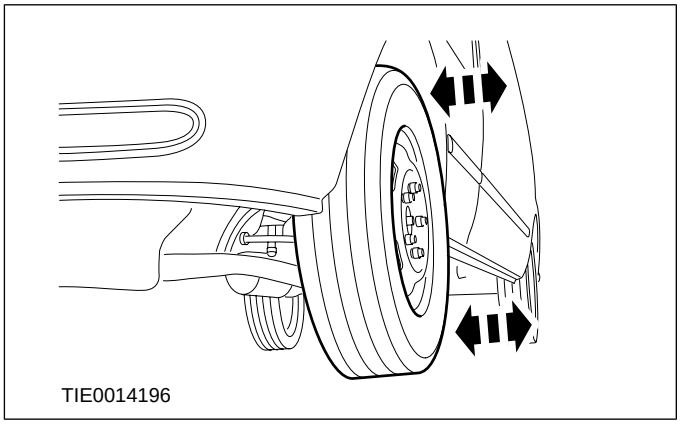
Check

1. **NOTE:Do not to confuse lower arm ball joint looseness with bearing looseness.**

   Raise and support the front of the vehicle. For additional information, refer to:(100-02 Jacking and Lifting)

   Jacking (Description and Operation), Lifting (Description and Operation).

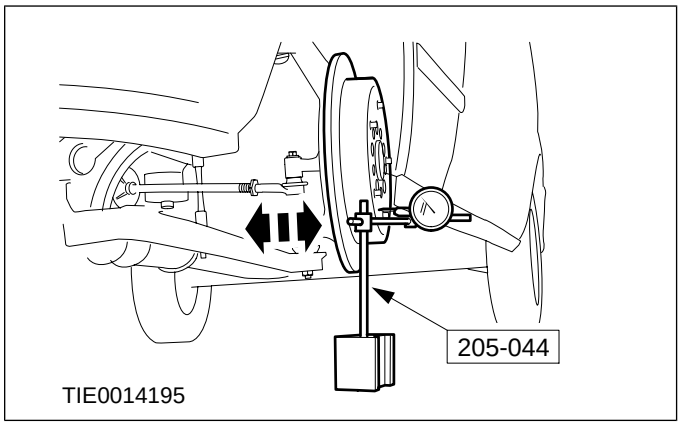
2. **Check for loose front wheel bearings by rocking the wheels at the top and bottom.**



3. **Spin the wheel quickly by hand and make sure the wheel turns smoothly without noise from the wheel bearings.**
4. **Remove the front brake caliper anchor plate.**

   For additional information, refer to:Brake Caliper Anchor Plate (206-03 Front Disc Brake, Removal and Installation).

5. **Position a suitable Dial indicator gauge fixture or equivalent, against the wheel hub, then push and pull the wheel hub. Measure the end play of the wheel hub and front wheel bearing assembly. There should be no end play. If end play exists, install new wheel bearings.**



6. **Install the front brake caliper anchor plate.**

   For additional information, refer to:Brake Caliper Anchor Plate (206-03 Front Disc Brake, Removal and Installation).

SECTION 204-01 Front Suspension

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 204-01-2

DESCRIPTION AND OPERATION

Front Suspension 204-01-3

DIAGNOSIS AND TESTING

Front Suspension 204-01-5

REMOVAL AND INSTALLATION

Wheel Hub — RWD	(14 371 0)	204-01-6
Front Wheel Bearing	(14 411 0)	204-01-10
Front Stabilizer Bar	(14 752 0)	204-01-11
Lower Arm	(14 706 0)	204-01-12
Lower Arm Bushing	(14 724 0)	204-01-14
Wheel Knuckle	(14 343 0)	204-01-16
Lower Arm Ball Joint — RWD	(14 735 0)	204-01-19
Driver Side Strut and Spring Assembly	(14 781 0)	204-01-24
Passenger Side Strut and Spring Assembly	(14 781 0)	204-01-26

DISASSEMBLY AND ASSEMBLY

Front Strut and Spring Assembly	(14 783 4)	204-01-28

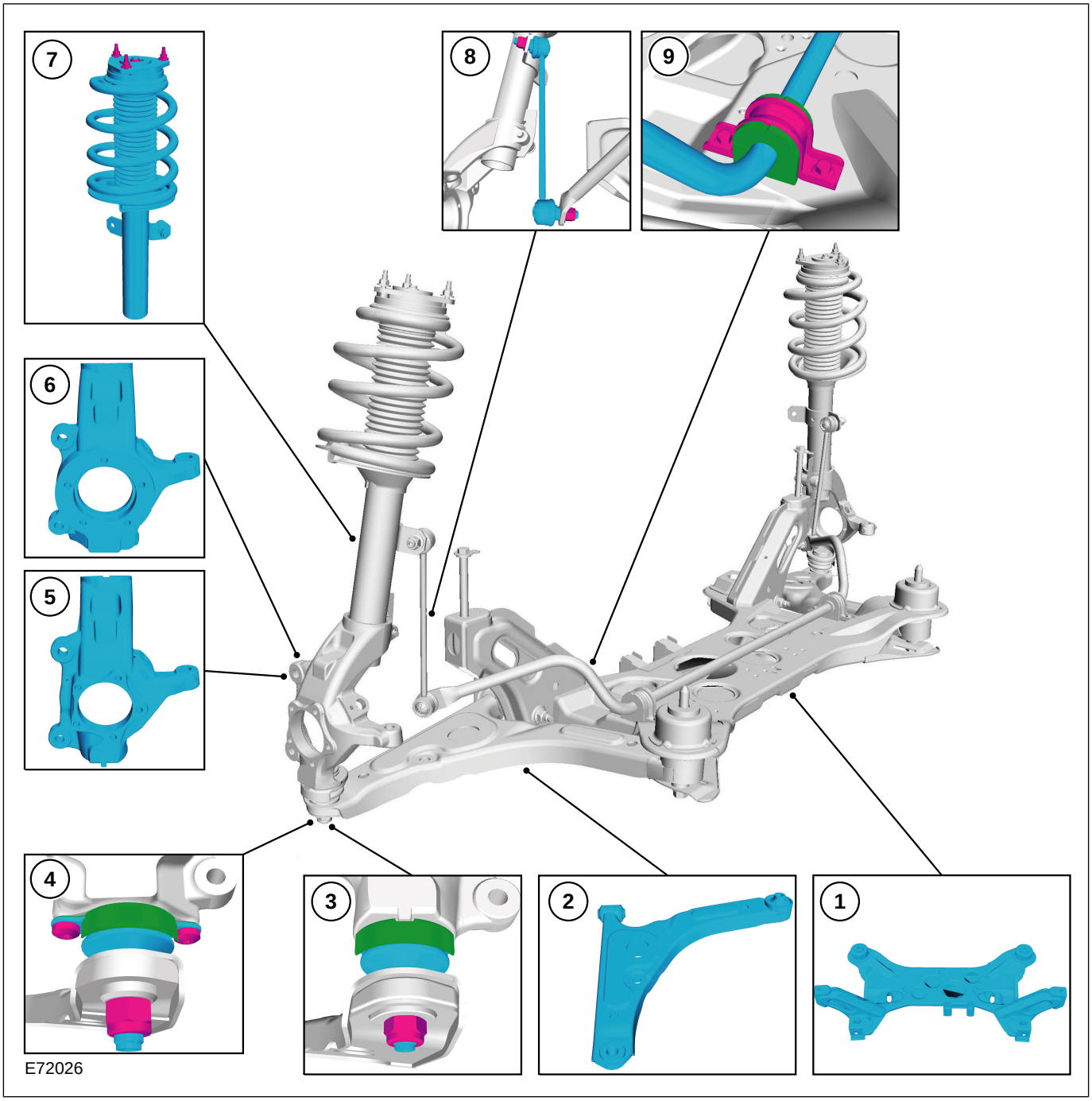
SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Lower arm ball joint retaining nut - with a flat diameter of 24 mm	150	111	-
Lower arm ball joint retaining nut - with a flat diameter of 30 mm	250	184	-
Lower arm ball joint retaining bolts	63	46	-
Wheel knuckle pinch bolt	90	66	-
Wheel spindle retaining nut	440	324	-
Halfshaft retaining nut	500	370	-
Wheel speed sensor harness to strut and spring assembly retaining nut	48	35	-
Wheel speed sensor retaining bolt	8	-	71
Stabilizer bar link retaining nuts	55	41	-
Top mount retaining nuts	30	22	-
Thrust bearing retaining nut	70	52	-
Transmission support insulator to front axle cross-member retaining bolts	40	30	-
Transmission support insulator to transmission retaining bolts	55	41	-
Brake hose to strut and spring assembly retaining nut	25	18	-
Brake caliper anchor plate retaining bolts	175	129	-
Lower arm to front axle crossmember rear retaining bolt	300	221	-
Lower arm to front axle crossmember front retaining bolt	200	148	-
Stabilizer bar clamp retaining bolts	30	22	-
Tie-rod end retaining nut	80	59	-
Wheel hub retaining bolts	53	39	-
Brake disc retaining bolts	69	51	-

DESCRIPTION AND OPERATION

Front Suspension



Item	Part Number	Description
1		Crossmember
2		Lower arm
3		Lower arm ball joint (vehicles with maximum permissible front axle load up to 1750 kg)
4		Lower arm ball joint (vehicles with maximum permissible front axle load over 1750 kg)
5		Wheel knuckle (vehicles with maximum permissible front axle load up to 1750 kg)

DESCRIPTION AND OPERATION

Item	Part Number	Description
6		Wheel knuckle (vehicles with maximum permissible front axle load over 1750 kg)
7		Strut and spring assembly
8		Stabilizer bar link
9		Stabilizer bar, clamp and bushing

DIAGNOSIS AND TESTING

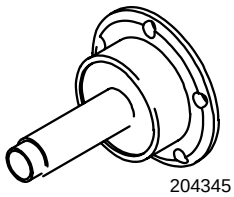
Front Suspension

REFER to Section 204-00 [Suspension System - General Information].

REMOVAL AND INSTALLATION

Wheel Hub — RWD (14 371 0)

Special Tool(s)

 204345	Remover, Wheel Bearing 204-345A

General Equipment

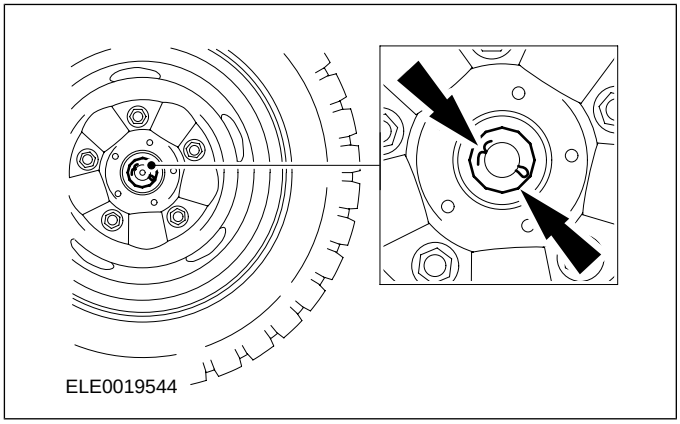
Hydraulic press

Materials

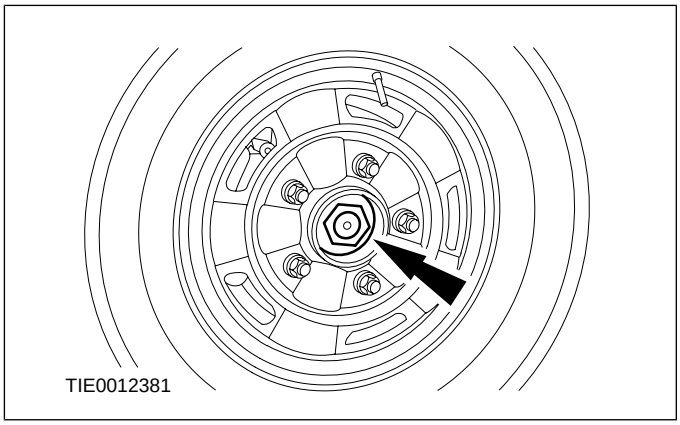
Name	Specification
High temperature grease	ESE-M12A4-A

Removal

1. **Remove the wheel spindle retaining nut locking ring.**
   - Discard the cotter pin.



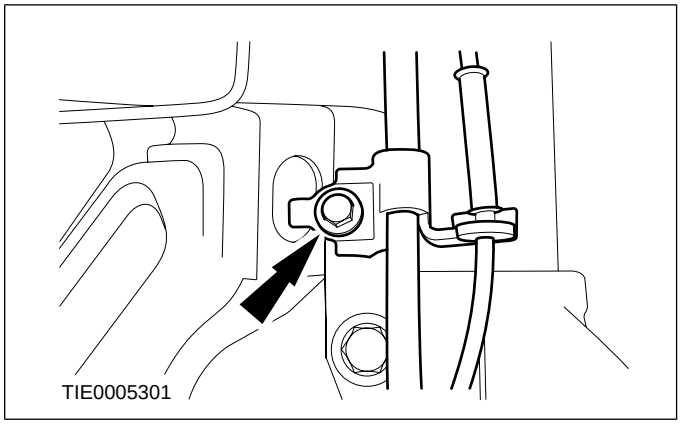
2. **Loosen the wheel spindle retaining nut.**



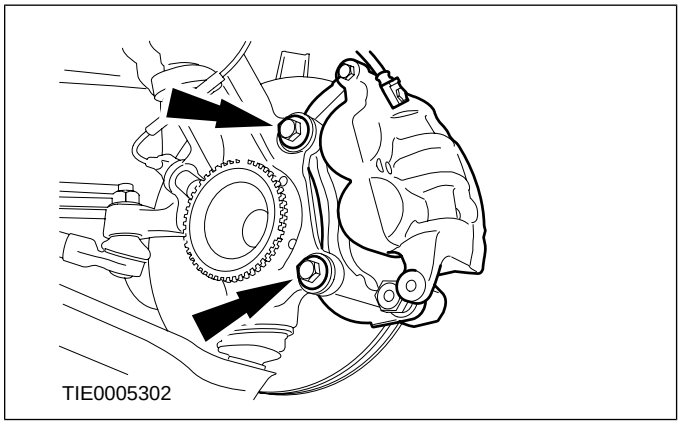
3. **Remove the wheel and tire.**

   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

4. **Detach the brake hose from the suspension strut.**



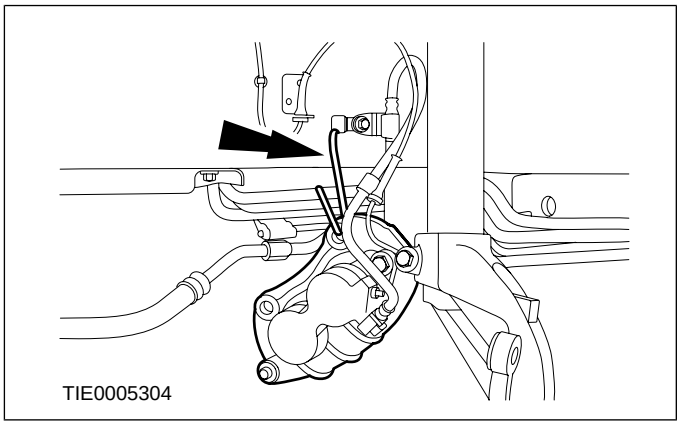
5. **Detach the brake caliper and anchor plate from the wheel knuckle.**



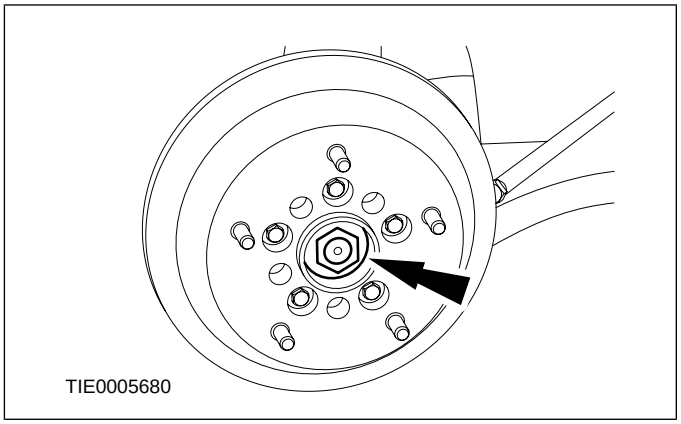
6. **⚠CAUTION:Suspend the brake caliper and anchor plate to prevent load being placed on the brake hose.**

REMOVAL AND INSTALLATION

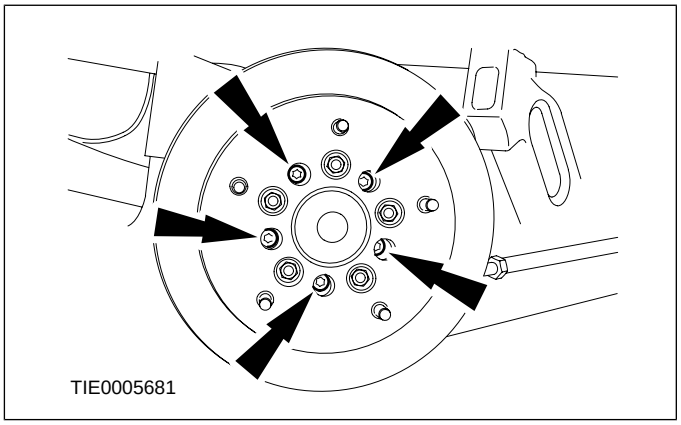
Suspend the brake caliper and anchor plate.



7. **Remove the wheel spindle.**
   - Remove the wheel spindle retaining nut and washer.

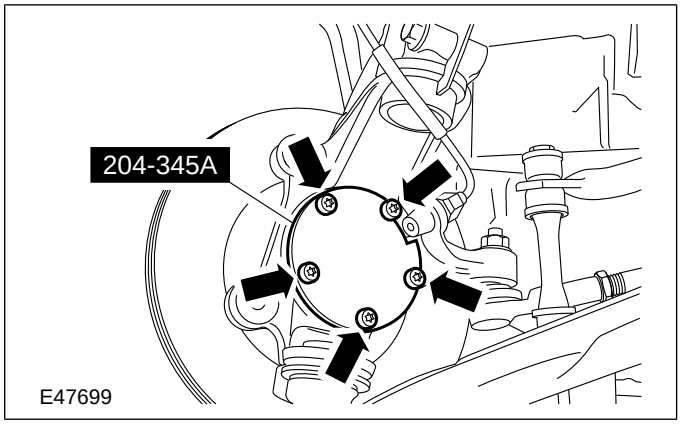


8. **Remove the wheel hub and brake disc assembly retaining bolts.**



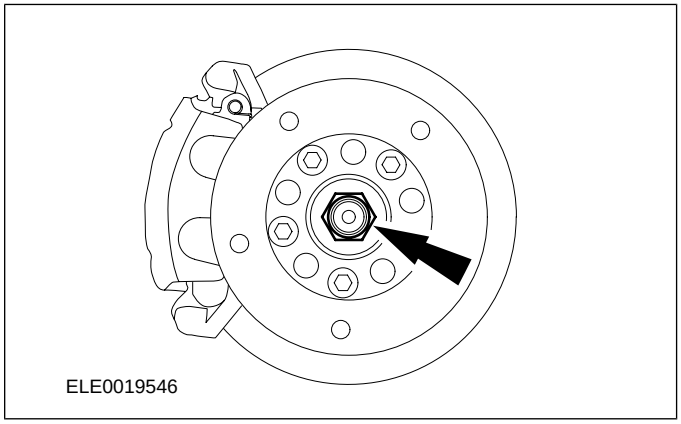
9. **CAUTION:Make sure that the special tool cut out is aligned with the wheel speed sensor.**

Using the wheel hub retaining bolts, install the special tool.

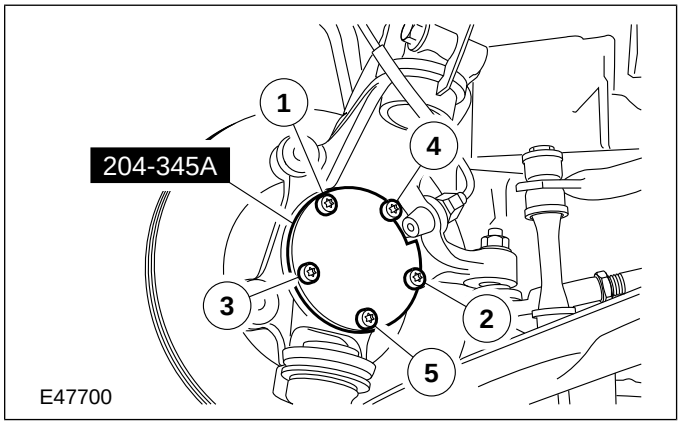


10. **WARNING:Attach the wheel spindle retaining nut to the special tool. Failure to follow this instruction may result in personal injury.**

Attach the wheel spindle retaining nut to the special tool.



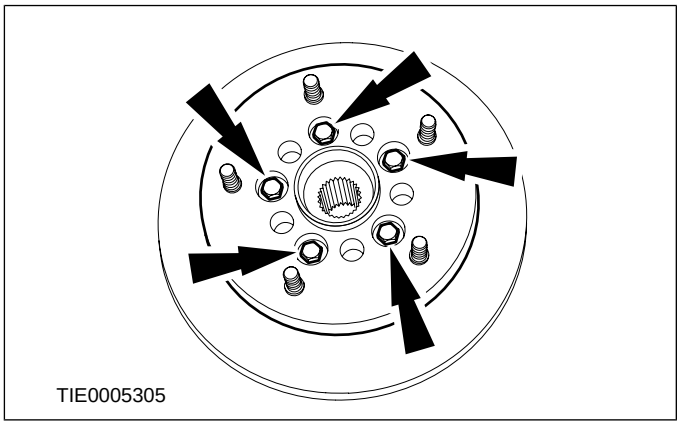
11. **Using the special tool, remove the wheel hub and brake disc assembly.**
   - Tighten the retaining bolts in the sequence shown.



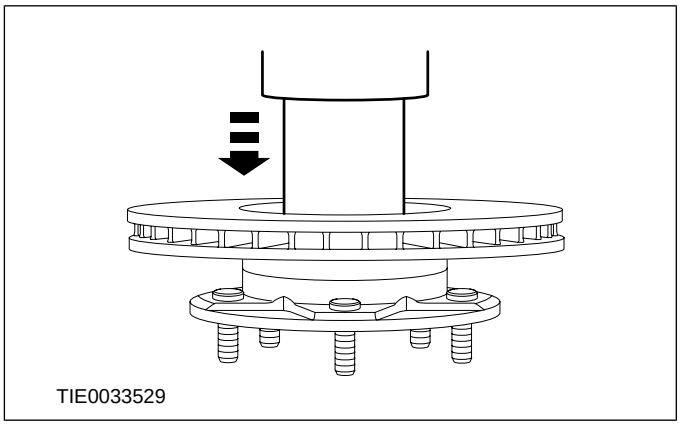
12. **Remove the special tool.**

REMOVAL AND INSTALLATION

13. **Remove the brake disc retaining bolts.**


TIE0005305

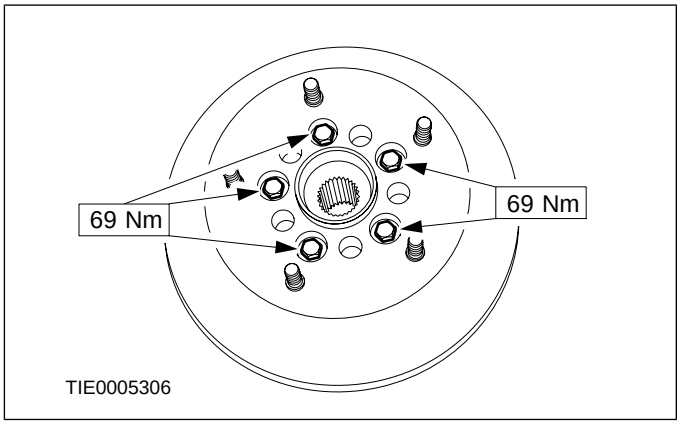
14. **Using a suitable hydraulic press and drift, remove the wheel hub.**


TIE0033529

Installation

1. **NOTE:Apply high temperature grease to the mating surfaces of the wheel bearing housing and the wheel knuckle.**

   Attach the brake disc to the wheel hub.

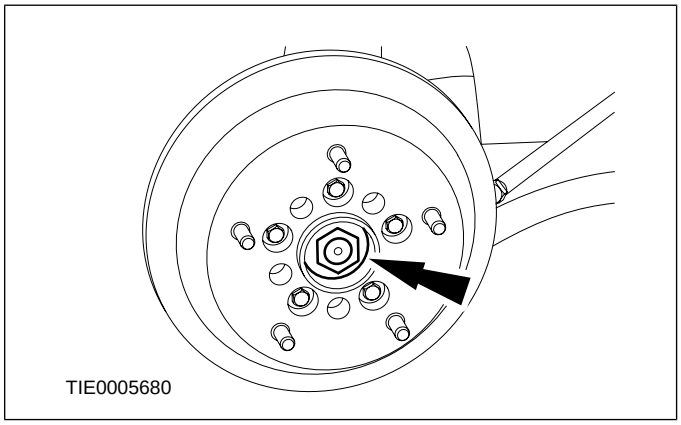


TIE0005306

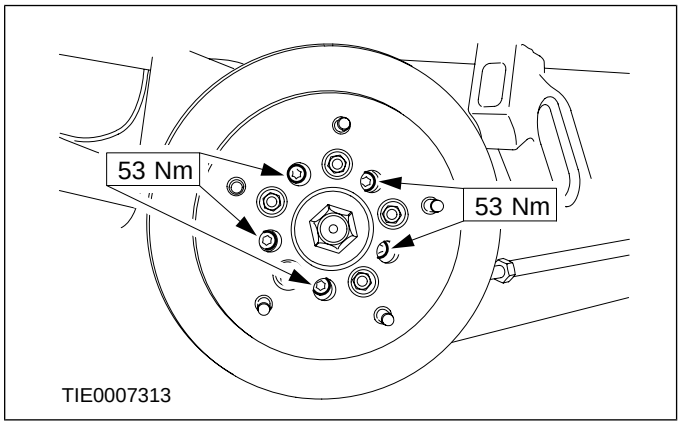
2. **NOTE:Use the old wheel spindle retaining nut.**

NOTE: Do not fully tighten the wheel spindle retaining nut at this stage (100 Nm maximum).

Attach the wheel hub and brake disc assembly to the wheel spindle and rotate the wheel hub 5 times.

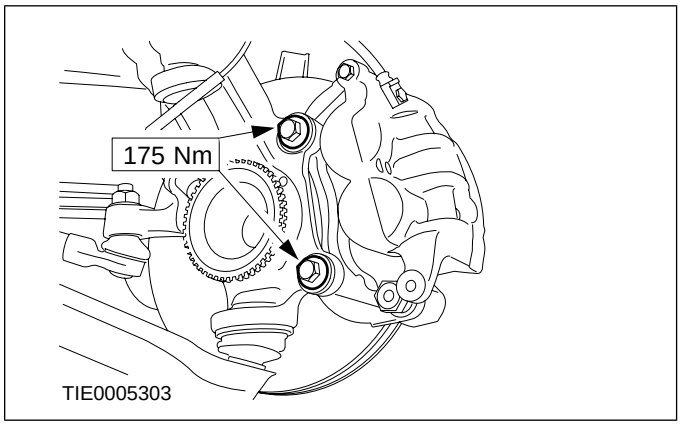

TIE0005680

3. **Install the wheel hub and brake disc assembly.**



TIE0007313

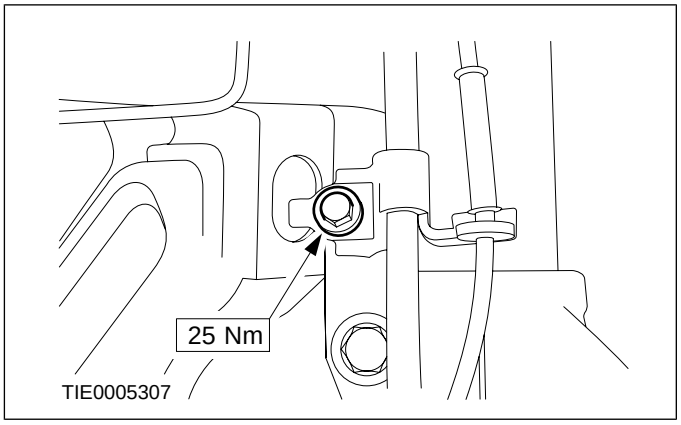
4. **Attach the brake caliper and anchor plate to the wheel knuckle.**



TIE0005303

REMOVAL AND INSTALLATION

5. **Attach the brake hose to the suspension strut.**



6. **Install the wheel and tire.**

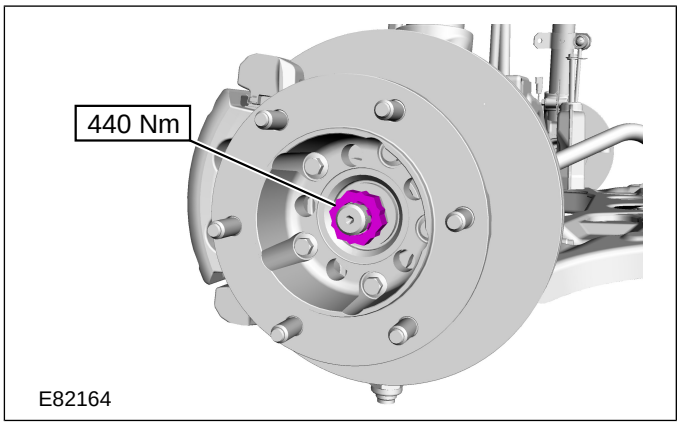
   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

7. **⚠CAUTION:Before installing the wheel spindle retaining nut locking ring, remove and discard the old wheel spindle retaining nut and install a new one.**

NOTE: Make sure the wheel spindle retaining nut washer is installed.

Install the wheel spindle retaining nut and washer.

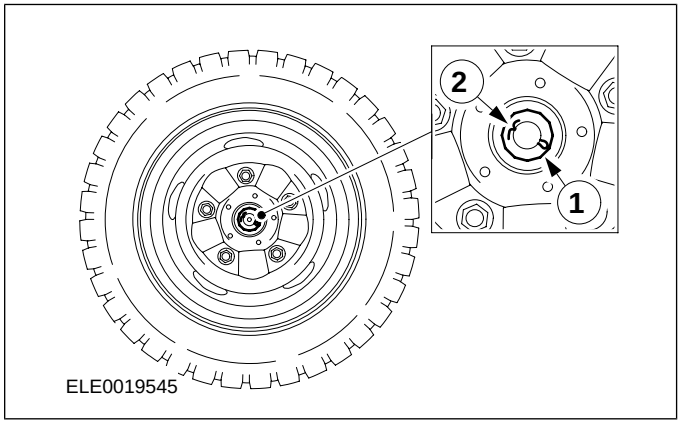
- Tighten the wheel spindle retaining nut in 4 stages:
  - Tighten the wheel spindle retaining nut to 250 Nm.
  - Rotate the wheel 5 times.
  - Fully tighten the wheel spindle retaining nut.
  - Rotate the wheel 5 times.



8. **NOTE:Install a new cotter pin.**

Install the wheel spindle retaining nut locking ring.

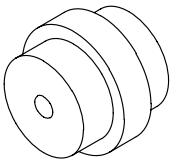
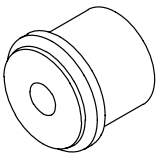
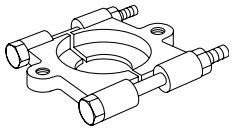
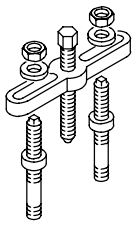
1. Attach the wheel spindle retaining nut locking ring.
2. Install the cotter pin.



REMOVAL AND INSTALLATION

Front Wheel Bearing (14 411 0)

Special Tool(s)

 1403801	Adaptor for 204-158 (14-038) (Thrust Pad) 204-158-01 (14-038-01)
 1503303	Adaptor for 205-066 205-066-03 (15-033-03)
 TI15091	Remover, Bearing/Gear 205-310 (15-091)
 15092	Remover, Bearing/Gear 205-311 (15-092)

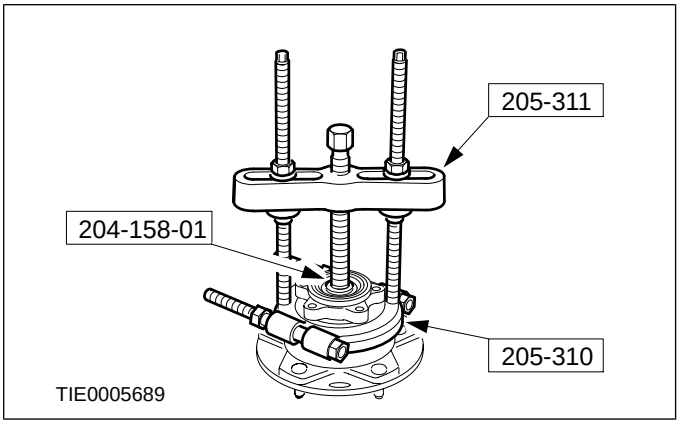
Removal

1. **Remove the wheel hub. For additional information, refer to:(204-01 Front Suspension)**

   Wheel Hub - RWD (Removal and Installation), Wheel Hub (Removal and Installation).

2. **NOTE:Whenever the wheel bearing is removed, a new wheel bearing must be installed.**

Using the special tools, remove the wheel bearing.



Installation

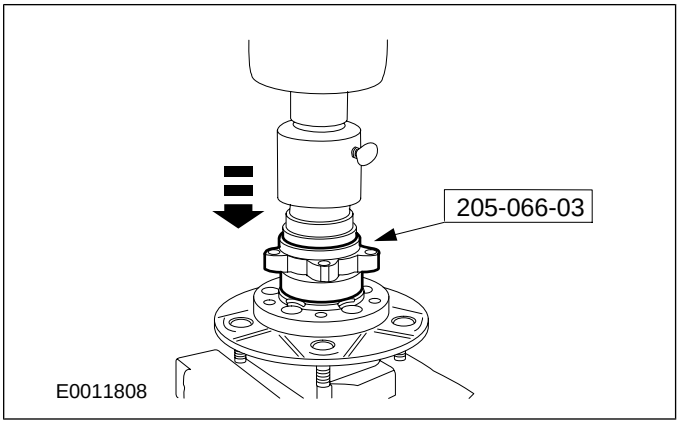
1. **⚠CAUTION:Do not apply excessive load on the wheel bearing.**

   Loosely assemble the wheel hub and wheel bearing with the press and apply minimum load to hold in position.

   - Rotate the wheel bearing 5 times before any load is applied.

2. **⚠CAUTION:Pressure must be stopped once the wheel bearing is in contact with the wheel hub surface.**

   Using the special tool, install the wheel bearing.



REMOVAL AND INSTALLATION

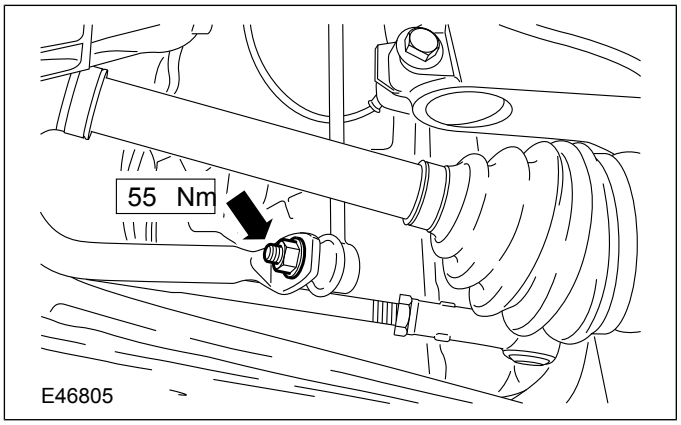
Front Stabilizer Bar (14 752 0)

Removal

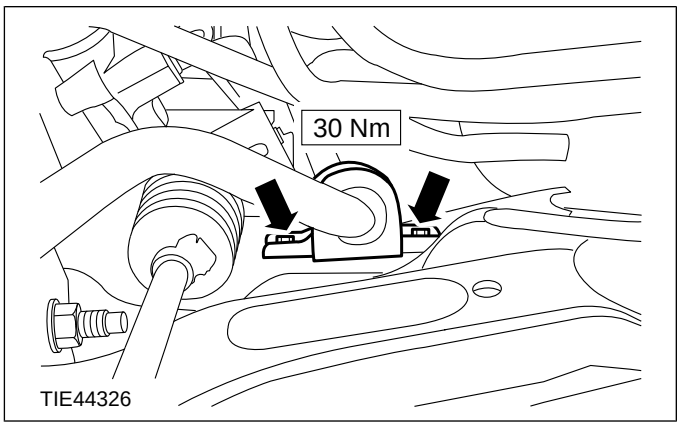
1. **Remove the front wheels and tires.**

   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

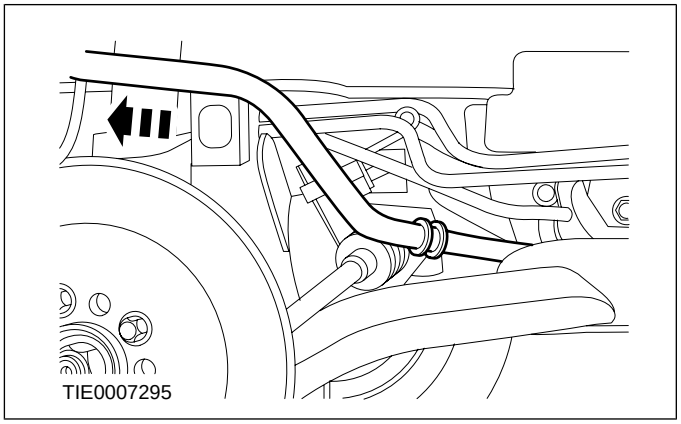
2. **Detach the stabilizer bar link from the stabilizer bar on both sides.**



3. **Remove the stabilizer bar clamp on both sides.**



4. **Remove the stabilizer bar.**



Installation

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

Lower Arm (14 706 0)

General Equipment

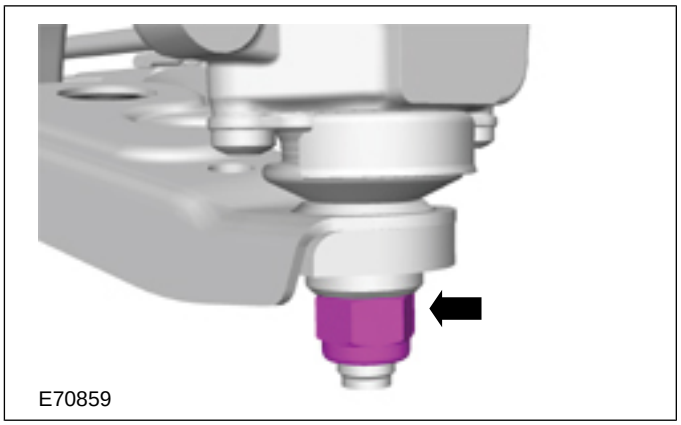
Two leg puller

Removal

1. **Remove the wheel and tire.**

   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

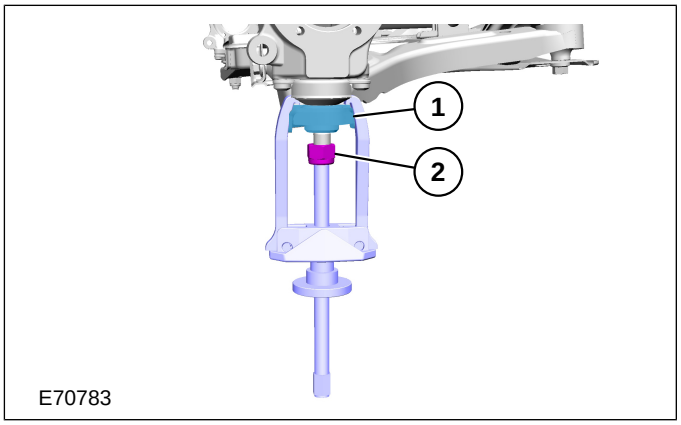
2. **Loosen the lower arm ball joint retaining nut.**



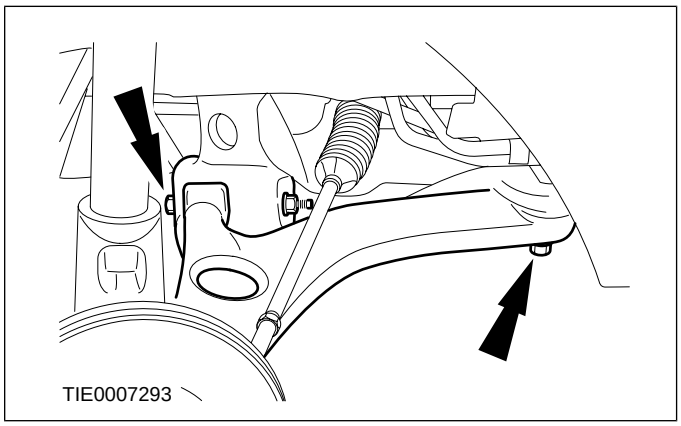
3. **CAUTION:Protect the ball joint seal using a soft cloth to prevent damage.**

   Using a suitable two leg puller, detach the lower arm from the wheel knuckle.

   1. Use a soft faced hammer to strike the lower arm.
   2. Remove and discard the retaining nut.

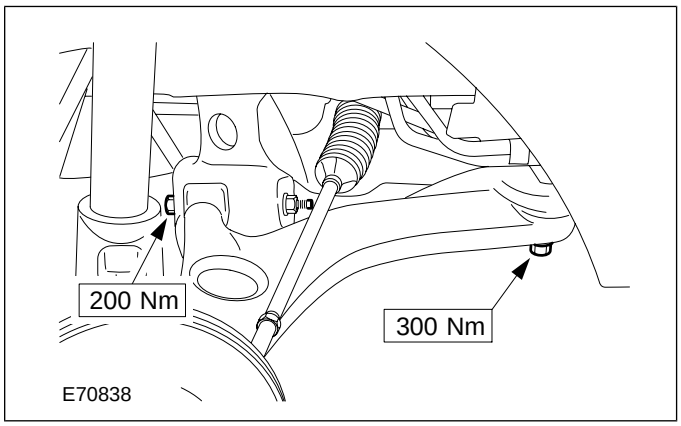


4. **Remove the lower arm.**



Installation

1. **Install the lower arm.**

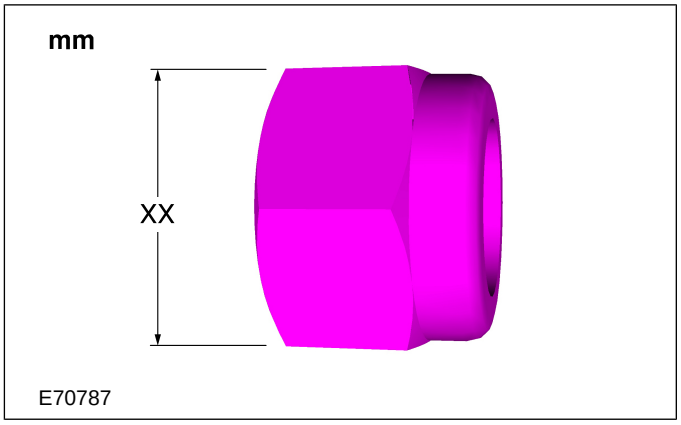


2. **WARNING:Install a new lower arm ball joint retaining nut. Failure to follow this instruction may result in personal injury.**

NOTE: Vehicles are equipped with a lower arm ball joint retaining nut with a flat diameter of either 24 mm or 30 mm.

REMOVAL AND INSTALLATION

Measure the lower arm ball joint retaining nut flat diameter to aid installation.



3. **CAUTION:Make sure that the ball joint ball does not rotate.**

   Install the lower arm ball joint retaining nut.

   For additional information, refer to:Specifications (204-01 Front Suspension, Specifications).

4. **Install the wheel and tire.**

   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

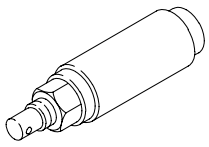
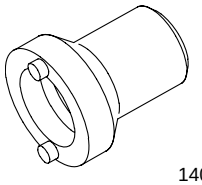
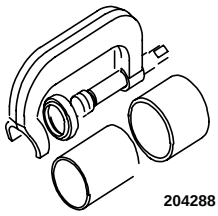
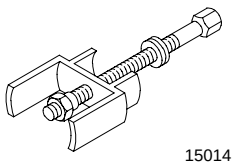
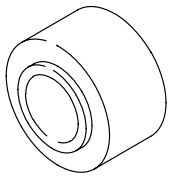
5. **Check the toe setting and adjust as necessary.**

   For additional information, refer to:Specifications (204-00 Suspension System - General Information, Specifications) / Front Toe Adjustment (204-00 Suspension System - General Information, General Procedures).

REMOVAL AND INSTALLATION

Lower Arm Bushing (14 724 0)

Special Tool(s)

 14037	Installer, Wheel Hub 204–148 (14–037)
 14049	Socket, Hub Nut 204–174 (14–049)
 204288	Remover/Installer, Ball Joint 204–288A (14–063A)
 15014	Remover/Installer, Rear Suspension Bushing 205–050 (15–014)
 21178	Installer, Timing Cover Oil Seal 303–427 (21–178)

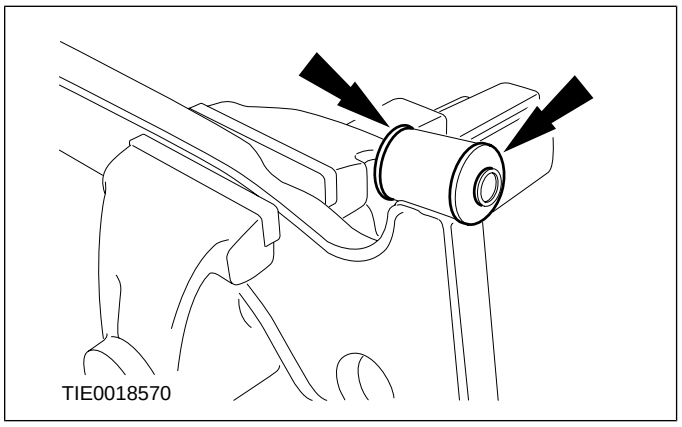
Materials	
Name	**Specification**
Silicone Grease	ESE-M1C171-A

Removal

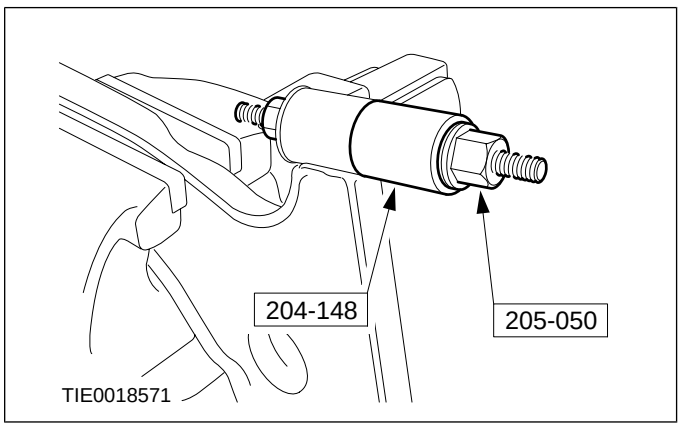
1. **Remove the lower arm.**

   For additional information, refer to:Lower Arm (204-01 Front Suspension, Removal and Installation).

2. **Secure the lower arm in a vise.**
3. **Using a suitable knife, remove the rubber ends of the lower arm horizontal bushing.**



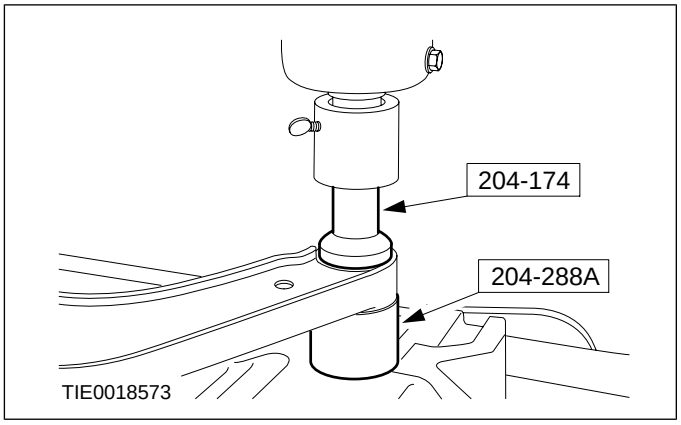
4. **Using the special tools, remove the lower arm horizontal bushing.**



5. **Remove the lower arm from the vise.**

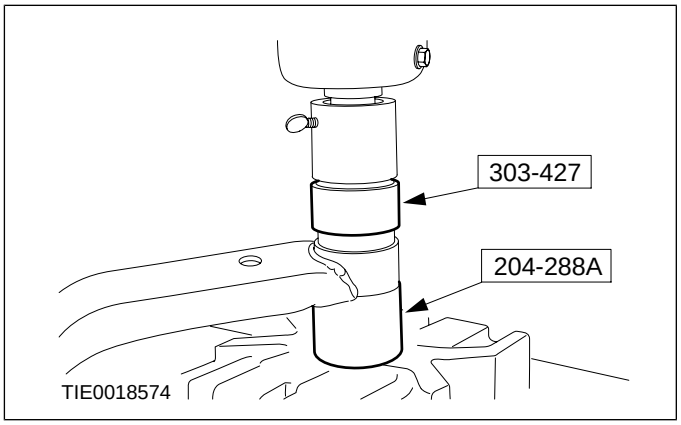
REMOVAL AND INSTALLATION

6. Using the special tools, remove the lower arm vertical bushing.

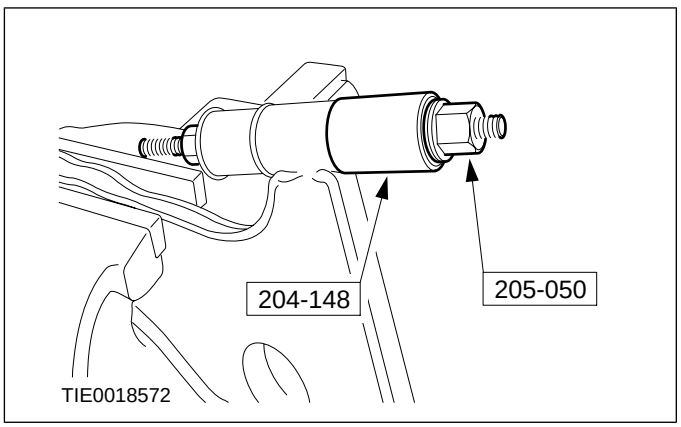


Installation

1. Using the special tool, install the lower arm vertical bushing.



2. Secure the lower arm in a vise.
3. Lubricate the lower arm horizontal bushing with grease.
4. Using the special tools, install the lower arm horizontal bushing.



5. Install the lower arm.

   For additional information, refer to:Lower Arm (204-01 Front Suspension, Removal and Installation).

6. Check the toe setting and adjust as necessary. For additional information, refer to:(204-00 Suspension System - General Information)

   Specifications (Specifications), Front Toe Adjustment (General Procedures).

REMOVAL AND INSTALLATION

Wheel Knuckle (14 343 0)

General Equipment

Two leg puller

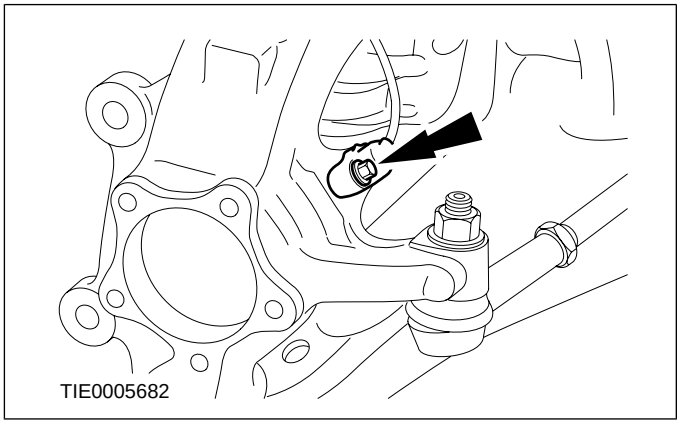
Removal

All vehicles

1. **Remove the wheel hub. For additional information, refer to:(204-01 Front Suspension)**

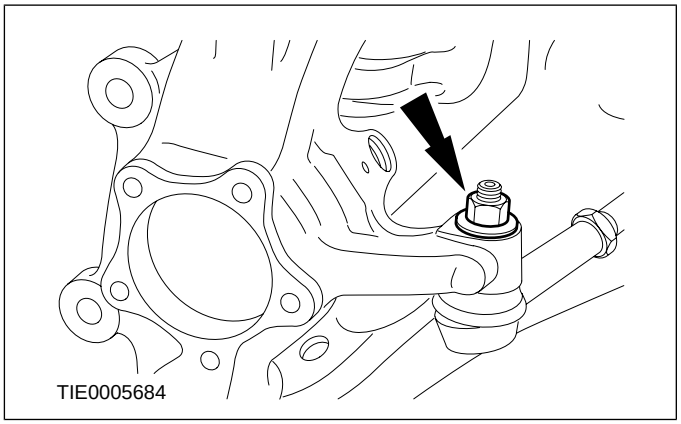
   Wheel Hub - RWD (Removal and Installation), Wheel Hub (Removal and Installation).

2. **Detach the wheel speed sensor from the wheel knuckle.**



3. **CAUTION:Leave the tie-rod end retaining nut in place to protect the ball joint stud.**

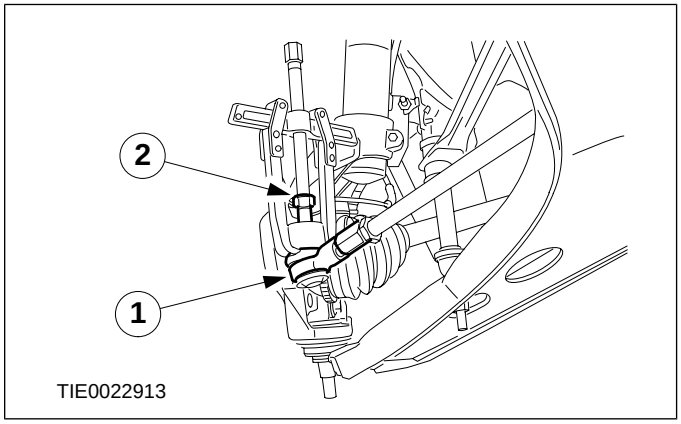
   Loosen the tie-rod end retaining nut.



4. **CAUTION:Protect the ball joint seal using a soft cloth to prevent damage.**

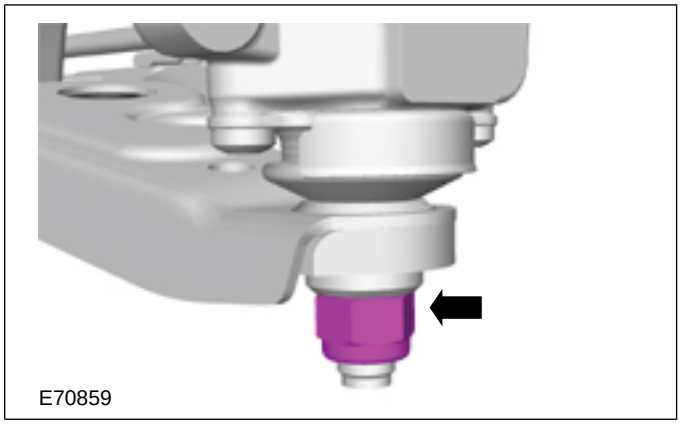
   Using a suitable two leg puller, detach the tie-rod end from the wheel knuckle.

1. Release the tie-rod end.
2. Remove and discard the tie-rod end retaining nut.



Vehicles with 2.3L engine or 2.4L diesel engine

5. **Loosen the lower arm ball joint retaining nut.**



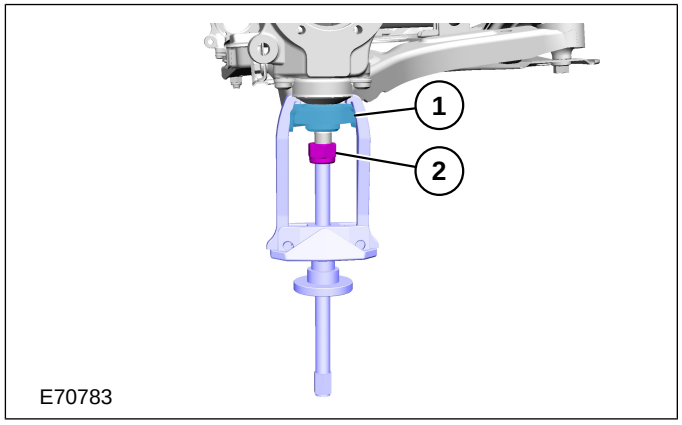
6. **CAUTION:Protect the ball joint seal using a soft cloth to prevent damage.**

   Using a suitable two leg puller, detach the lower arm from the wheel knuckle.

1. Use a soft faced hammer to strike the lower arm.

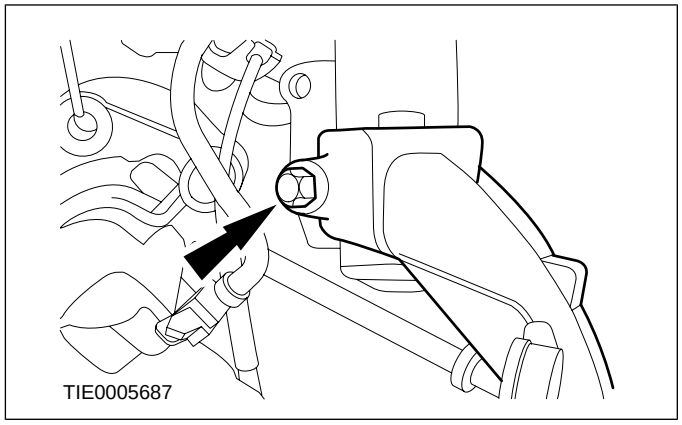
REMOVAL AND INSTALLATION

2. Remove and discard the lower arm ball joint retaining nut.



All vehicles

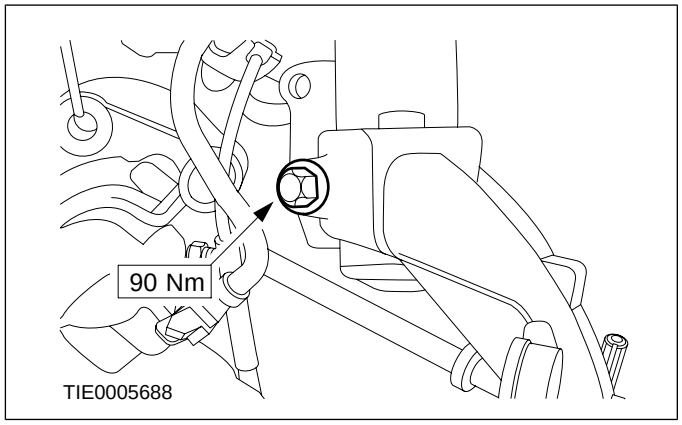
7. Remove the wheel knuckle.



Installation

All vehicles

1. Install the wheel knuckle.

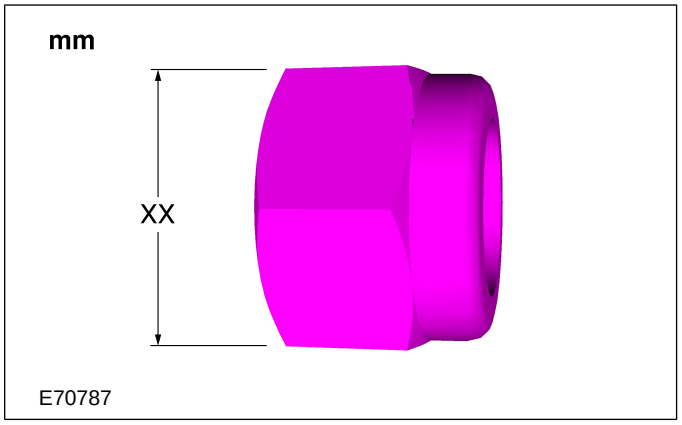


Vehicles with 2.3L engine or 2.4L diesel engine

2. WARNING:Install a new lower arm ball joint retaining nut. Failure to follow this instruction may result in personal injury.

NOTE: Vehicles are equipped with a lower arm ball joint retaining nut with a flat diameter of either 24 mm or 30 mm.

Measure the lower arm ball joint retaining nut flat diameter to aid installation.



3. CAUTION:Make sure that the ball joint ball does not rotate.

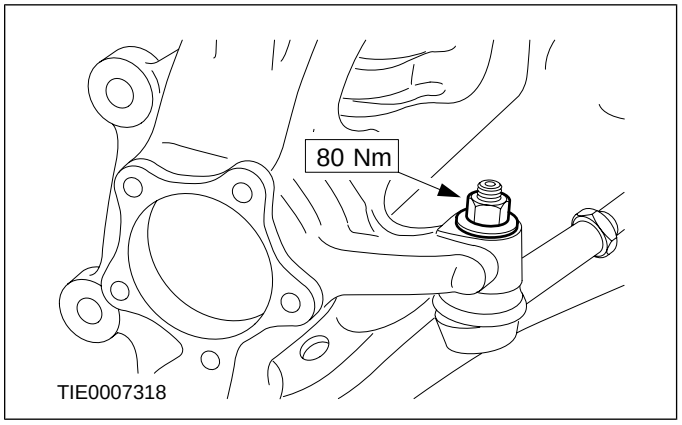
Install the lower arm ball joint retaining nut.

For additional information, refer to:Specifications (204-01 Front Suspension, Specifications).

All vehicles

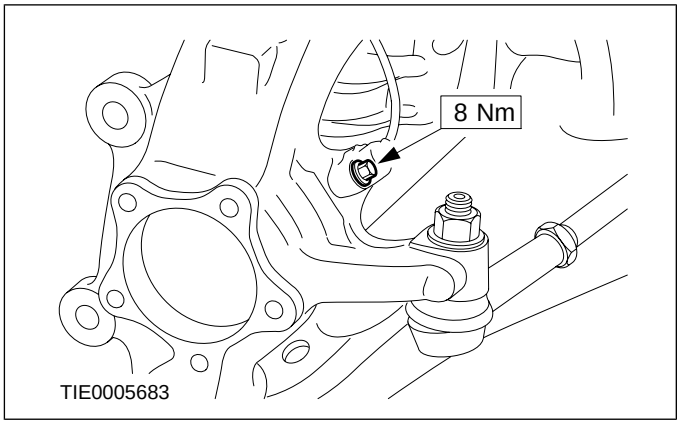
4. WARNING:Install a new tie-rod end retaining nut. Failure to follow this instruction may result in personal injury.

Attach the tie-rod end to the wheel knuckle.



REMOVAL AND INSTALLATION

5. Attach the wheel speed sensor to the wheel knuckle.



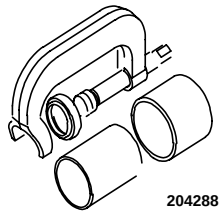
6. Install the wheel hub. For additional information, refer to:(204-01 Front Suspension)

   Wheel Hub - RWD (Removal and Installation),
   Wheel Hub (Removal and Installation).

REMOVAL AND INSTALLATION

Lower Arm Ball Joint — RWD (14 735 0)

Special Tool(s)

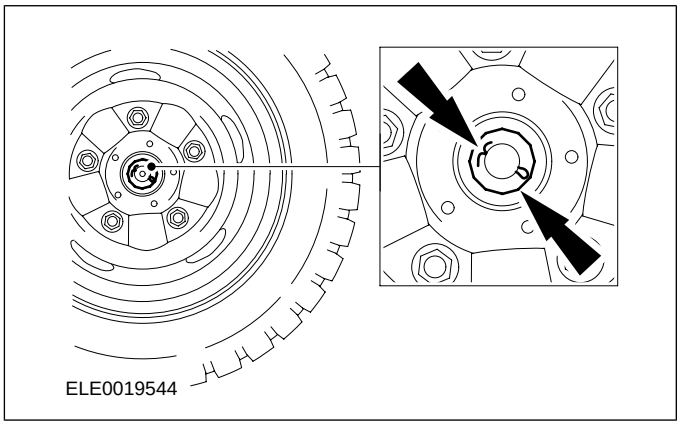
 204288	Remover/Installer, Ball Joint 204-288A (14-063A)

General Equipment

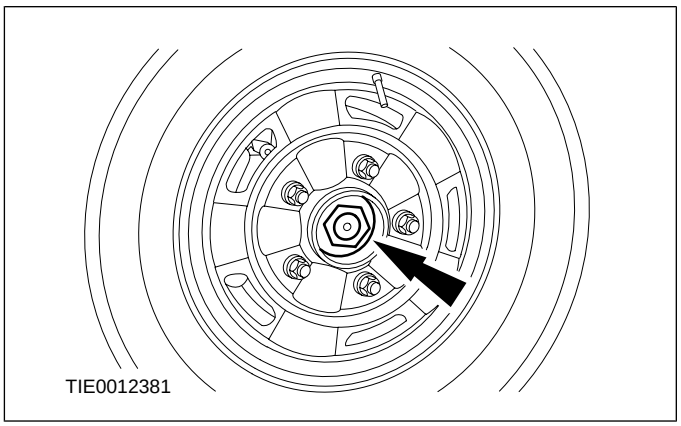
Two leg puller

Removal

1. **Remove the wheel spindle retaining nut locking ring.**
   - Discard the cotter pin.


ELE0019544

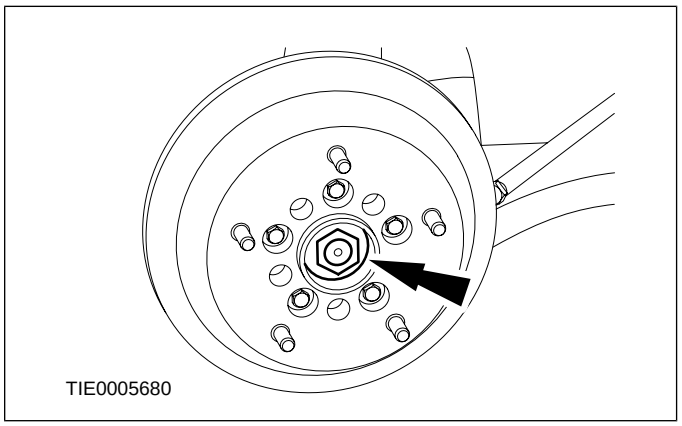
2. **Loosen the wheel spindle retaining nut.**


TIE0012381

3. **Remove the wheel and tire.**

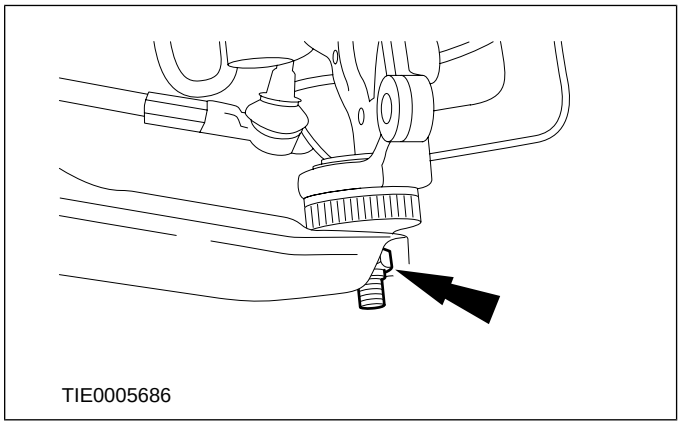
   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

4. **Remove the wheel spindle.**
   - Remove the wheel spindle retaining nut and washer.


TIE0005680

5. **NOTE: The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 24 mm.**

   Loosen the lower arm ball joint retaining nut.


TIE0005686

NOTE: The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 24 mm.

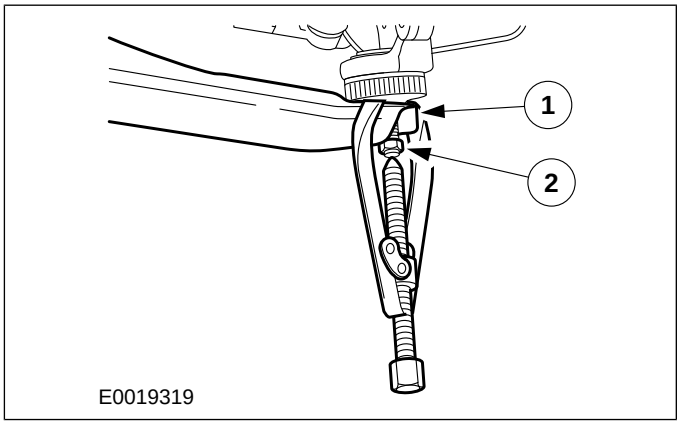
6. **CAUTION: Protect the ball joint seal using a soft cloth to prevent damage.**

   Using a suitable two leg puller, detach the lower arm from the wheel knuckle.

   1. Use a soft faced hammer to strike the lower arm.

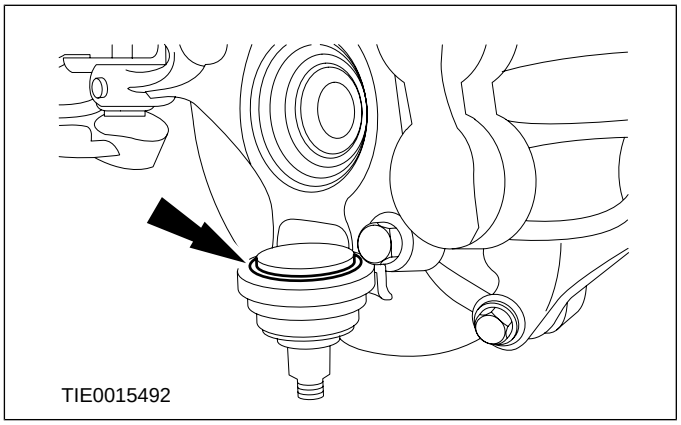
REMOVAL AND INSTALLATION

2. Remove and discard the retaining nut.



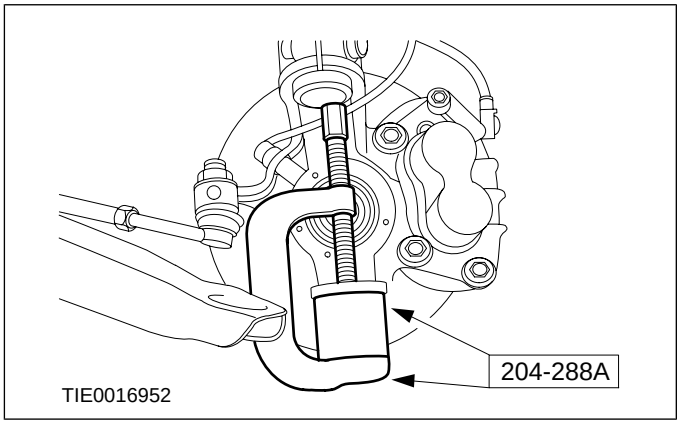
7. **NOTE:The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 24 mm.**

   Remove the circlip.



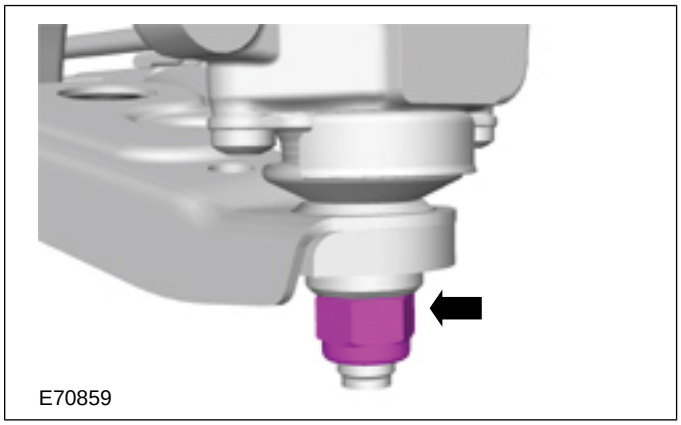
8. **NOTE:The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 24 mm.**

   Using the special tool, remove the lower arm ball joint.



9. **NOTE:The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 30 mm.**

   Loosen the lower arm ball joint retaining nut.

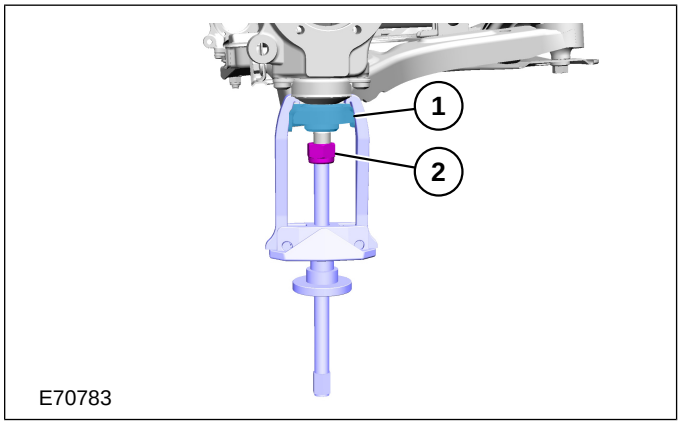


NOTE: The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 30 mm.

10. **CAUTION:Protect the ball joint seal using a soft cloth to prevent damage.**

    Using a suitable two leg puller, detach the lower arm from the wheel knuckle.

    1. Use a soft faced hammer to strike the lower arm.
    2. Remove and discard the retaining nut.



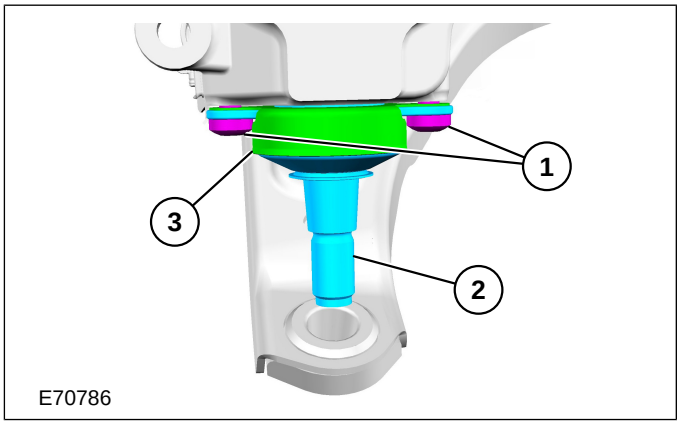
11. **NOTE:The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 30 mm.**

    Remove the lower arm ball joint.

    1. Remove the lower arm ball joint retaining bolts.
    2. Remove the lower arm ball joint.

REMOVAL AND INSTALLATION

3. Remove the heat shield.

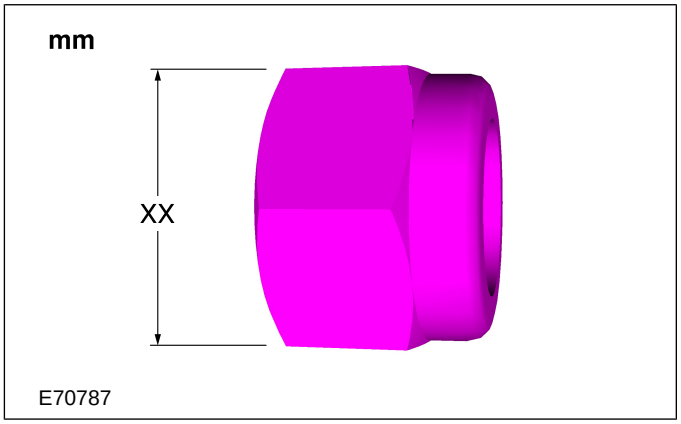


Installation

1. **WARNING:Install a new lower arm ball joint retaining nut. Failure to follow this instruction may result in personal injury.**

NOTE: Vehicles are equipped with a lower arm ball joint retaining nut with a flat diameter of either 24 mm or 30 mm.

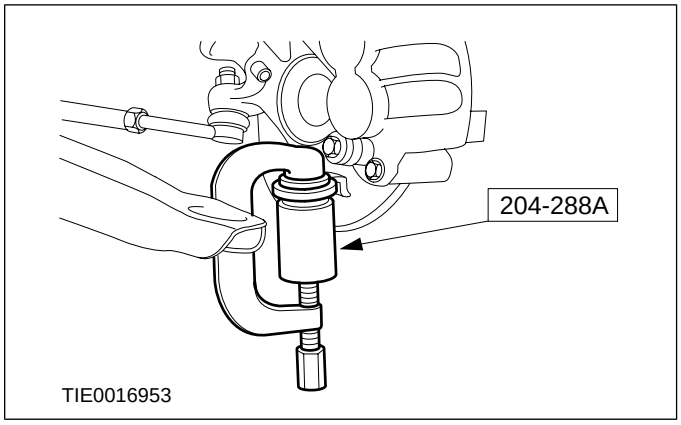
Measure the lower arm ball joint retaining nut flat diameter to aid installation.



2. **NOTE:The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 24 mm.**

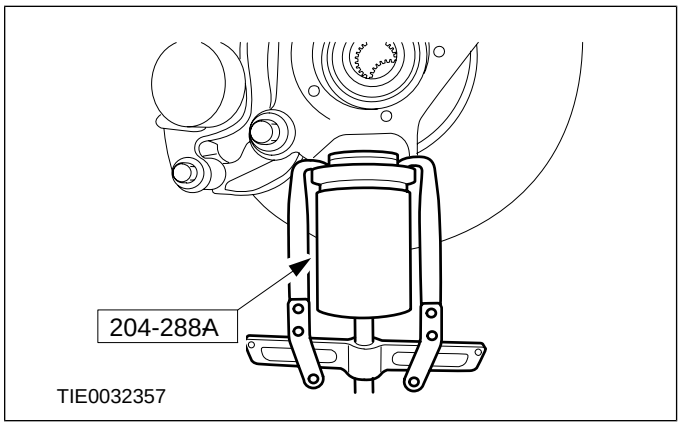
NOTE: Use only the special tool to install the lower arm ball joint to the wheel knuckle. Do not use any other tools if there is a gap between the lower arm ball joint and the wheel knuckle.

Using the special tool, attach the lower arm ball joint to the wheel knuckle.



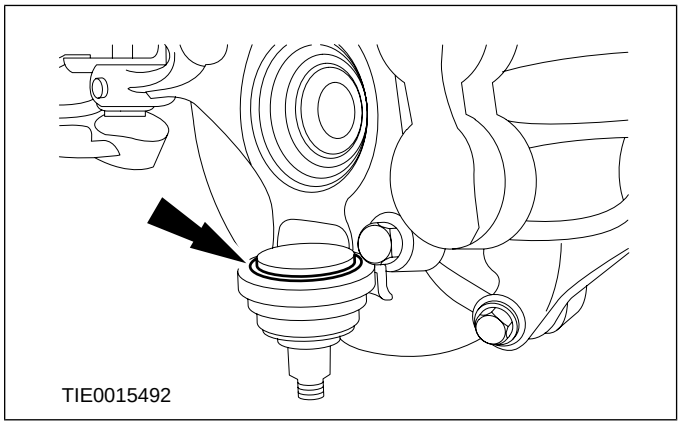
3. **NOTE:The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 24 mm.**

Using the special tool and a suitable two leg puller, install the lower arm ball joint.



4. **NOTE:The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 24 mm.**

Install the circlip.



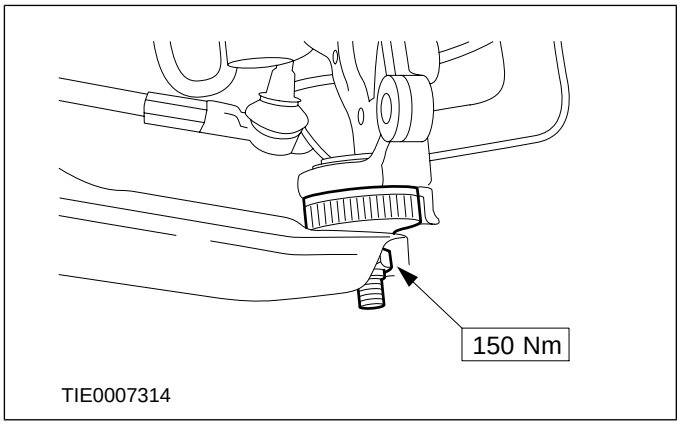
REMOVAL AND INSTALLATION

NOTE: The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 24 mm.

5. **WARNING: Install a new lower arm ball joint retaining nut. Failure to follow this instruction may result in personal injury.**

   CAUTION: Make sure that the ball joint ball does not rotate.

   Attach the lower arm to the wheel knuckle.

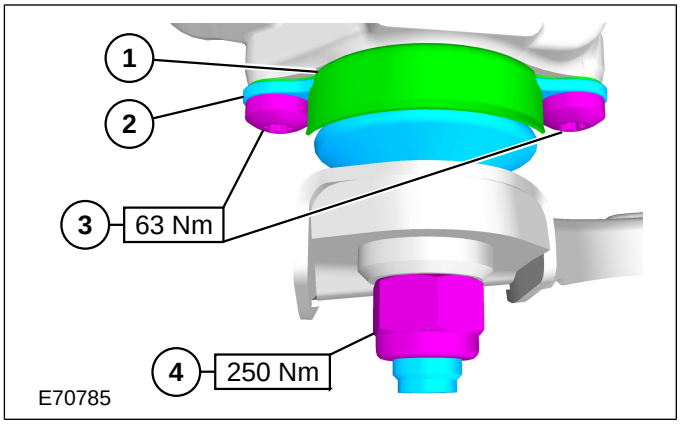


6. **CAUTION: Make sure that the ball joint ball does not rotate.**

NOTE: The following step is only required for vehicles with a ball joint retaining nut with a flat diameter of 30 mm.

Install the lower arm ball joint.

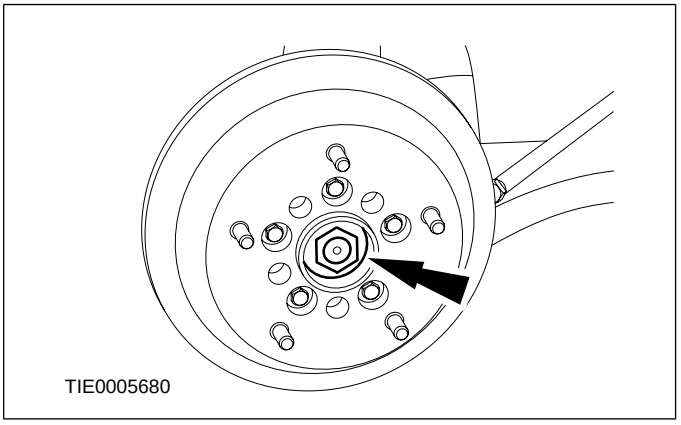
1. Locate the heat shield correctly on to the lower arm ball joint.
2. Locate the lower arm ball joint correctly.
3. Install the lower arm ball joint retaining bolts.
4. Install the lower arm ball joint retaining nut.



7. **NOTE: Do not fully tighten the wheel spindle retaining nut at this stage.**

   Install the wheel spindle.

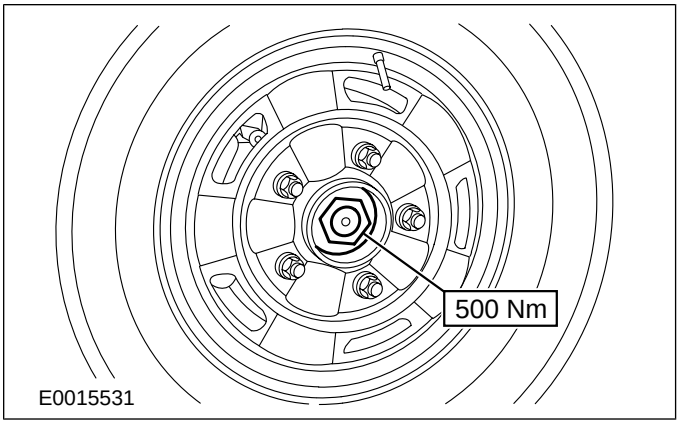
- Install the wheel spindle retaining nut and washer.



8. **Install the wheel and tire.**

   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

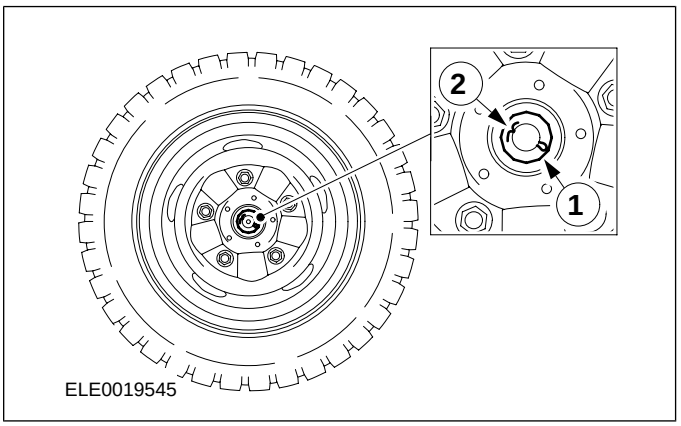
9. **Tighten the wheel spindle retaining nut.**



10. **NOTE: Install a new cotter pin.**

    Install the wheel spindle retaining nut locking ring.

- Install the cotter pin.



REMOVAL AND INSTALLATION

11. Check the toe setting and adjust as necessary. For additional information, refer to:(204-00 Suspension System - General Information)

    Specifications (Specifications),
    Front Toe Adjustment (General Procedures).

REMOVAL AND INSTALLATION

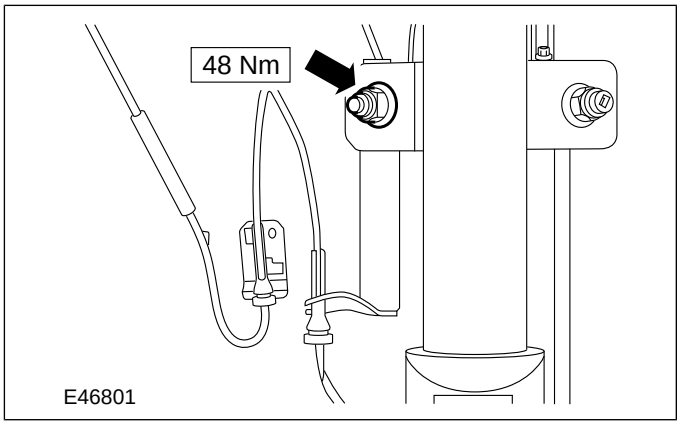
Driver Side Strut and Spring Assembly (14 781 0)

Removal

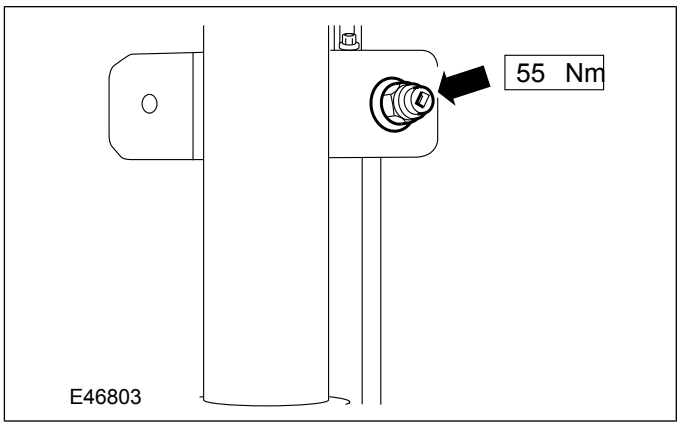
1. **Remove the driver side wheel and tire.**

   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

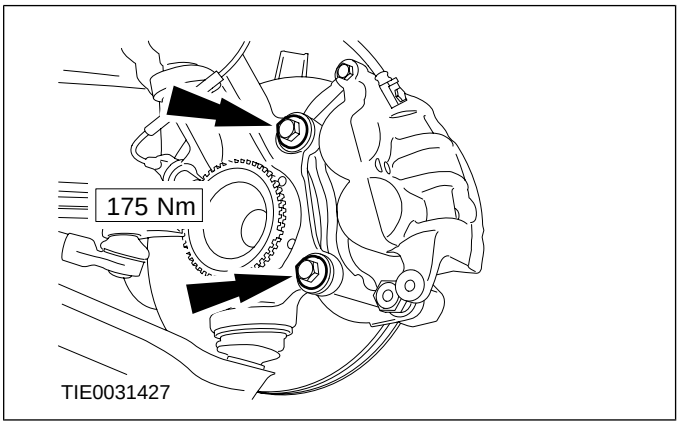
2. **Detach the wheel speed sensor from the strut and spring assembly.**



3. **Detach the stabilizer bar link from the strut and spring assembly.**

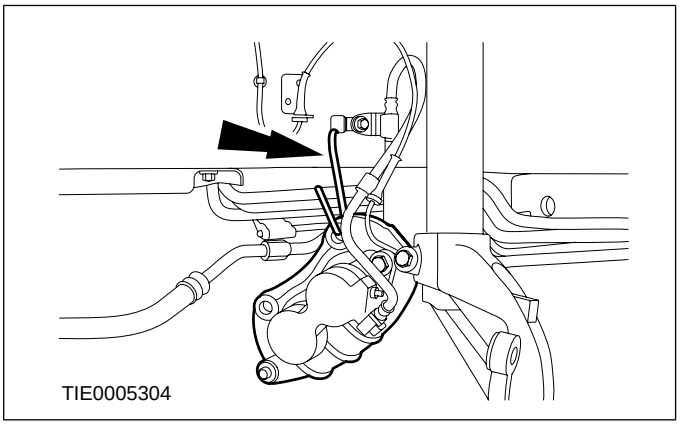


4. **Detach the brake caliper and anchor plate from the wheel knuckle.**

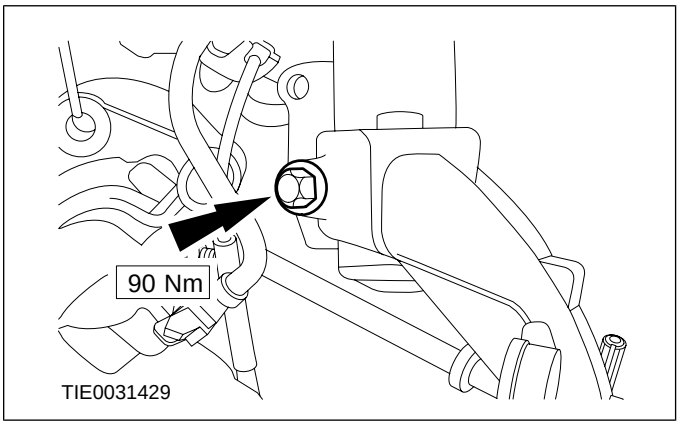


5. **⚠CAUTION:Suspend the brake caliper and anchor plate to prevent load being placed on the brake hose.**

   Suspend the brake caliper and anchor plate.

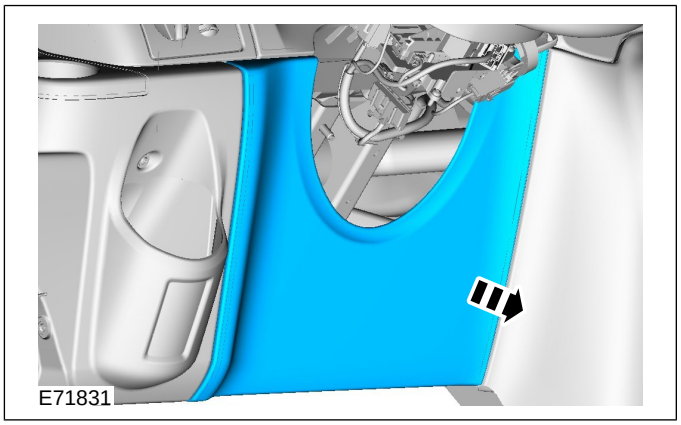


6. **Detach the wheel knuckle from the suspension strut.**

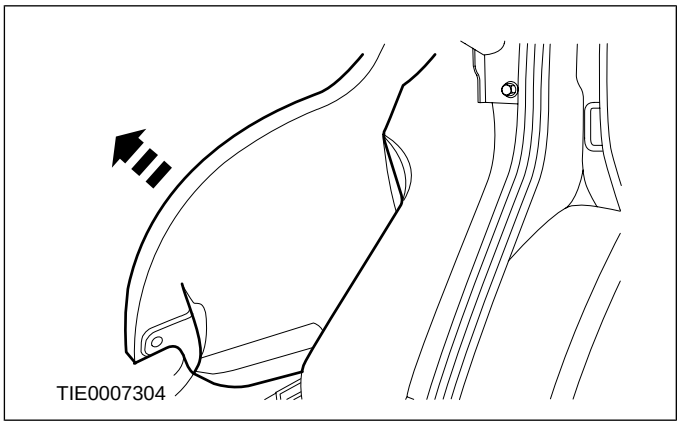


REMOVAL AND INSTALLATION

7. Remove the instrument panel lower panel.

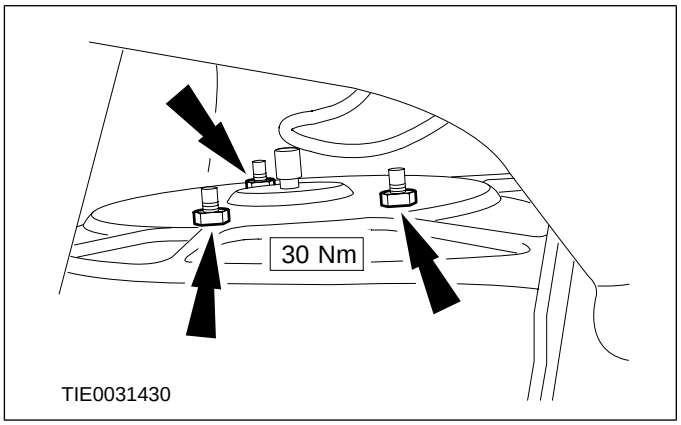


8. Detach the floor covering to access the strut and spring assembly retaining nuts.



9. ⚠CAUTION:With the aid of another technician, support the strut and spring assembly.

   Remove the strut and spring assembly.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

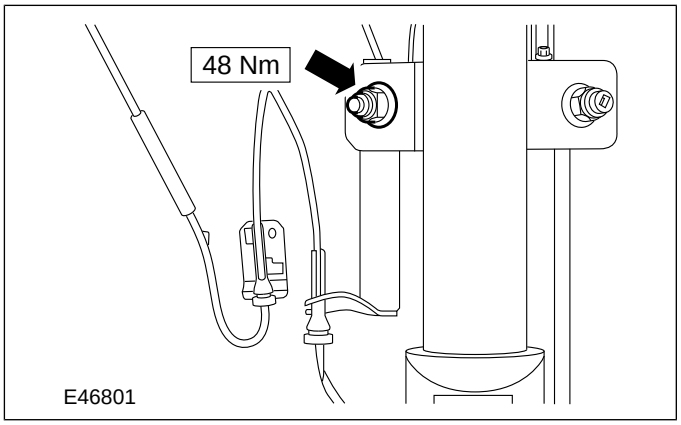
Passenger Side Strut and Spring Assembly (14 781 0)

Removal

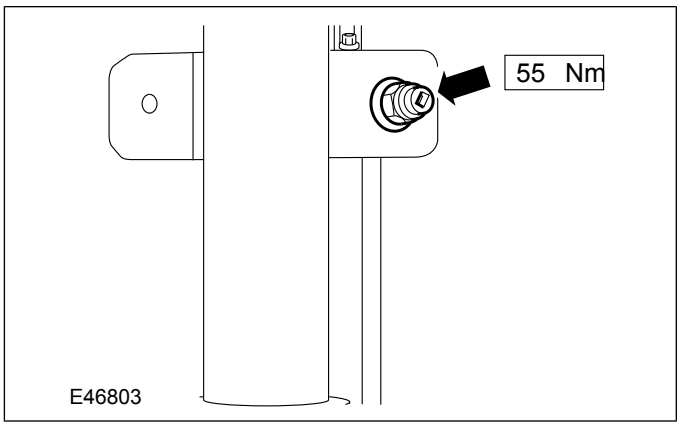
1. **Remove the passenger side wheel and tire.**

   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

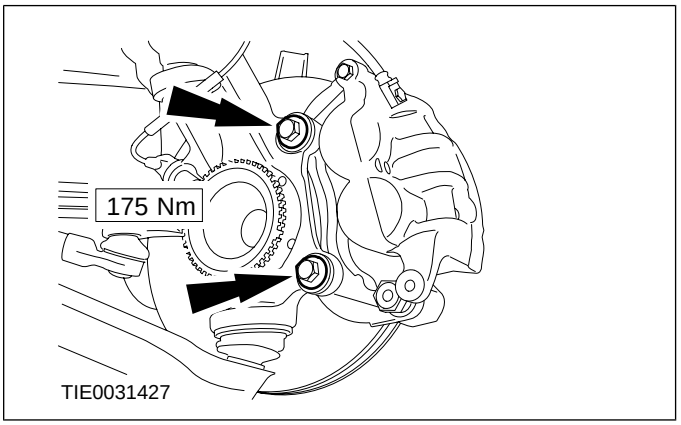
2. **Detach the wheel speed sensor from the strut and spring assembly.**



3. **Detach the stabilizer bar link from the strut and spring assembly.**

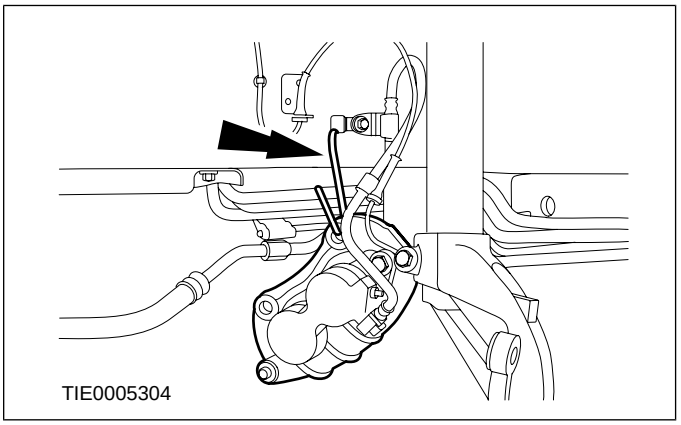


4. **Detach the brake caliper and anchor plate from the wheel knuckle.**

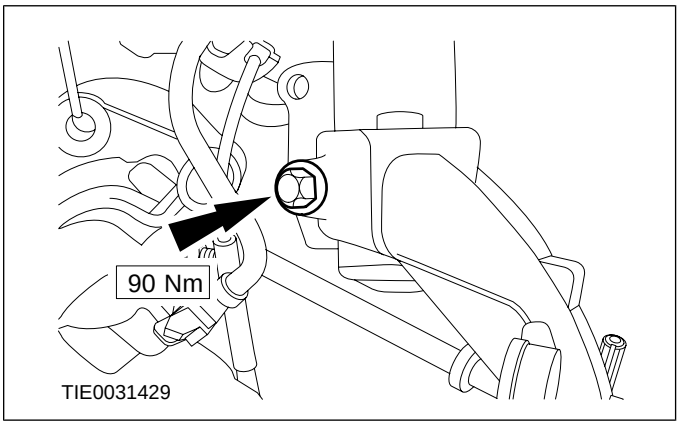


5. **⚠CAUTION:Suspend the brake caliper and anchor plate to prevent load being placed on the brake hose.**

   Suspend the brake caliper and anchor plate.

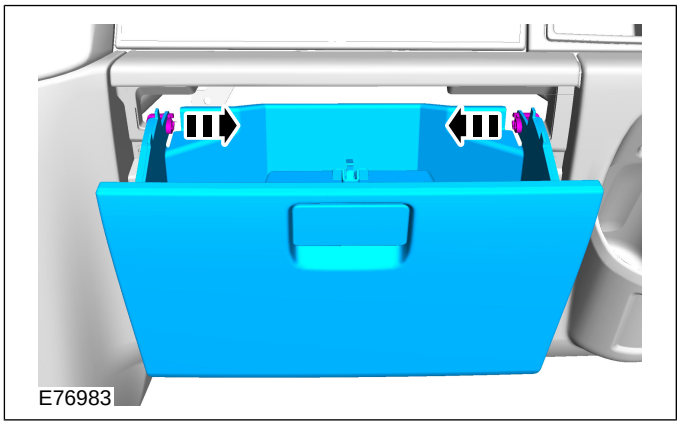


6. **Detach the suspension strut from the wheel knuckle.**

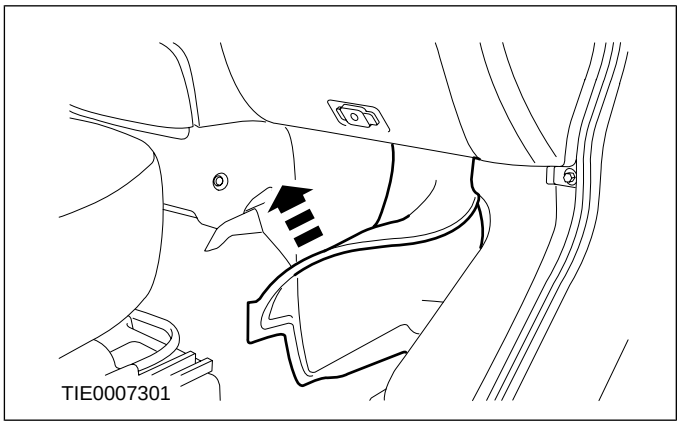


REMOVAL AND INSTALLATION

7. Remove the glove compartment.

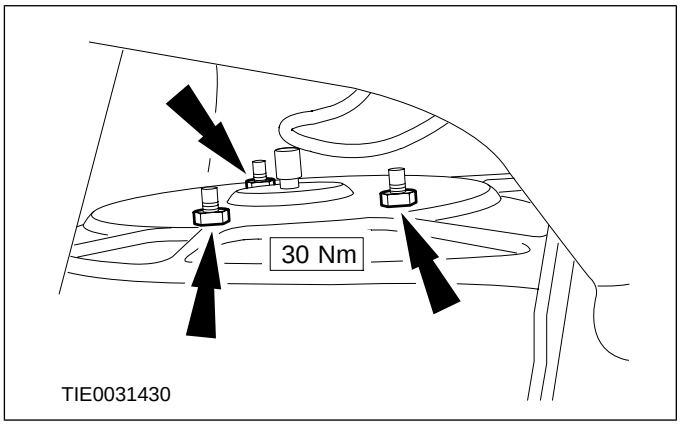


8. Detach the floor covering to access the strut and spring assembly retaining nuts.



9. ⚠CAUTION:With the aid of another technician, support the strut and spring assembly.

   Remove the strut and spring assembly.



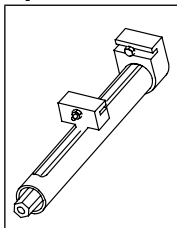
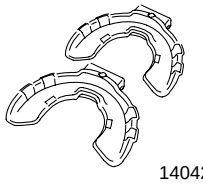
Installation

1. To install, reverse the removal procedure.

DISASSEMBLY AND ASSEMBLY

Front Strut and Spring Assembly (14 783 4)

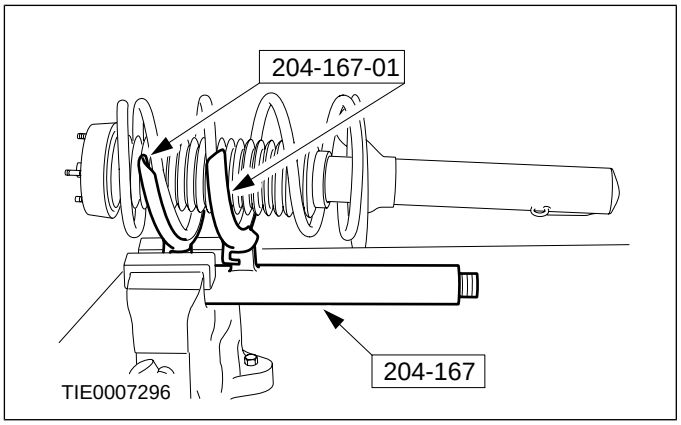
Special Tool(s)

 14042	Compressor, Coil Spring 204-167 (14-042)
 1404201	Adaptors for 204-167 204-167-01 (14-042-01)

Disassembly

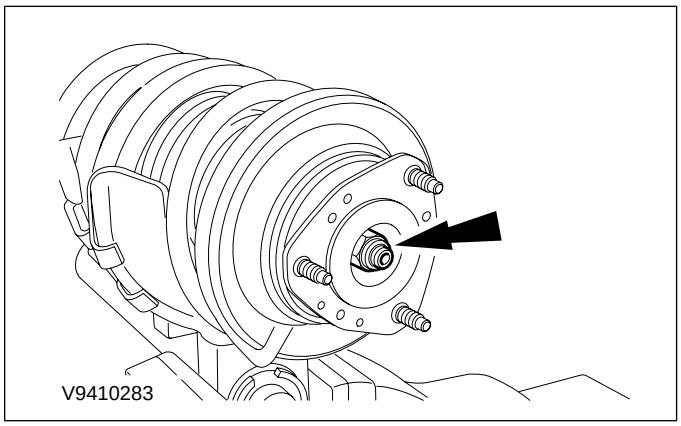
1. **WARNING:The spring is under extreme tension; care must be taken at all times. Failure to follow this instruction may result in personal injury.**

   Using the special tools, compress the spring.

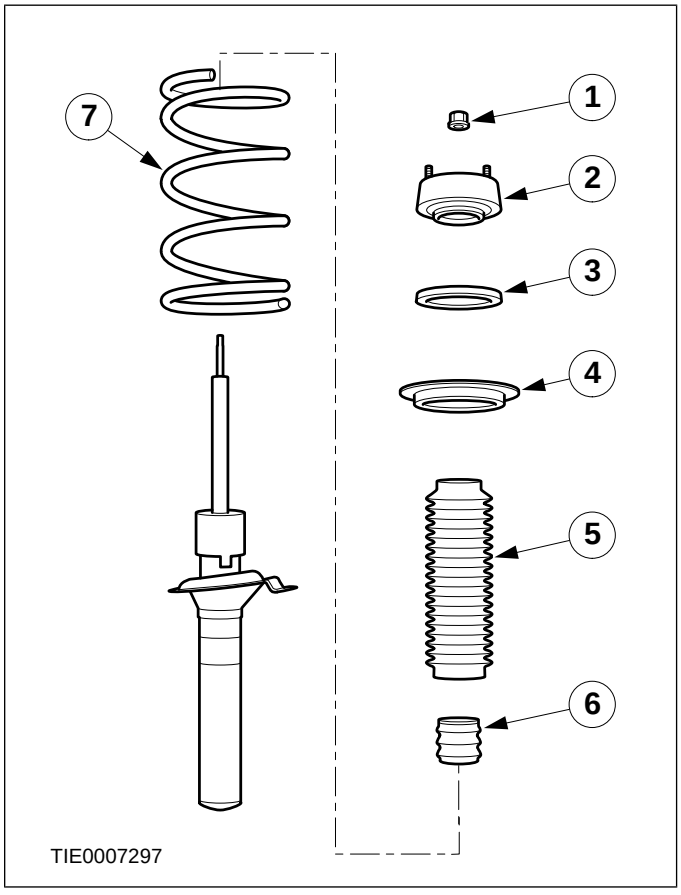


2. **CAUTION:Use an Allen key to prevent the piston rod from rotating.**

Loosen the thrust bearing retaining nut.



3. **Disassemble the strut and spring assembly.**
   1. Remove the thrust bearing retaining nut.
   2. Remove the top mount.
   3. Remove the thrust bearing.
   4. Remove the spring seat.
   5. Remove the boot.
   6. Remove the bump stop.
   7. Remove the spring.

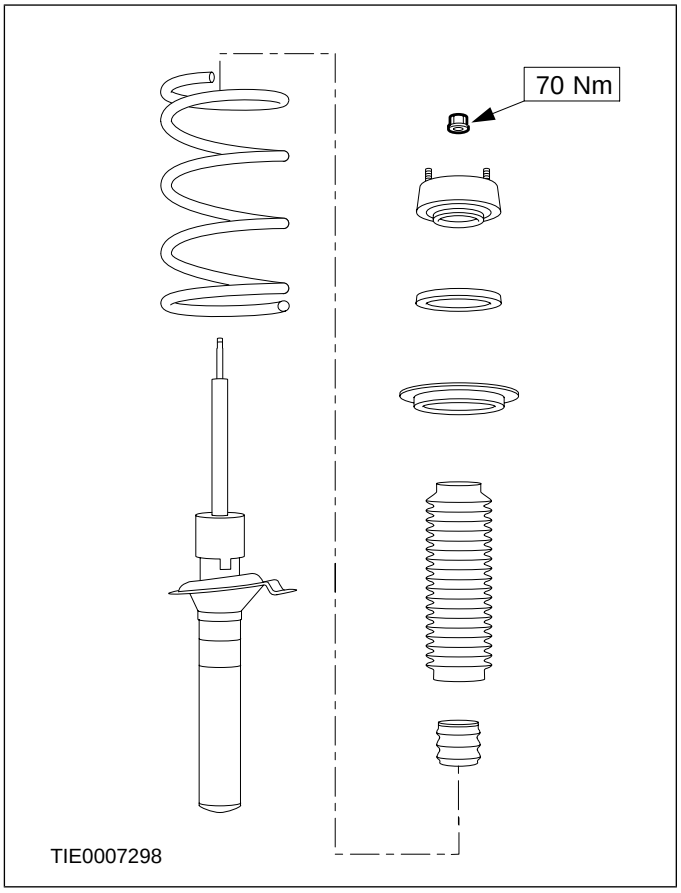


DISASSEMBLY AND ASSEMBLY

Assembly

1. **⚠CAUTION:The ends of the spring must locate correctly in the spring seats.**

   To assemble, reverse the disassembly procedure.



SECTION 204-02 Rear Suspension

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 204-02-2

DESCRIPTION AND OPERATION

Rear Suspension 204-02-3

DIAGNOSIS AND TESTING

Rear Suspension 204-02-5

REMOVAL AND INSTALLATION

Rear Stabilizer Bar ..... (15 752 0) 204-02-6
Wheel Spindle ..... (15 366 0) 204-02-7
Spring ..... (15 621 0) 204-02-11

SPECIFICATIONS

Torque Specifications

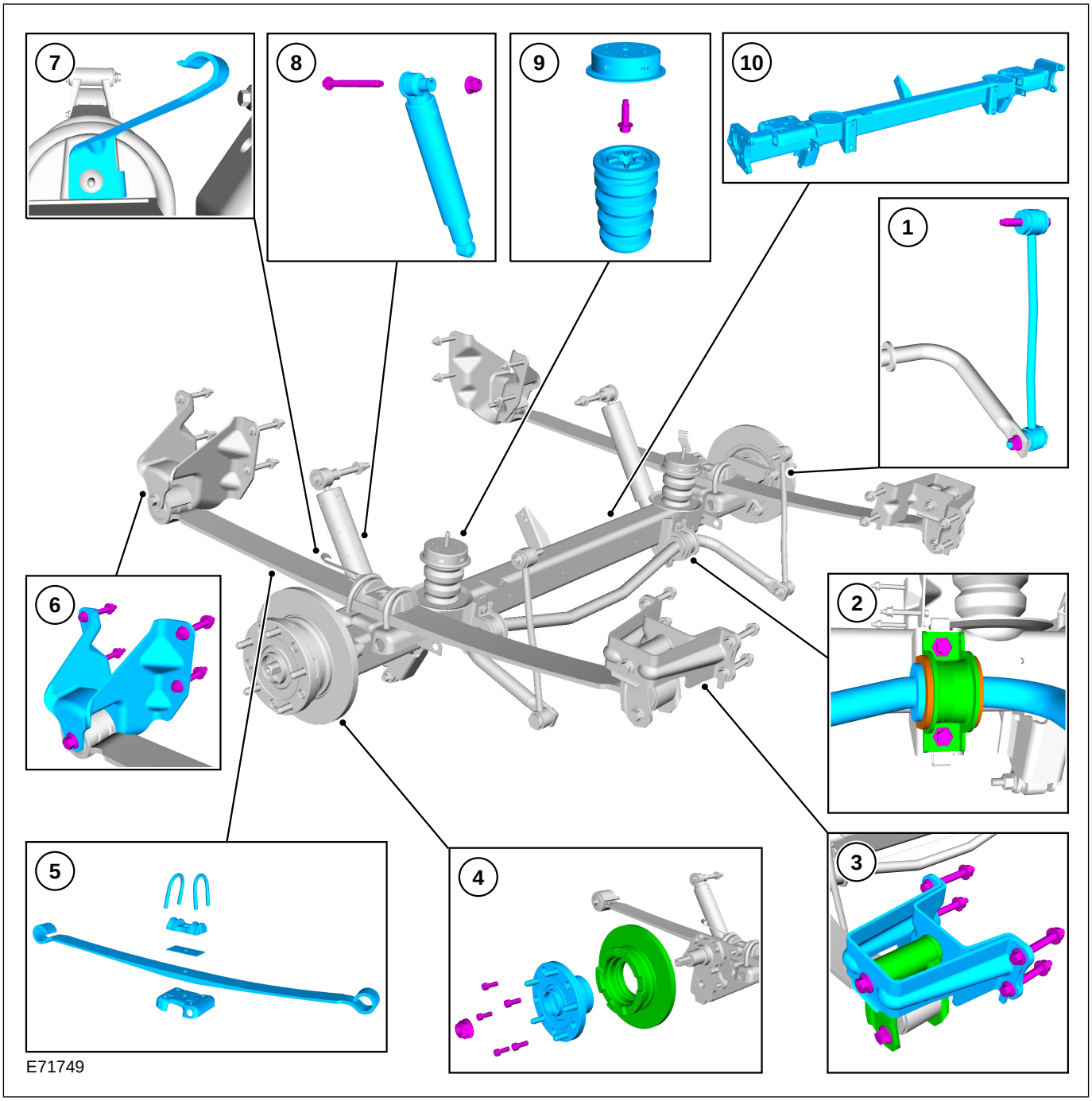
Description	Nm	lb-ft	lb-in
U-bolt nuts	a	–	–
Spring hanger upper retaining bolt	115	85	–
Spring hanger lower retaining bolt	115	85	–
Spring front nut	225	166	–
Spring front bracket retaining nuts	90	66	–
Spring rear bracket retaining nuts	90	66	–
Shock absorber lower retaining nut and bolt	80	59	–
Shock absorber upper retaining nut	150	111	–
Stabilizer bar retaining bolts	40	30	–
Stabilizer bar connecting link upper bolt	103	76	–
Stabilizer bar connecting link lower nut	103	76	–
Rear axle bump stop retaining screws	20	15	–
Wheel spindle retaining bolts	133	98	–
Wheel hub retaining nut – with a flange diameter of 44 mm	300	221	–
Wheel hub retaining nut – with a flange diameter of 51 mm	450	332	–
Wheel speed sensor retaining nut	8	–	71
Wheel cylinder union	14	10	–
Brake tube bracket retaining bolt	20	15	–
Brake load sensor proportioning valve bracket retaining bolt	8	–	71
Noise, vibration and harshness damper retaining bolts	8	–	71

a) Refer to the procedure in this section.

DESCRIPTION AND OPERATION

Rear Suspension

Chassis Cab



Item	Description
1	Stabilizer bar link (if equipped)
2	Stabilizer bar, clamp and bushing (if equipped)
3	Spring rear mounting bracket and spring hanger
4	Wheel hub

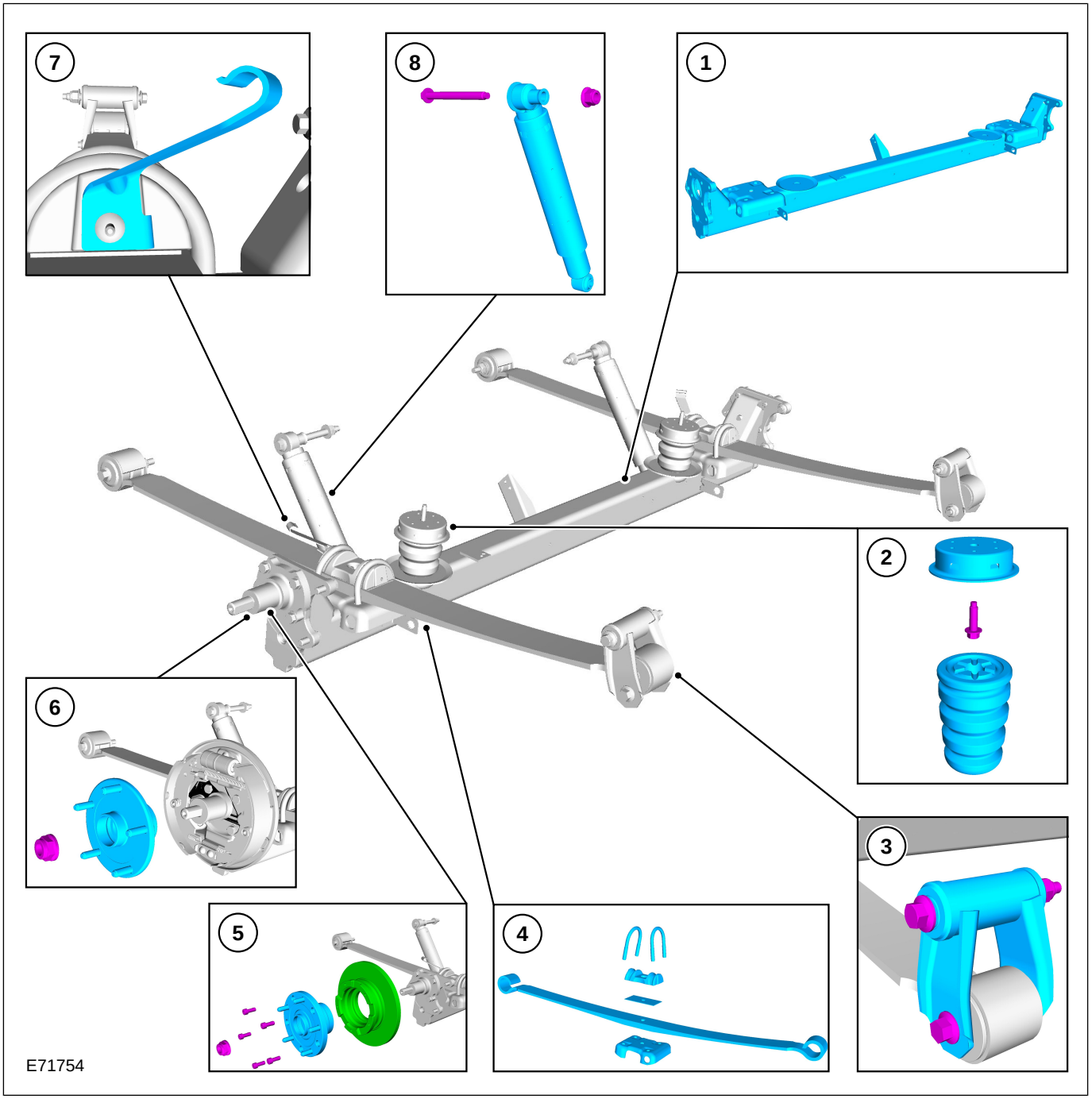
Item	Description
5	Spring, u-bolts and guide plate
6	Spring front mounting bracket
7	Brake load sensor proportioning valve bracket
8	Shock absorber

DESCRIPTION AND OPERATION

Item	Description
9	Bump stop

Item	Description
10	Beam axle

Van, bus and kombi



Item	Description
1	Beam axle
2	Bump stop
3	Spring hanger
4	Spring, u-bolts and guide plate
5	Wheel hub (vehicles with rear disc brakes)

Item	Description
6	Wheel hub (vehicles with rear drum brakes)
7	Brake load sensor proportioning valve bracket
8	Shock absorber

DIAGNOSIS AND TESTING

Rear Suspension

REFER to Section 204-00 [Suspension System - General Information].

REMOVAL AND INSTALLATION

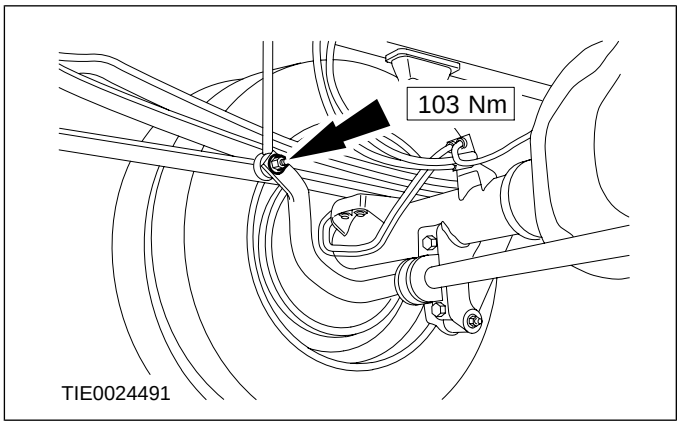
Rear Stabilizer Bar (15 752 0)

Removal

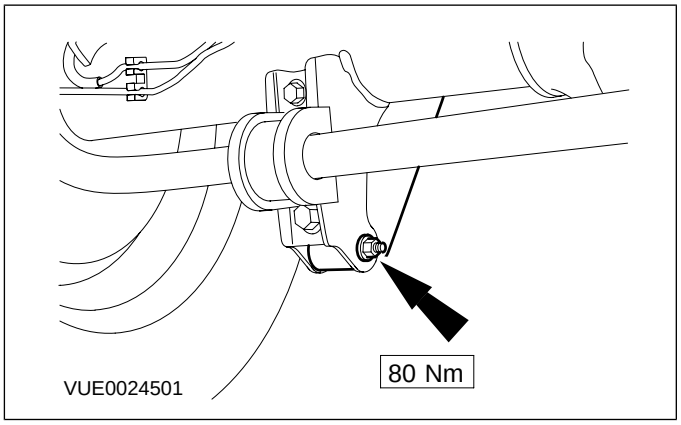
1. **Raise and support the vehicle. For additional information, refer to:(100-02 Jacking and Lifting)**

   Jacking (Description and Operation), Lifting (Description and Operation).

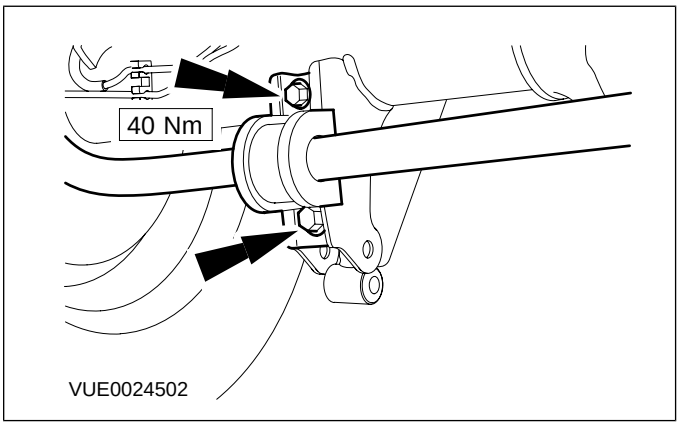
2. **Detach the stabilizer bar connecting links from the stabilizer bar.**
   - Discard the nuts.



3. **Detach the shock absorbers from the axle housing.**



4. **Remove the stabilizer bar.**



Installation

1. **NOTE:Install new stabilizer bar connecting link to stabilizer bar nuts.**

   To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Wheel Spindle (15 366 0)

General Equipment

Brake hose clamp

Removal

All vehicles

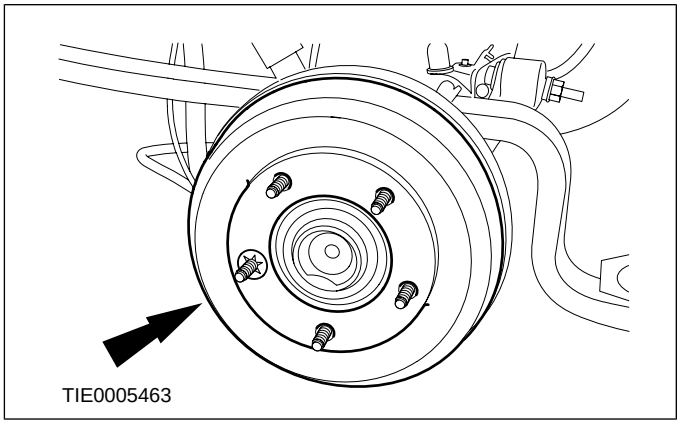
CAUTION:If brake fluid is spilt on the paintwork, the affected area must be immediately washed down with cold water.

1. **Remove the wheel and tire.**

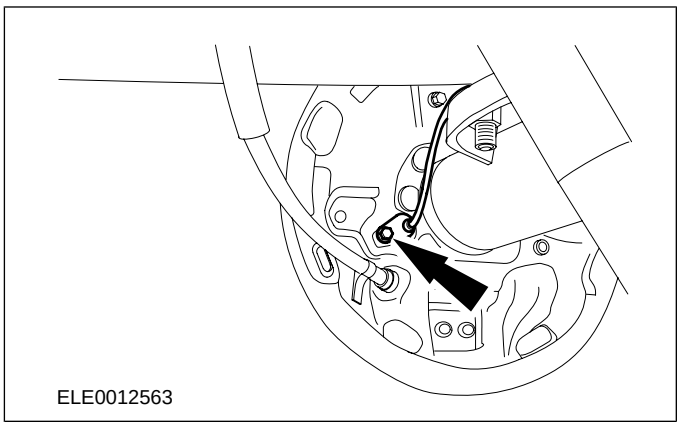
   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

Vehicles with rear drum brakes

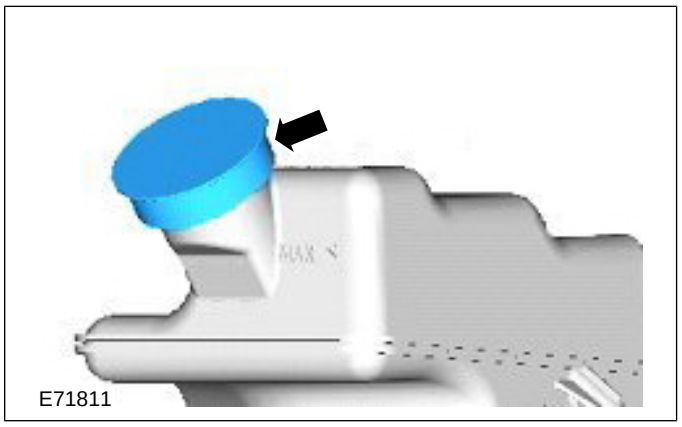
2. **Remove the brake drum.**
   - Remove and discard the retainer (if equipped).



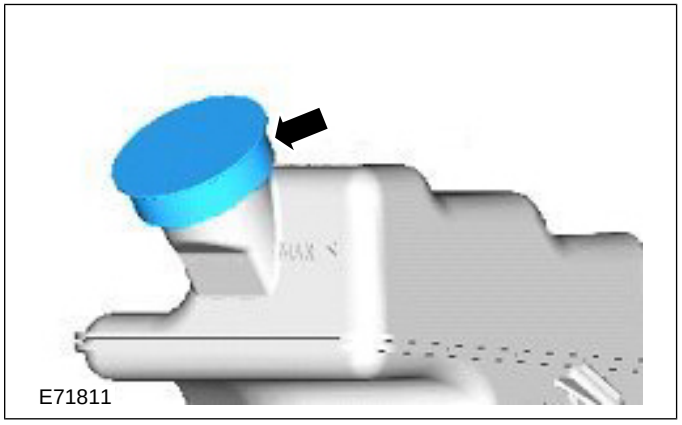
3. **Detach the rear wheel speed sensor from the brake backing plate.**



4. **Remove the brake fluid reservoir cap.**

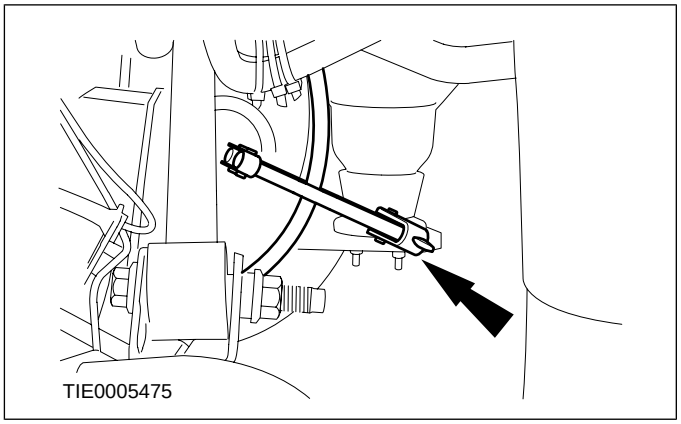


5. **Drain the brake system.**
   1. Connect one end of a suitable piece of clear plastic pipe to the brake caliper bleed nipple and place the other end into a suitable container.
   2. Loosen the brake caliper bleed nipple.
   3. Depress the brake pedal until all the brake fluid is drained from the brake fluid reservoir.
   4. Tighten the brake caliper bleed nipple.
   5. Repeat the draining procedure on the opposite side brake caliper.
6. **Install the brake fluid reservoir cap.**



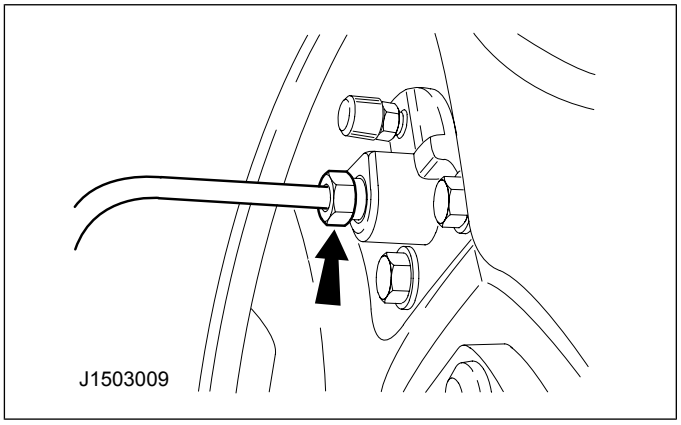
REMOVAL AND INSTALLATION

7. **Using a suitable brake hose clamp, clamp the brake hose.**



8. **⚠CAUTION:Cap the brake tube to prevent fluid loss or dirt ingress.**

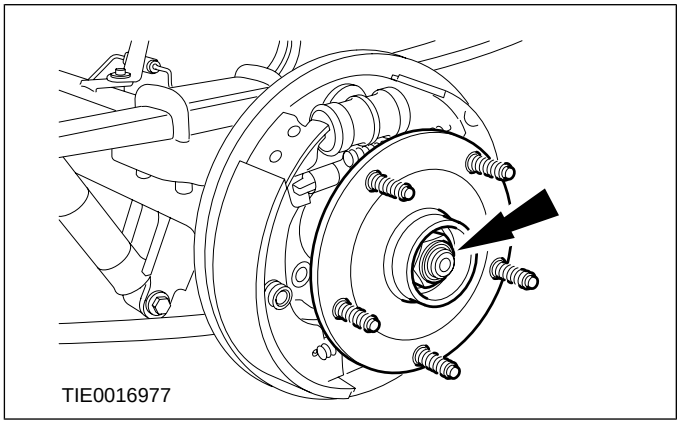
   Disconnect the brake tube from the wheel cylinder.



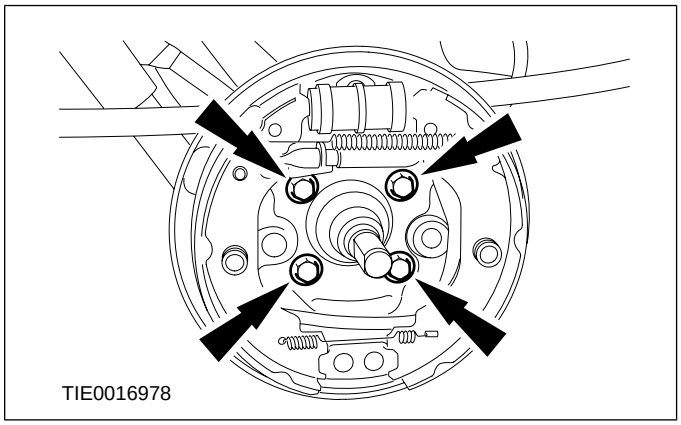
9. **NOTE:Make a note of the position of the wheel hub retaining nut washer to aid installation (if equipped).**

   Remove and discard the wheel hub retaining nut.

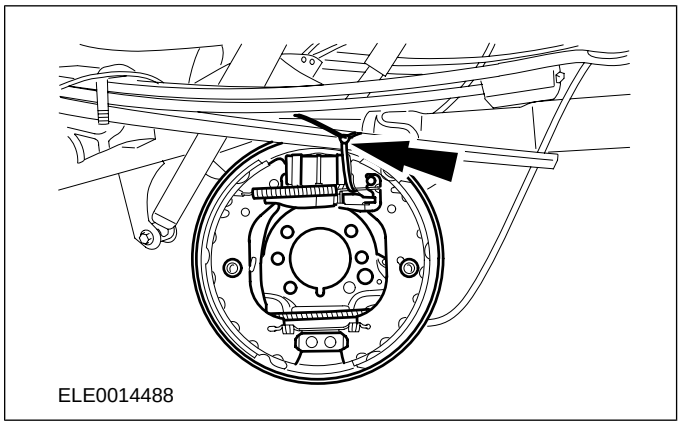
   - Remove and discard the wheel hub retaining nut washer (if equipped).



10. **Remove the wheel spindle.**



11. **Using cable ties, secure the brake backing plate assembly to the rear spring.**

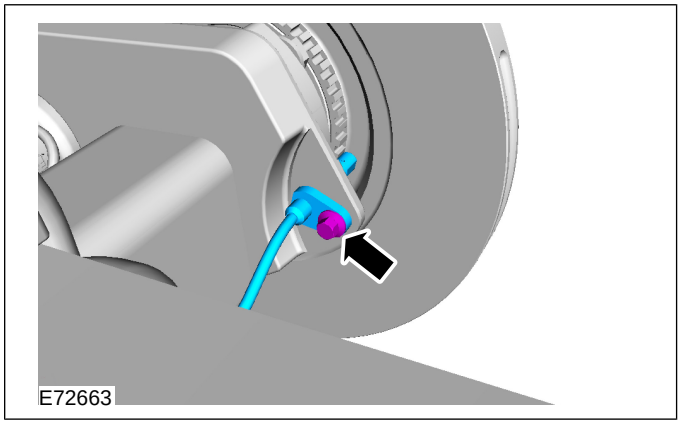


Vehicles with rear disc brakes

12. **Remove the brake disc.**

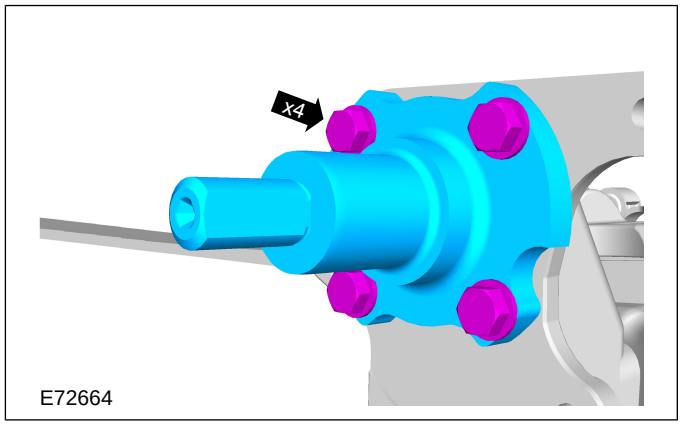
    For additional information, refer to:Brake Disc - FWD (206-04 Rear Disc Brake, Removal and Installation).

13. **Detach the rear wheel speed sensor from the wheel spindle.**



REMOVAL AND INSTALLATION

14. Remove the wheel spindle.



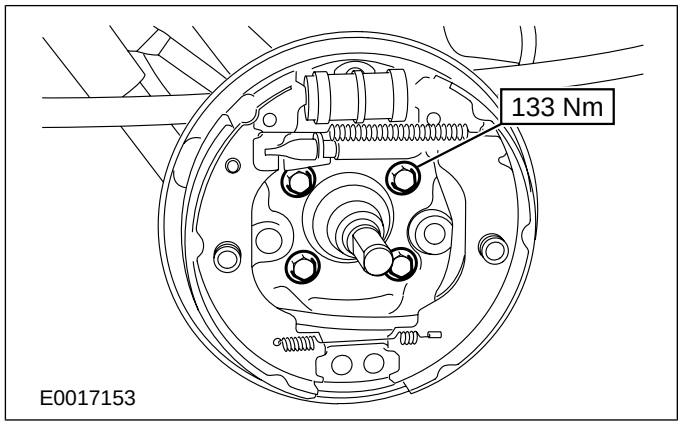
Installation

Vehicles with rear drum brakes

1. Position the brake backing plate assembly.

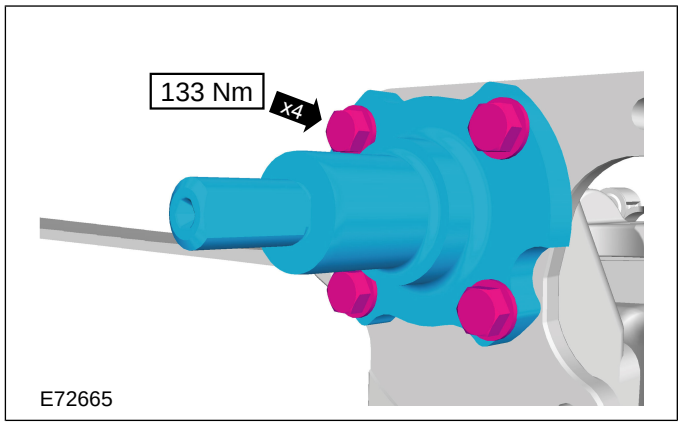
- Remove the cable ties.

2. Install the wheel spindle.

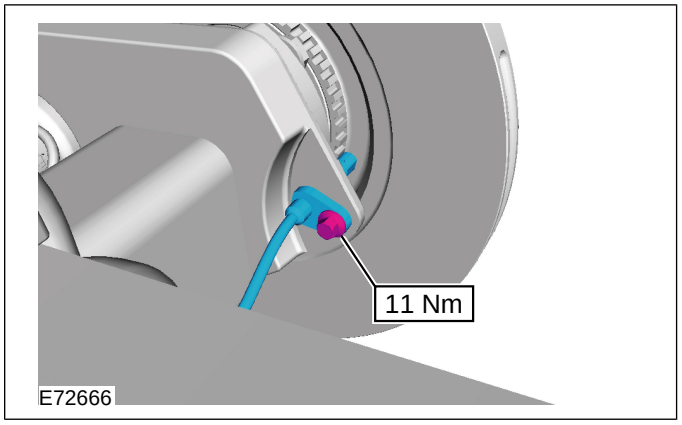


Vehicles with rear disc brakes

3. Install the wheel spindle.



4. Attach the rear wheel speed sensor to the wheel spindle.

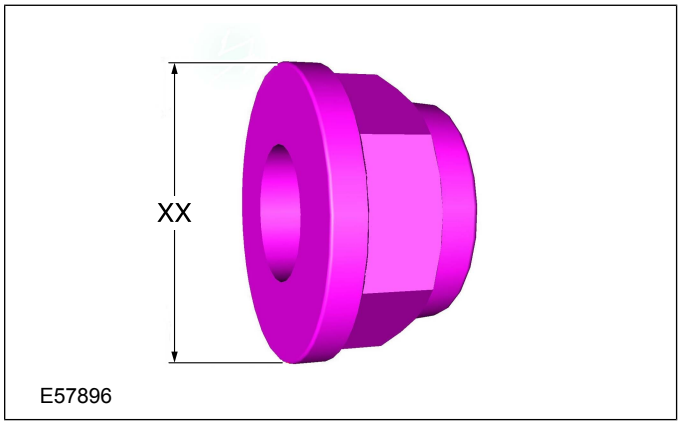


All vehicles

5. NOTE:Install a new wheel hub retaining nut.

NOTE: Vehicles are equipped with a wheel hub retaining nut with a flange diameter of either 44 mm or 51 mm.

Measure the wheel hub retaining nut flange diameter to aid installation.



6. ⚠CAUTION:On vehicles equipped with a 44 mm flange diameter wheel hub retaining nut, make sure that the wheel hub retaining nut washer is installed with the flat face towards the wheel bearing.

Install the wheel hub.

- Tighten the wheel hub retaining nut in 5 stages:
  - Stage 1: Rotate the wheel hub 5 times.
  - Stage 2: Rotate the wheel hub in the opposite direction while tightening the wheel hub retaining nut to 200 Nm.
  - Stage 3: Rotate the wheel hub 5 times.

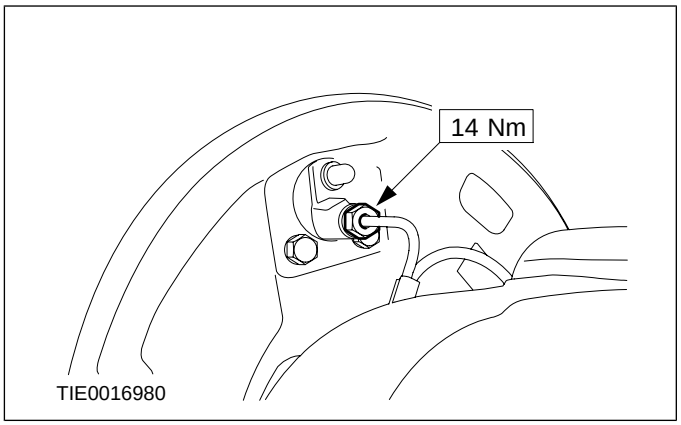
REMOVAL AND INSTALLATION

- Stage 4: Rotate the wheel hub in the opposite direction while tightening the wheel hub retaining nut to the specified torque.

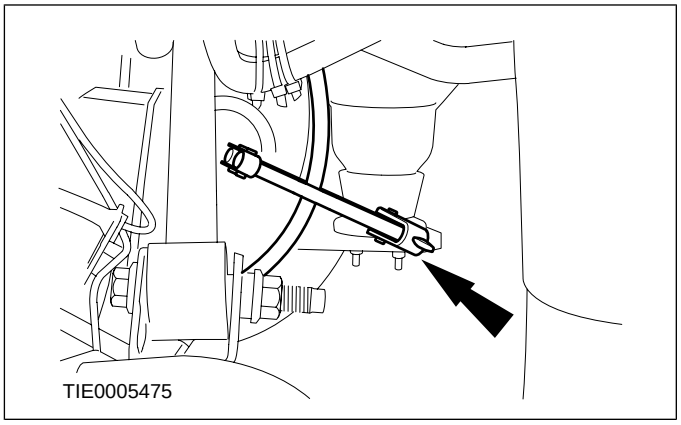
  For additional information, refer to:Specifications (204-02 Rear Suspension, Specifications).
- Stage 5: Rotate the wheel hub 5 times.

Vehicles with rear drum brakes

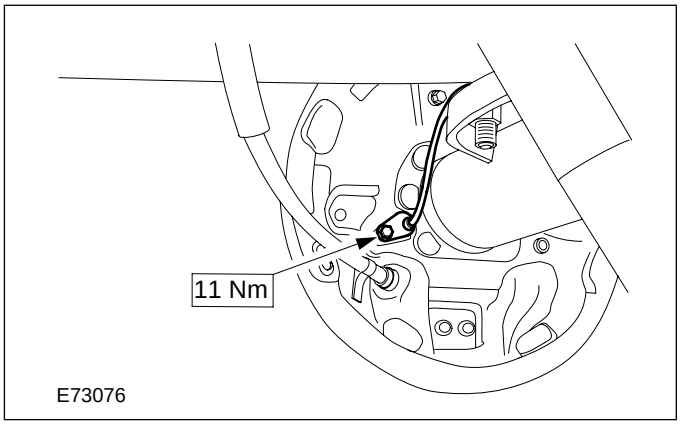
7. **Connect the brake tube to the wheel cylinder.**



8. **Remove the brake hose clamp.**



9. **Attach the rear wheel speed sensor to the brake backing plate.**



10. **Install the brake drum.**
11. **Install the wheel and tire.**

    For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).
12. **Bleed the brake system.**

    For additional information, refer to:Brake System Bleeding (206-00 Brake System - General Information, General Procedures) / Brake System Pressure Bleeding (206-00 Brake System - General Information, General Procedures).

Vehicles with rear disc brakes

13. **Install the brake disc.**

    For additional information, refer to:Brake Disc - FWD (206-04 Rear Disc Brake, Removal and Installation).

REMOVAL AND INSTALLATION

Spring (15 621 0)

General Equipment

Transmission jack

Removal

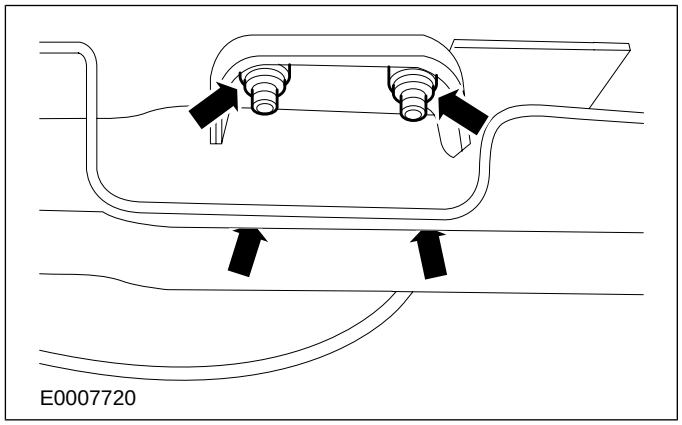
1. **Raise and support the vehicle.**

   For additional information, refer to:Jacking (100-02 Jacking and Lifting, Description and Operation) / Lifting (100-02 Jacking and Lifting, Description and Operation).

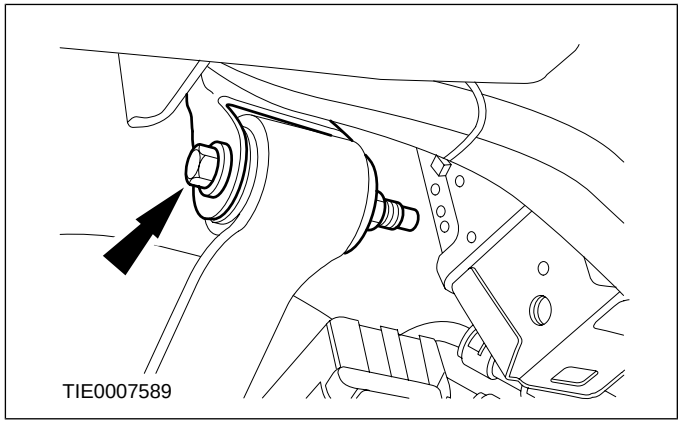
2. **Using a suitable transmission jack, support the rear axle assembly.**

3. **Remove the spring U-bolts.**

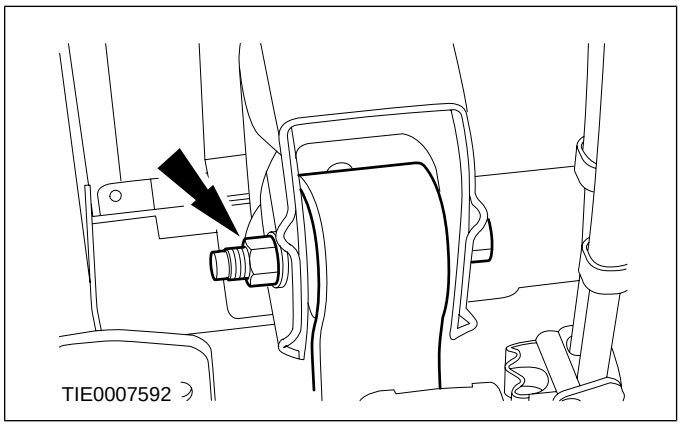
   - Discard the nuts.



4. **Remove the spring rear nut and bolt.**



5. **Remove the spring front nut and bolt.**



6. **Remove the spring.**

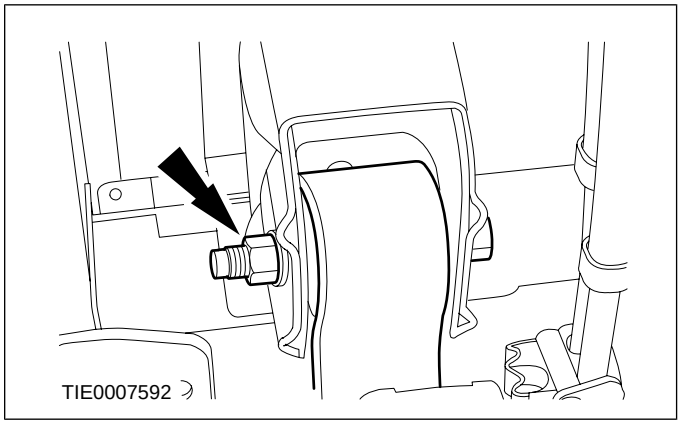
Installation

NOTE: Final tightening of the rear suspension components should be carried out when the vehicle weight is on the road wheels.

1. **CAUTION:Install a new locknut.**

NOTE: Do not fully tighten the spring rear nut at this stage.

Install the spring front nut and bolt.

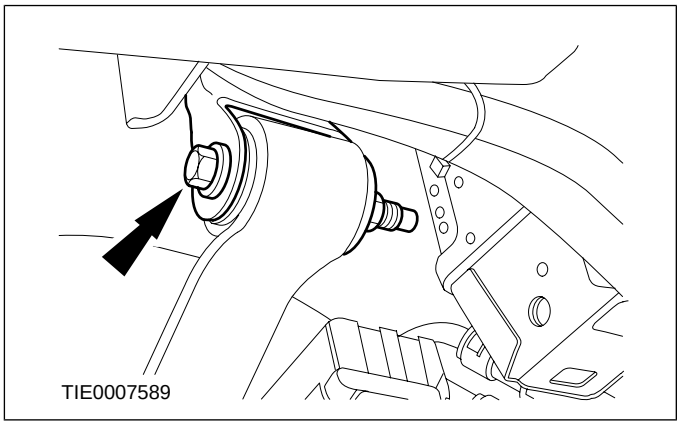


2. **CAUTION:Install a new locknut.**

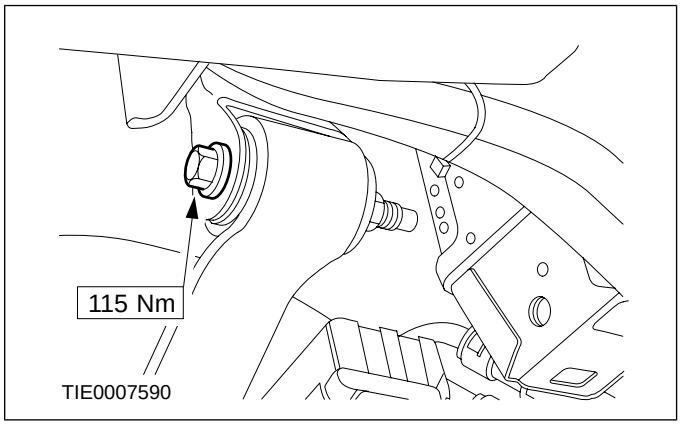
NOTE: Do not fully tighten the spring rear nut at this stage.

REMOVAL AND INSTALLATION

Install the spring rear nut and bolt.



6. **Tighten the spring rear nut.**

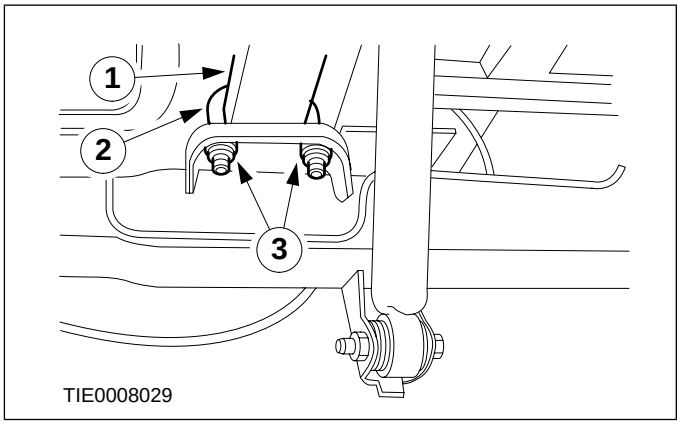


3. **NOTE:Install new spring U-bolt nuts.**

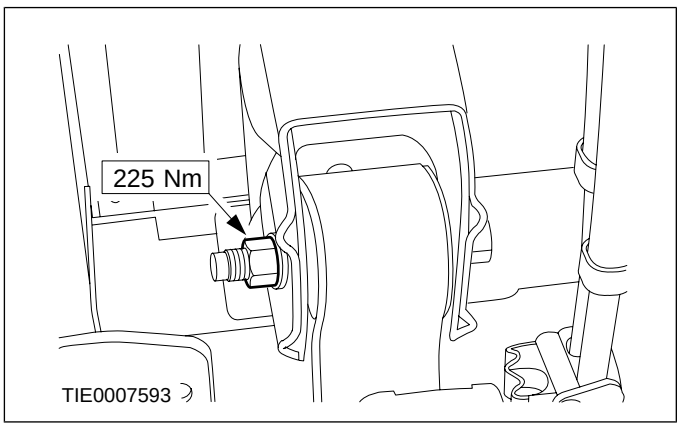
NOTE: Do nut fully tighten the spring U-bolt nuts at this stage.

Install the spring U-bolts.

1. Locate the spring to the rear axle assembly.
2. Install the guide plate and U-bolts.
3. Install the nuts.

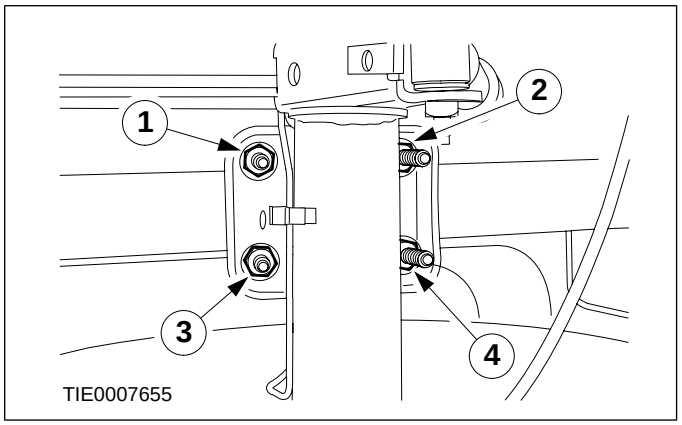


4. **Lower the vehicle.**
5. **Tighten the spring front nut.**



7. **Tighten the spring U-bolt nuts in the sequence shown in seven stages.**

- Stage 1: Tighten nuts 1 through 4 to 25 Nm.
- Stage 2: Tighten nuts 1 through 4 to 50 Nm.
- Stage 3: Tighten nuts 1 through 4 to 75 Nm.
- Stage 4: Tighten nuts 1 through 4 to 100 Nm.
- Stage 5: Tighten nuts 1 through 4 to 125 Nm.
- Stage 6: Tighten nuts 1 through 4 to 150 Nm.
- Stage 7: Tighten nuts 1 through 4 to 175 Nm.



SECTION 204-04 Wheels and Tires

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 204-04-2

DIAGNOSIS AND TESTING

Wheels and Tires..... 204-04-3
Inspection and Verification..... 204-04-3
Symptom Chart..... 204-04-4

REMOVAL AND INSTALLATION

Wheel and Tire..... 204-04-8

SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Wheel nuts	200	148	-

Wheel and Tire Assembly Runout Specifications

Description	Alloy Wheel (mm)	Steel Wheel (mm)
Wheel lateral runout	0.3	0.8
Tire lateral runout	1.5	1.5
Maximum lateral runout	1.8	2.3
Wheel radial runout	0.3	0.8
Tire radial runout	1.3	1.3
Maximum radial runout	1.6	2.1

DIAGNOSIS AND TESTING

Wheels and Tires

Inspection and Verification

Visual Inspection Chart

Mechanical
Wheel(s)
Tire(s)
Tire pressure(s) *
Wheel nuts
Wheel studs
* Vehicles equipped with a tire pressure monitoring system must be inspected for correct operation, REFER to Worldwide Diagnostic System (WDS).

To maximize tire performance, inspect the tires for signs of incorrect inflation and uneven wear which may indicate a need for balancing, rotation or suspension alignment. Tires should also be checked frequently for cuts, stone bruises, abrasions, blisters and for objects that may have become embedded in the tread. More frequent inspections are recommended when rapid or extreme temperature changes occur or when road surfaces are rough or occasionally littered with foreign material.

As a further visible check of tire condition, tread wear indicators are molded into the bottom of the tread grooves. When these indicator bands become visible, new tires must be installed.

Tire Wear Diagnosis

Uneven wear is usually caused by either excessive camber or excessive toe on tires.

Sometimes incorrect toe settings or worn struts will cause severe `cupping' or `scalloped' tire wear on non-driven wheels.

Severely incorrect toe settings will also cause other unusual wear patterns.

Tire Vibration Diagnosis

A tire vibration diagnostic procedure always begins with a road test. The road test and customer interview (if available) will provide much of the information needed to find the source of a vibration.

During the road test, drive the vehicle on a road that is smooth and free of undulations. If vibration is apparent, note and record the following:

- the speed at which the vibration occurs.
- what type of vibration occurs in each speed range.
  - mechanical or audible
- how the vibration is affected by changes in the following:
  - engine torque
  - vehicle speed
  - engine speed
- type of vibration - sensitivity:
  - torque sensitive
  - vehicle speed sensitive
  - engine speed sensitive

The following explanations help isolate the source of the vibration.

Torque Sensitive

This means that the condition can be improved or made worse by accelerating, decelerating, coasting, maintaining a steady vehicle speed or applying engine torque.

Vehicle Speed Sensitive

This means that the vibration always occurs at the same vehicle speed and is not affected by engine torque, engine speed or the transmission gear selected.

DIAGNOSIS AND TESTING

Engine Speed Sensitive

This means that the vibration occurs at varying vehicle speeds when a different transmission gear is selected. It can sometimes be isolated by increasing or decreasing engine speed with the transmission in NEUTRAL or by stall testing with the transmission in gear. If the condition is engine speed sensitive, the cause is probably not related to the tires.

If the road test indicates that there is tire whine, but no shake or vibration, the noise originates with the contact between the tire and the road surface.

A thumping noise usually means that the tire is flat or has soft spots making a noise as they slap the roadway. Tire whine can be distinguished from axle noise. Tire whine remains the same over a range of speeds.

A complete road test procedure is described in Section 100-04.

REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).

Symptom Chart

Symptom	Possible Sources	Action
• Tire(s) show excess wear on edge of tread	• Tire(s) under-inflated.	• ADJUST the tire pressure(s).
	• Vehicle overloaded.	• CORRECT as necessary.
	• Incorrect wheel alignment.	• ADJUST the wheel alignment. REFER to:(204-00 Suspension System - General Information) Specifications (Specifications), Front Toe Adjustment (General Procedures).
• Tire(s) show excess wear in center of tread	• Tire(s) over-inflated.	• ADJUST the tire pressure(s).
• Other excessive tire wear concerns	• Incorrect tire pressure(s).	• ADJUST the tire pressure(s).
	• Wheel and tire assemblies need rotating.	• ROTATE the wheel and tire assemblies.
	• Incorrect wheel alignment.	• ADJUST the wheel alignment. REFER to:(204-00 Suspension System - General Information) Specifications (Specifications), Front Toe Adjustment (General Procedures).
	• Vehicle overloaded.	• CORRECT as necessary.
	• Loose or leaking front strut and spring assembly.	• TIGHTEN or INSTALL new suspension components as necessary. REFER to:Shock Absorber and Spring Assembly (204-01 Front Suspension, Removal and Installation).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Wheel bearings worn.	• INSTALL new wheel bearings as necessary. REFER to: Wheel Bearing (204-01 Front Suspension, Removal and Installation), Wheel Bearing (204-02 Rear Suspension, Removal and Installation).
	• Suspension components, bushings and ball joints.	• CHECK or INSTALL new suspension components as necessary.
	• Excessive lateral or radial runout of wheel or tire.	• BALANCE the wheel and tire assemblies. Using a suitable dial indicator gauge and holding fixture, CHECK lateral and radial runout of the wheel and tire assemblies. INSTALL new wheel and tire assemblies as necessary. REFER to:(204-04 Wheels and Tires) Specifications (Specifications), Wheel and Tire (Removal and Installation).
• Wobble or shimmy affecting wheel runout	• Damaged wheel.	• INSPECT the wheel rims for damage. BALANCE the wheel and tire assemblies. Using a suitable dial indicator gauge and holding fixture, CHECK lateral and radial runout of the wheel and tire assemblies. INSTALL new wheel and tire assemblies as necessary. REFER to:(204-04 Wheels and Tires) Specifications (Specifications), Wheel and Tire (Removal and Installation).
	• Front wheel bearing.	• CHECK or INSTALL new wheel bearings as necessary. REFER to:Wheel Bearing (204-01 Front Suspension, Removal and Installation).
• Excessive vehicle vibration, rough steering	• Suspension components.	• CHECK or INSTALL new suspension components as necessary.
• Vehicle vibrations from wheels and tires	• Incorrect tire pressure(s).	• ADJUST the tire pressure(s).
	• Wheel or tire imbalance.	• BALANCE the wheel and tire assemblies.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Uneven tire wear.	• INSTALL a new tire(s) as necessary. REFER to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).
	• Brake disc imbalance.	• CHECK the brake disc for foreign material.
	• Water in tire(s).	• REMOVE the water.
	• Bent wheel.	• INSTALL a new wheel and tire assembly. REFER to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).
	• Incorrectly seated tire bead.	• SPIN the wheel on the vehicle. EXAMINE the area where the tire and the wheel meet. If that section of the tire appears to waver while being rotated, the tire bead may not be correctly seated on the wheel. REMOVE the tire and CLEAN the bead seat areas on both wheel and tire.
	• Excessive lateral or radial runout of wheel or tire.	• BALANCE the wheel and tire assemblies. Using a suitable dial indicator gauge and holding fixture, CHECK the lateral and radial runout of the wheel and tire assemblies. INSTALL new wheel and tire assemblies as necessary. REFER to:(204-04 Wheels and Tires) Specifications (Specifications), Wheel and Tire (Removal and Installation).
	• Foreign material between wheel mounting face and hub mounting surface.	• CLEAN mounting surfaces.
	• Front wheel bearing.	• CHECK or INSTALL new wheel bearings as necessary. REFER to:Wheel Bearing (204-01 Front Suspension, Removal and Installation).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Rust streaks from the wheel stud holes in the wheel	• Wheel nuts.	• REMOVE the wheel and tire assembly. Inspect the wheel nuts and wheel and tire assembly for damage. INSTALL new wheel nuts and wheel and tire assemblies as necessary. REFER to:(204-04 Wheels and Tires) Specifications (Specifications), Wheel and Tire (Removal and Installation).
• Seized wheel nuts	• Corrosion.	• CAUTION: Do not permit lubricant to get on cone sets of stud holes or on cone angle of wheel nuts. If corrosion is slight, wire brush away. If corrosion is excessive, INSTALL new wheel studs and nuts. REFER to:(204-04 Wheels and Tires) Specifications (Specifications), Wheel and Tire (Removal and Installation). If the condition persists, LUBRICATE the first three threads of each wheel stud with a graphite-based lubricant.
	• Vehicle overloaded	• CORRECT as necessary.

REMOVAL AND INSTALLATION

Wheel and Tire

Removal

CAUTION:Do not use heat to loosen a seized wheel nut. Heat may damage the wheel and wheel hub.

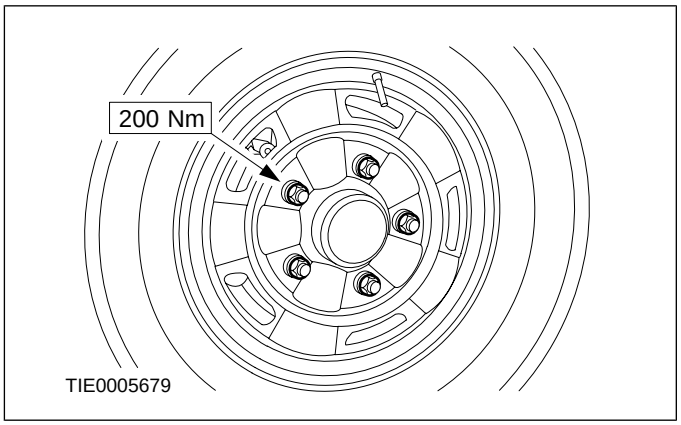
1. **Loosen the wheel nuts.**
2. **Raise and support the vehicle. For additional information, refer to:(100-02 Jacking and Lifting)**

   Jacking (Description and Operation), Lifting (Description and Operation).
3. **Remove the wheel and tire.**

Installation

1. **WARNING:Remove any corrosion or dirt from the mounting surfaces of the wheel, wheel hub or brake drum. Corrosion or dirt on the mounting surfaces may cause the wheel nuts to loosen and the wheel to come off while the vehicle is in motion. Failure to follow this instruction may result in personal injury.**

   Clean the wheel, wheel hub and brake drum mounting surfaces.
2. **Install the wheel and tire assembly.**
3. **Lower the vehicle.**
4. **Tighten the wheel nuts.**



SECTION 205-00 Driveline System - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

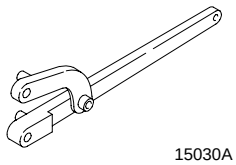
DIAGNOSIS AND TESTING

Driveline System..... 205-00-2
Inspection and Verification..... 205-00-2
Noise Acceptability..... 205-00-2
Universal Joint Inspection..... 205-00-2
Inspection for Bent Rear Axle..... 205-00-2
Analysis of Leakage..... 205-00-4
Axle Vent..... 205-00-4
Drive Pinion Oil Seal..... 205-00-4
Axle Shaft Oil Seals..... 205-00-5
Analysis of Vibration..... 205-00-5
Tires..... 205-00-5
Driveline Angle..... 205-00-5
Universal Joint Wear..... 205-00-6
Pilot Runout..... 205-00-6
Wheel hub or Axle Flange Face Runout..... 205-00-7
Drive Pinion and Drive Pinion Flange..... 205-00-7
Axle Noise..... 205-00-7
Gear Howl and Whine..... 205-00-7
Bearing Whine..... 205-00-7
Chuckle..... 205-00-8
Knock..... 205-00-8
Clunk..... 205-00-9
Total Backlash Check..... 205-00-9
Axle Shaft Bearing Noise..... 205-00-9
Bearing Rumble..... 205-00-10
Analysis of Inoperative Conditions..... 205-00-10
Broken Welds..... 205-00-10
Wheel Bearing Wear or Damage..... 205-00-10
Symptom Chart..... 205-00-10
Component Tests..... 205-00-10
Driveshaft Vibrates..... 205-00-12
Drive Pinion Flange Runout Check..... 205-00-12
Tooth Contact Pattern Check - Gearset..... 205-00-13
Contact Pattern Location..... 205-00-13

DIAGNOSIS AND TESTING

Driveline System

Special Tool(s)

 15030A	Flange Holding Wrench, Universal 205-072 (15-030A)

Inspection and Verification

Certain axle noise or vibration symptoms are also common to the engine, transmission, wheel bearings, tires and other parts of the vehicle. For this reason, make sure that the cause of the trouble is in the axle before disassembling, adjusting or repairing the axle.

REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).

Certain driveshaft vibration symptoms are common to the engine accessory drive, the engine, transmission or tires. Make sure the cause of the concern is the driveshaft before repairing or installing a new driveshaft.

REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).

Noise Acceptability

NOTE:A gear driven unit will produce a certain amount of noise. Some noise is acceptable and audible at certain speeds or under various driving conditions such as a newly tarmaced road. Slight noise is not detrimental to the operation of the axle and is considered normal.

Universal Joint Inspection

Raise and support the vehicle. REFER to:(100-02 Jacking and Lifting)

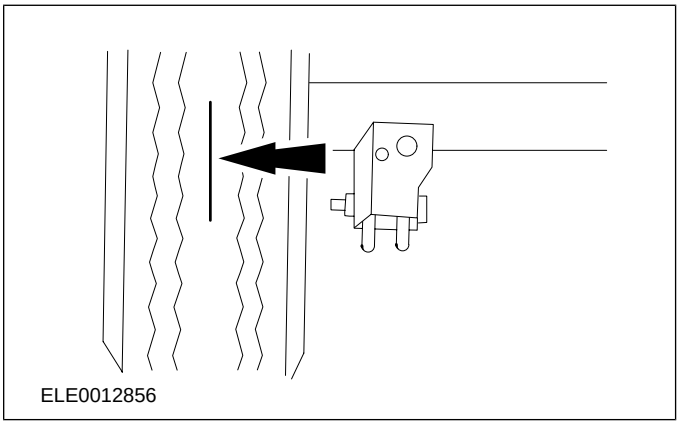
Jacking (Description and Operation),
Lifting (Description and Operation).

Place the vehicle on a wheel free lift and rotate the driveshaft by hand. Check for rough operation or seized universal joints.

Inspection for Bent Rear Axle

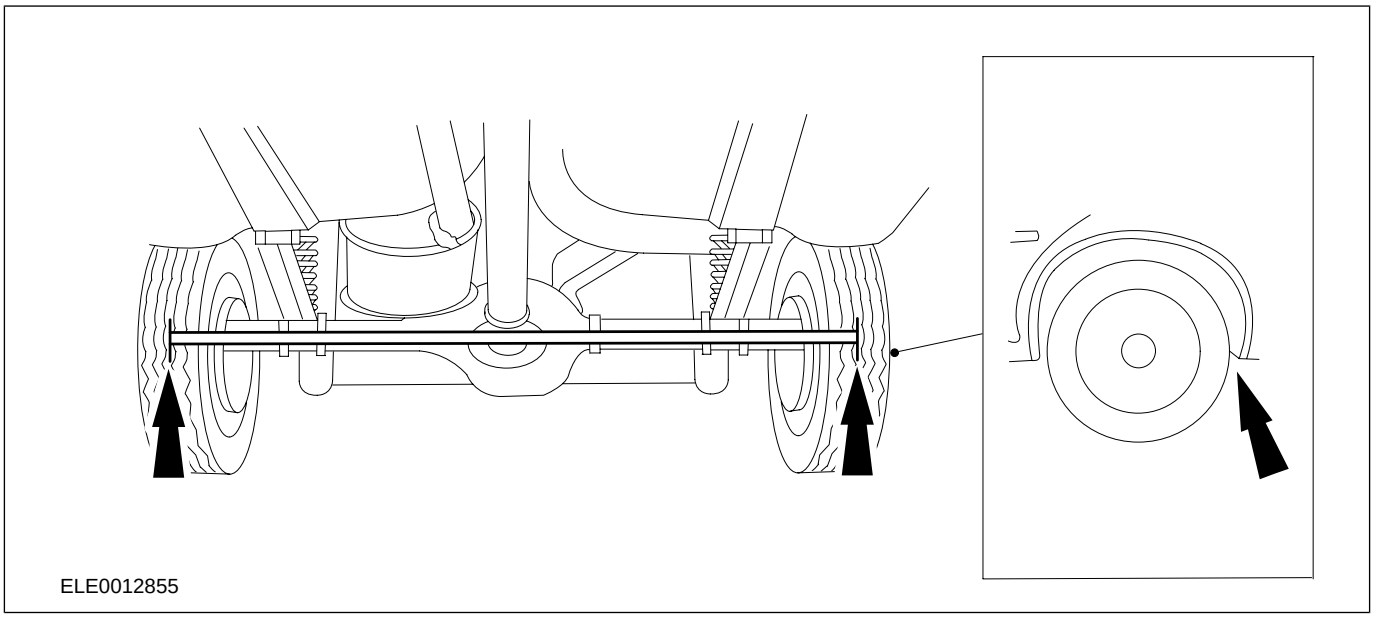
1. Raise and support the vehicle. REFER to:(100-02 Jacking and Lifting)

   Jacking (Description and Operation),
   Lifting (Description and Operation).
   Allow the rear axle to be freely suspended.
2. Use white chalk or paint to mark a vertical line on the center of each rear tire.


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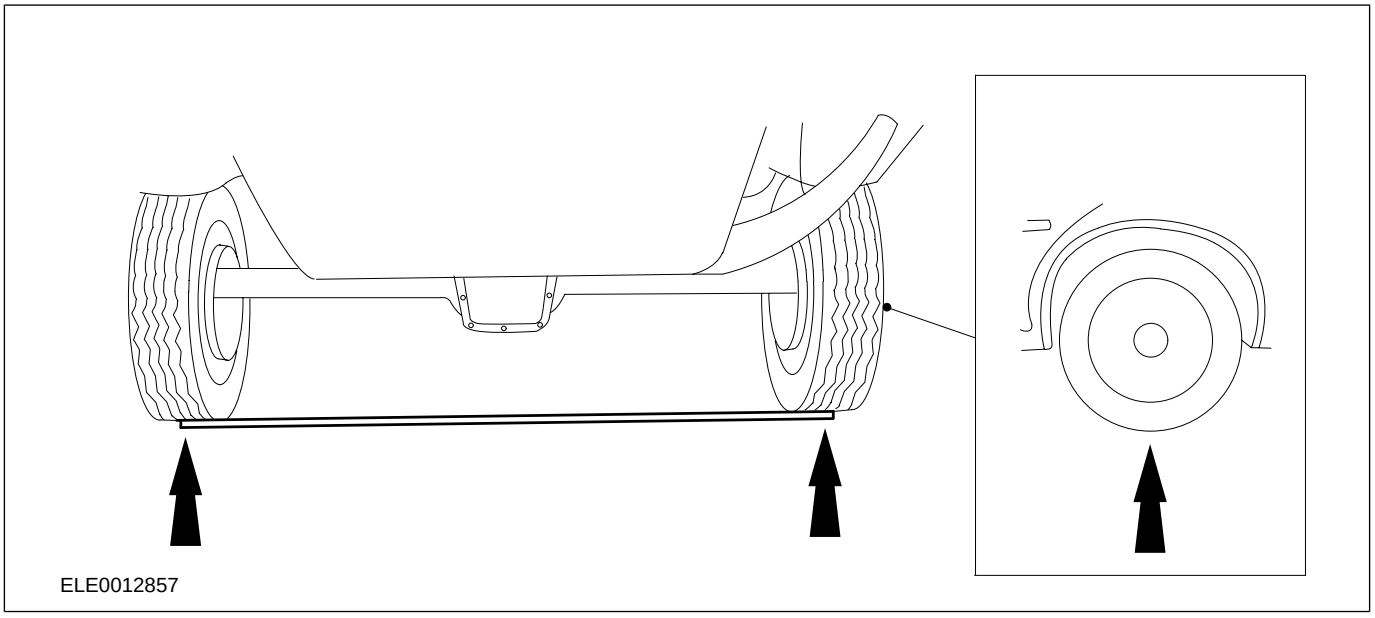
3. Adjust both wheels so that the markings face the front of the vehicle. With a tape measure, measure the distance between the marks and note this measurement (front measurement).

DIAGNOSIS AND TESTING



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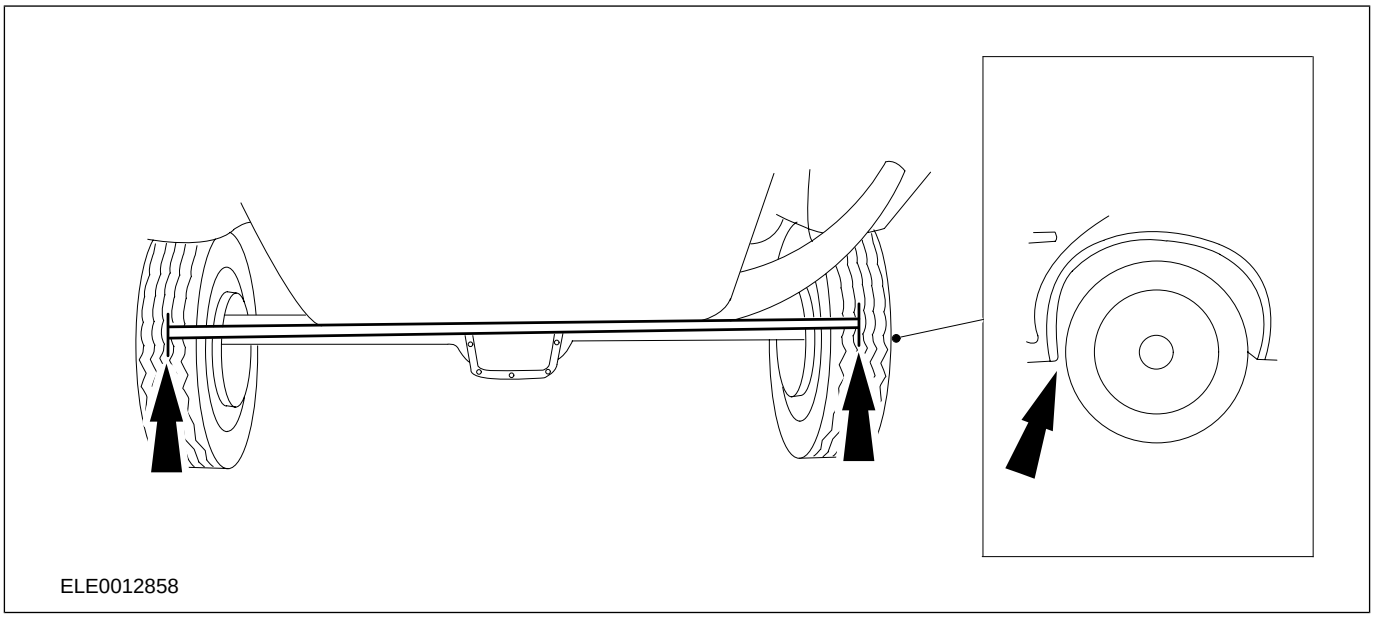
4. Rotate the rear wheels so the markings are directly underneath the vehicle. With a tape measure, measure the distance between the marks and note this measurement (bottom measurement).



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5. Rotate the rear wheels so the markings face the rear of the vehicle. With a tape measure, measure the distance between the marks and note this measurement (rear measurement).

DIAGNOSIS AND TESTING



6. Compare the front and the rear measurements (Steps 3 and 5) to find the toe - in or toe - out condition.
   - Toe - in occurs when the front measurement is less than the rear measurement.
   - Toe - out occurs when the rear measurement is less than the front measurement.
7. To determine camber, find the average of the front and the rear measurements (Steps 3 and 5). Subtract the bottom measurement (Step 4) from this number.

Positive (+) camber is when the bottom measurement is less than the average of the front and rear measurements. Negative (-) camber is when the bottom measurement is greater than the average of the front and rear measurements.

8. The results of the calculations in Steps 6 and 7 must conform to the following specification:

Toe - in: 0 - 1.6 mm.

Toe - out: 0 - 4.8 mm.

Camber: 0 ± 4 mm.

If the axle housing does not meet these specifications, a new axle housing must be installed.

REFER to:Axle Assembly (205-02 Rear Drive Axle/Differential, Removal and Installation).

9. After the axle housing has been installed, repeat steps the previous steps.

Analysis of Leakage

Clean up the leaking area to identify the exact source.

A blocked axle housing vent can cause excessive drive pinion oil seal lip wear due to the internal pressure buildup.

Make sure axle oil level is 6 - 14 mm below the bottom of the oil fill hole.

Axle Vent

NOTE: If a blocked vent cannot be cleared, install a new one.

A blocked vent will cause excessive oil seal lip wear due to internal pressure buildup. If a leak occurs, check the vent. Make sure the vent hose is not kinked. Remove the hose from the vent nipple and clear the hose of any foreign material. While the hose is removed, pass a length of mechanics wire or a small diameter Allen key in and out of the vent to clean it. Connect the hose when done.

Drive Pinion Oil Seal

Leaks at the axle drive pinion oil seal orginate for the following reasons:

– The drive pinion oil seal was not correctly installed.

DIAGNOSIS AND TESTING

Any damage to the oil seal bore (dings, dents, gouges, or other imperfections) will distort the oil seal casing and allow leakage past the outer edge of the axle drive pinion oil seal.

The axle drive pinion oil seal can be torn, cut, or gouged if it is not installed correctly. The spring that holds the axle drive pinion oil seal lip against the drive pinion flange may be dislodged resulting in allowing leakage past the lip of the oil seal.

The rubber oil seal lips can occasionally become hard (like plastic) with cracks at the lip contact point. The contact point on the drive pinion flange may blacken, indicating excessive heat. Marks, nicks, gouges, or rough surface texture on the oil seal journal of the drive pinion flange will also cause leaks.

Axle drive pinion oil seal wear 1.27 mm or greater is considered excessive.

A new drive pinion flange must be installed if any of these conditions exist.

Metal chips or sand trapped at the oil seal lip may also cause oil leaks. This can cause a wear groove on the drive pinion flange and heavy drive pinion oil seal wear.

When an oil seal leak occurs, install a new oil seal and check the vent. Make sure they are clean and free of foreign material.

Axle Shaft Oil Seals

The axle shaft oil seals are susceptible to the same kinds of damage as axle drive pinion oil seals if incorrectly installed. The oil seal bore must be clean and the oil seal lip handled carefully to avoid cutting or tearing it. The axle shaft journal surface must be free of nicks, gouges, and rough surface texture.

Analysis of Vibration

Few vibration conditions are caused by the front or rear axle. Follow the diagnosis procedure unless there is a good reason to suspect the axle.

REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).

Tires

WARNING:Do not balance the wheels and tires while they are mounted on the vehicle. Possible tire disintegration/differential failure could result, causing personal injury/extensive component damage. Use an off - vehicle wheel and tire balancer only.

Most vibration in the rear end is caused by tires or driveline angle.

Vibration is a concern with modern, high - mileage tires if they are not ``true'' both radially and laterally. They are more susceptible to vibration around the limits of radial and lateral runout of the tire and wheel assembly. They also require more accurate balancing. Wheel and tire runout checks, truing and balancing are normally done before axle inspection.

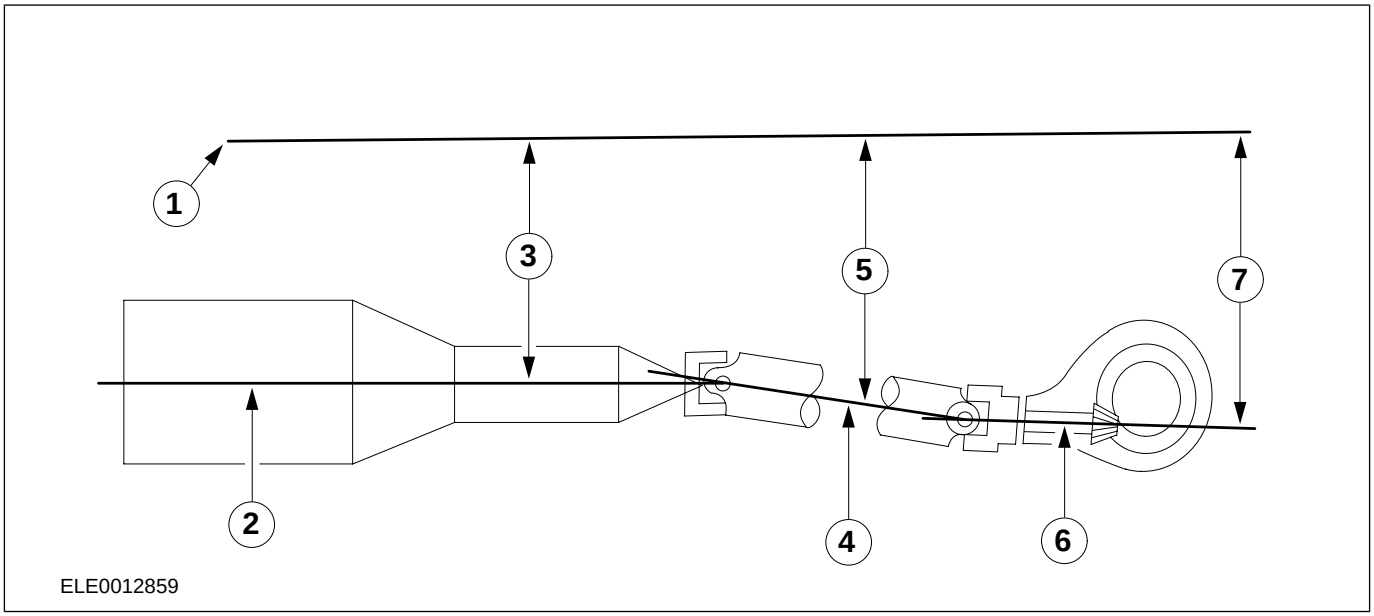
REFER to:Wheels and Tires (204-04 Wheels and Tires, Diagnosis and Testing).

Driveline Angle

Driveline angularity is the angular relationship between the engine crankshaft, the driveshaft, and the rear axle drive pinion. Factors determining driveline angularity include ride height, rear spring, and engine mounts.

DIAGNOSIS AND TESTING

Driveline Angle



Item	Description
1	Bottom of the frame
2	Engine crankshaft centerline
3	Engine angle
4	Driveshaft and coupling shaft centerline
5	Driveshaft and coupling angle
6	Rear axle drive pinion centerline
7	Axle drive pinion angle

An incorrect driveline (drive pinion) angle can often be detected by the driving condition in which the vibration occurs.

– A vibration during coasting from 72 to 56 km/h 45 to 35 mph) is often caused by a high axle drive pinion angle.
– A vibration during acceleration, from 56 to 72 km/h (35 to 45 mph) may indicate a low drive pinion angle.

When these conditions exist, check the driveline angles.

REFER to:Suspension System (204-00 Suspension System - General Information, Diagnosis and Testing).

If the tires and driveline angle are not the cause, carry out the NVH tests to determine whether the concern is caused by a condition in the axle.

REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).

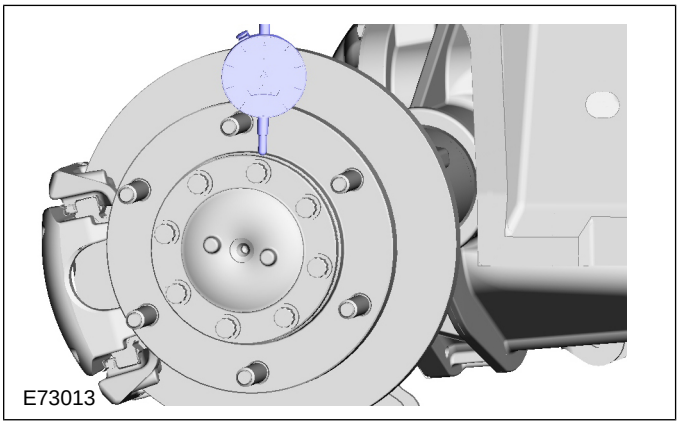
Universal Joint Wear

Place the vehicle on a wheel free lift and rotate the driveshaft by hand. Check for rough operation or seized universal joints.

Pilot Runout

1. **NOTE:Clean the wheel hub flange with abrasive paper before positioning the dial indicator gauge with magnetic base.**

   Position the dial indicator with magnetic base as close to the wheel hub or axle flange face as possible. Zero the indicator dial.



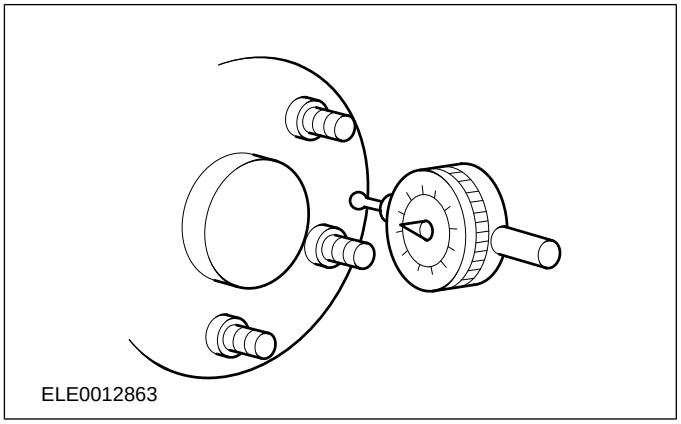
2. Rotate the wheel hub or axle flange one full turn and note the maximum and minimum measurements. The difference between the maximum and minimum measurements will be the total runout. Pilot runout must not exceed 0.15 mm.

DIAGNOSIS AND TESTING

Wheel hub or Axle Flange Face Runout

NOTE: If the axle shaft assembly is removed, check the runout of the axle shaft itself. The forged (unmachined) part of the axle shaft is allowed to have as much as 3.0 mm runout. This alone will not cause a vibration condition.

1. Position the dial indicator gauge on the wheel hub or axle flange face, as close to the outer edge as possible. Zero the indicator dial.


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2. Rotate the wheel hub or axle flange one full turn and note the maximum and minimum measurements. The difference between the maximum and minimum measurements will be the total face runout. The runout must not exceed 0.25 mm.

Drive Pinion and Drive Pinion Flange

Check the drive pinion flange runout when all other checks have failed to show the cause of vibration.

One cause of excessive drive pinion flange runout is incorrect installation of the axle drive pinion oil seal. Check to see if the spring on the oil seal lip has been dislodged before installing a new ring gear and drive pinion.

Axle Noise

NOTE: Before disassembling the axle to diagnose and correct gear noise, eliminate the tires, exhaust system, trim items, roof racks, axle shafts and wheel bearings as possible causes. Follow the diagnostic procedures.

REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).

The noises described as follows usually have specific causes that can be diagnosed by observation as the unit is disassembled. The initial clues are the type of noise heard during the road test.

Gear Howl and Whine

Howling or whining of the ring gear and drive pinion is due to an incorrect gear pattern, gear damage or incorrect bearing preload.

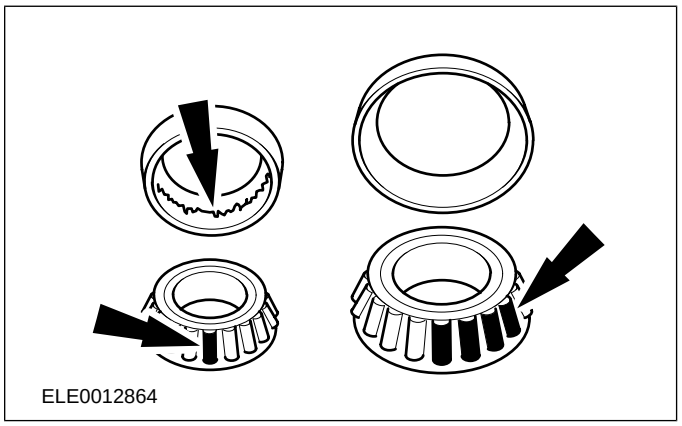
Bearing Whine

Bearing whine is a high - pitched sound similar to a whistle. It is usually caused by worn or damaged drive pinion bearings, which are operating at driveshaft speed. Bearing noise occurs at all driving speeds. This distinguishes it from gear whine which usually comes and goes as speed changes.

As noted, drive pinion bearings make a high - pitched, whistling noise, usually at all speeds. If however there is only one drive pinion bearing that is worn or damaged, the noise may vary in different driving phases. New drive pinion bearings must not be installed unless scoring or damage is found or there is a specific drive pinion bearing noise. A worn or damaged bearing will normally be obvious at disassembly. Examine the large diameter of the rollers for wear. If the drive pinion bearings original blend radius has worn to a sharp edge, a new front and rear drive pinion bearing must be installed.

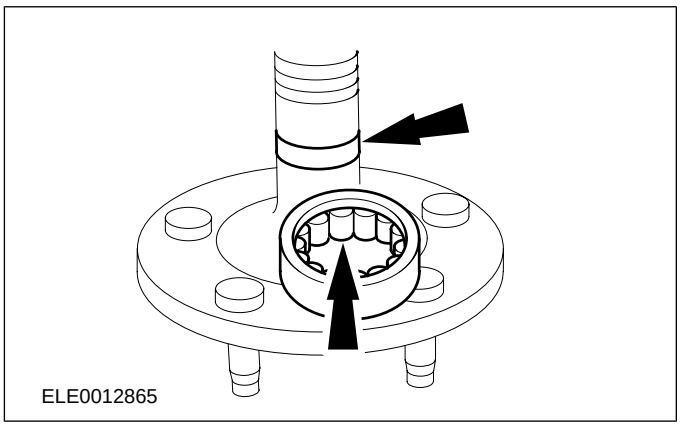
NOTE:A low - pitched rumble normally associated with a worn or damaged wheel bearing can be caused by an exterior luggage rack or tires.

A wheel bearing noise can be mistaken for a drive pinion bearing noise. Check the wheel bearing for a spalled cup, and spalled or damaged rollers. Install a new wheel bearing if any of these concerns are detected.


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DIAGNOSIS AND TESTING

If the wheel bearing is damaged, the roller surface on the axle shaft may also be damaged. Install a new axle shaft if any damage is detected.


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Chuckle

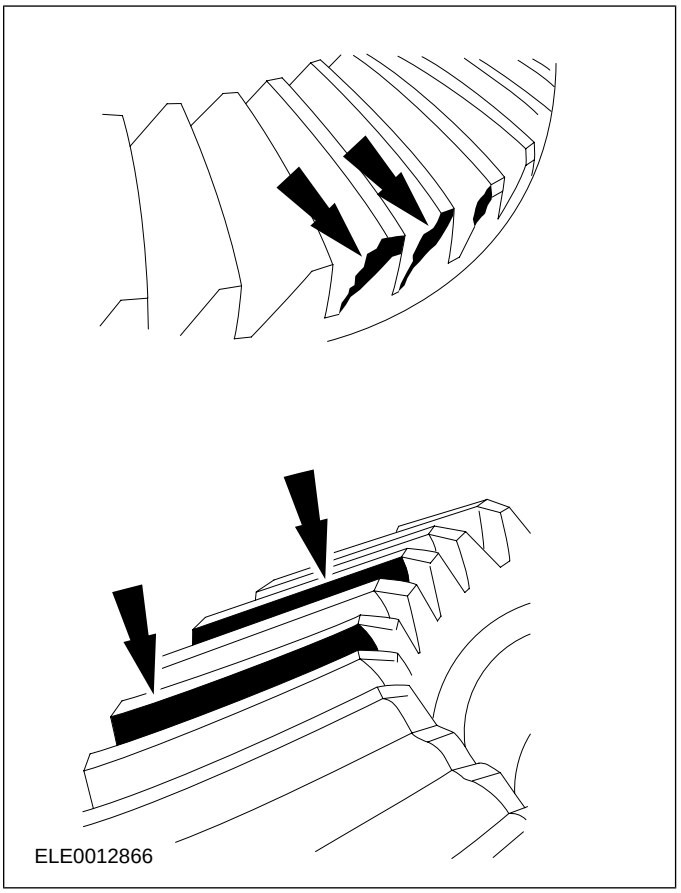
Chuckle that occurs on coasting is usually caused by excessive clearance between the differential gear wheel hub and the differential case bore.

Damage to a gear tooth on the coast side can cause a noise identical to a chuckle. A very small tooth nick or ridge on the edge of a tooth can cause the noise.

Clean the gear tooth nick or ridge with a small grinding wheel. If the damaged area is larger than 3.2 mm, install a new gearset.

To check the ring gear and drive pinion, remove as much oil as possible from the gears with clean solvent. Wipe the gears dry or blow them dry with compressed air. Look for scored or damaged teeth. Also look for cracks or other damage.

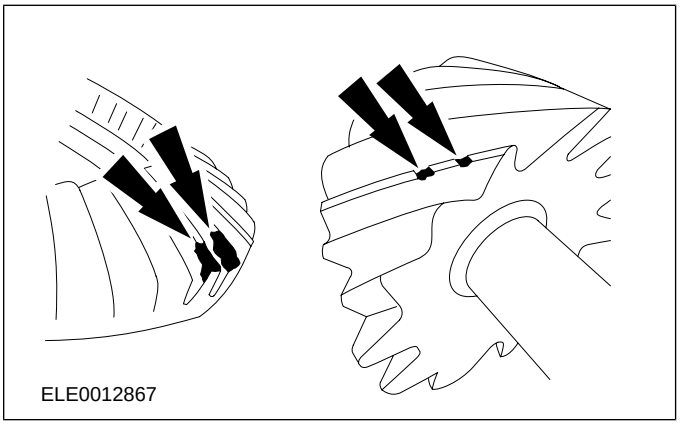
If either gear is scored or damaged badly, a new ring gear and drive pinion must be installed.


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If metal has broken loose, the axle housing must be cleaned to remove particles that will cause damage. At this time if any other damaged parts are found in the axle housing, new parts must also be installed.

Knock

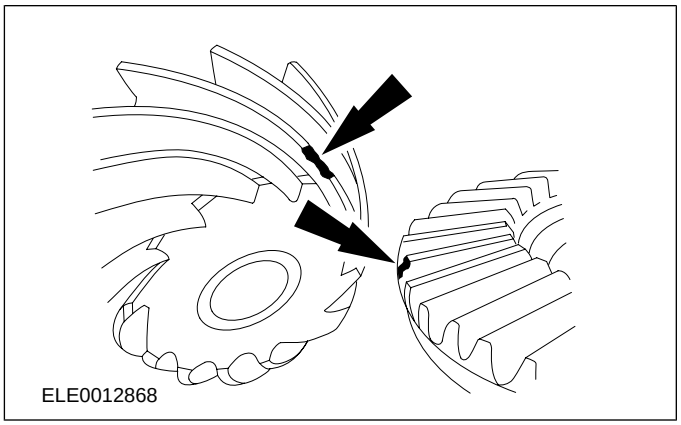
Knock, which can occur on all driving phases, has several causes including damaged teeth or gearset.


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In most cases, one of the following conditions will occur:

DIAGNOSIS AND TESTING

1. A gear tooth damaged on the drive side is a common cause of the knock. This can usually be corrected by grinding the damaged area.



2. **NOTE:Measure the end play with a dial indicator gauge and not by feel.**

   The knock is also caused by excessive end play in the axle shafts. Up to 0.76 mm is allowed in semi - floating axles. The frequency of the knock will be less because the axle shaft speed is slower than the driveshaft.

Clunk

Clunk is a metallic noise heard when the automatic transmission is engaged in REVERSE or DRIVE. The noise may also occur when throttle is applied or released. It is caused by backlash somewhere in the driveline or loose suspension components; it is felt or heard in the axle.

REFER to:Ring Gear Backlash Adjustment (205-00 Driveline System - General Information, General Procedures).

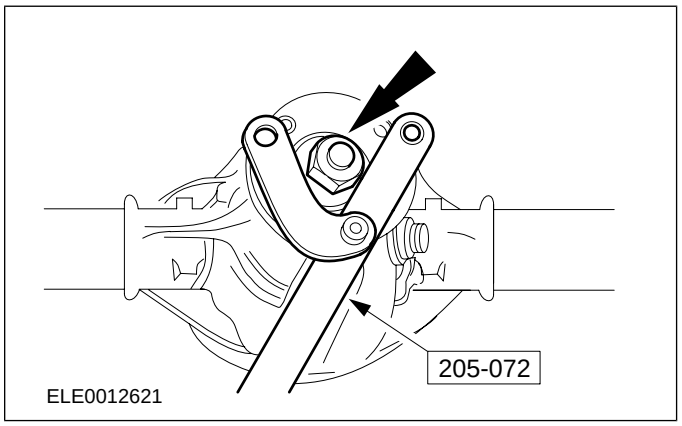
Additionally, clunk may be heard upon initial drive - away. This occurs as engine torque shifts vehicle weight, forcing changes in driveline angles, preventing the driveshaft slip - yoke from sliding on the output shaft. To correct this condition, lubricate the slip - yoke splines.

Total Backlash Check

1. Raise and support the vehicle. REFER to:(100-02 Jacking and Lifting)

   Jacking (Description and Operation), Lifting (Description and Operation).
2. Remove the driveshaft.

   REFER to:Driveshaft (205-01 Driveshaft, Removal and Installation).
3. Install the special tool.
   - Clamp a rigid bar or pipe to the tool. Clamp the other end of the bar or pipe to the frame or a body member in order to prevent movement of the drive pinion flange.



4. Lower the vehicle so that one rear wheel is resting on a wheel chock to prevent it from turning. The other rear wheel will be used to measure total rear axle backlash.
5. Rotate the free wheel slowly, by hand, until the feeling of driving the rear axle is encountered. Place a mark on the side of the tire, 305 mm from the center of the wheel, with a crayon or chalk.
6. While holding the crayon or chalk against the tire, rotate the wheel slowly in the opposite direction until the feeling of driving the rear axle is encountered again.
7. Measure the length of the mark on the tire.
   - If the length of the mark is 25 mm or less, the rear axle backlash is within specification.
   - If the mark is greater than 25 mm, check for these conditions:
     - Elongation of the differential drive pinion shaft and holes in the differential case.
     - Galling of the differential drive pinion shaft and bore.
     - Excessive ring gear and drive pinion backlash. Follow the procedure for the type of rear axle to check backlash.

Axle Shaft Bearing Noise

Axle shaft bearing noise is similar to gear noise and differential drive pinion bearing whine. Axle shaft bearing noise will usually distinguish itself from gear noise by occuring in all driving modes (drive, coast, and float), and will persist with the transmission in NEUTRAL while the vehicle is moving at the speed in which the concern is occuring. If the vehicle makes this noise, remove

DIAGNOSIS AND TESTING

the suspect axle shaft and install a new bearing and axle oil seal. Re - evaluate the vehicle for noise before removing any internal components.

Bearing Rumble

Bearing rumble sounds like marbles being tumbled. This condition is usually caused by a worn or damaged wheel bearing. The lower pitch is because the wheel bearing turns at only about one - third of the driveshaft speed. Wheel bearing noise also may be high - pitched, similar to gear noise, but will be evident in all driving modes.

Analysis of Inoperative Conditions

If the axle does not operate, it may be caused by broken welds or wheel bearing wear or damage.

Broken Welds

If axle housing welds are completely broken, install a new axle housing.

Wheel Bearing Wear or Damage

Because of the severe loads they must handle, new wheel bearings may be required at high mileage. If a wheel bearing fails at low mileage, it is often caused by overloading.

Symptom Chart

Symptom Chart

Symptom	Possible Sources	Action
• Oil leaking from the drive pinion oil seal, axle shaft oil seals or support arm to the housing	• Axle housing vent.	• CLEAN the axle housing vent.
	• Damage in the oil seal contact areas or dust slinger on the drive pinion flange dust shield.	• INSTALL a new drive pinion flange and the drive pinion oil seal if damage is found.

Component Tests

Driveline Vibration

Driveline vibration exhibits a higher frequency and lower amplitude than does high - speed shake. Driveline vibration is directly related to the speed of the vehicle and is usually noticed at various speed ranges. Driveline vibration can be perceived as a tremor in the floor pan or is heard as a rumble, hum or boom. Driveline vibration can exist in all drive modes, but may exhibit different symptoms depending upon whether the vehicle is accelerating, decelerating, floating, or coasting. Check the driveline angles if the vibration is particulary noticeable during acceleration or deceleration, especially at lower speeds. Driveline vibration can be duplicated by supporting the axle upon a vehicle lift or upon axle stands, though the brakes may need to be applied lightly in order to simulate road resistance.

1. Raise and support the vehicle promptly after road testing. Use a two post lift or axle stands to prevent tire flat - spotting. Engage the drivetrain and accelerate to the observed road test speed to verify the presence of the vibration. If the vibration is not evident, check the nondriving wheels with a wheel balancer to rule out imbalance as a possible cause. If required, balance the nondriving wheels and repeat the road test. If the vibration is still evident, proceed to the following step.
2. Mark the relative position of the drive wheels to the wheel bolts. Remove the wheels. Install all the wheel nuts in the reversed position and repeat the road speed acceleration test. If the vibration is gone, refer to the wheel and tire runout procedure.

   REFER to:Wheels and Tires (204-04 Wheels and Tires, Diagnosis and Testing).

   If the vibration persists, proceed to the following step.
3. Inspect the driveshafts for signs of physical damage, missing balance weight, undercoating, incorrect seating, wear and binding universal joints. Clean the driveshaft and install new universal joints or install a new driveshaft if

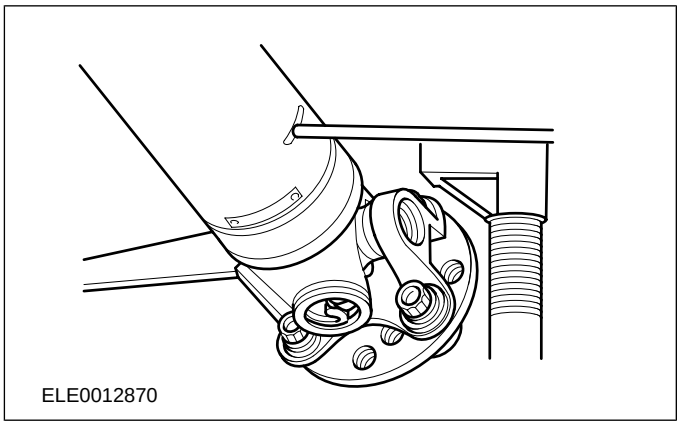
DIAGNOSIS AND TESTING

damaged. Check the index marks (paint spots) on the rear of the driveshaft and drive pinion flange. If these marks are more than one - quarter turn apart, disconnect the driveshaft and reindex to align the marks as closely as possible. After any corrections are made, recheck for vibration at the road test speed. If the vibration is gone, install the wheels and road test the vehicle. If the vibration persists, proceed to following step.

4. Raise and support the vehicle. REFER to:(100-02 Jacking and Lifting)

   Jacking (Description and Operation),
   Lifting (Description and Operation).
   Remove the wheels and tires.

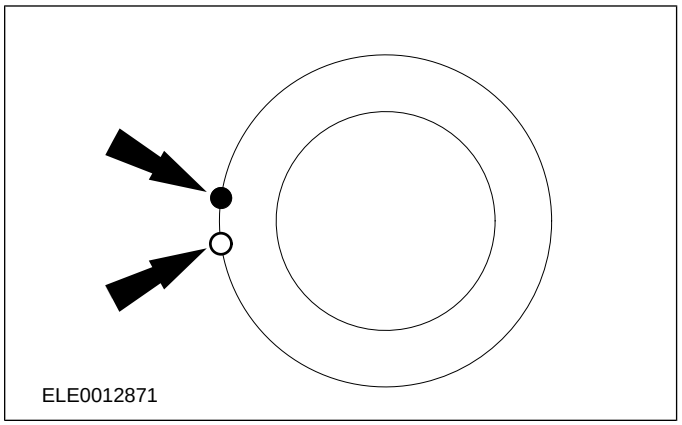
   REFER to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).
   Rotate the driveshaft by turning the axle and measure the runout at the front, the center, and the rear of the driveshaft with the dial indicator gauge. If the runout exceeds 0.89 mm at the front or center, a new driveshaft must be installed. If the front and center are within this limit, but the rear runout is not, mark the rear runout high point and proceed to following step. If the runout is within specifications at all points, proceed to following step.


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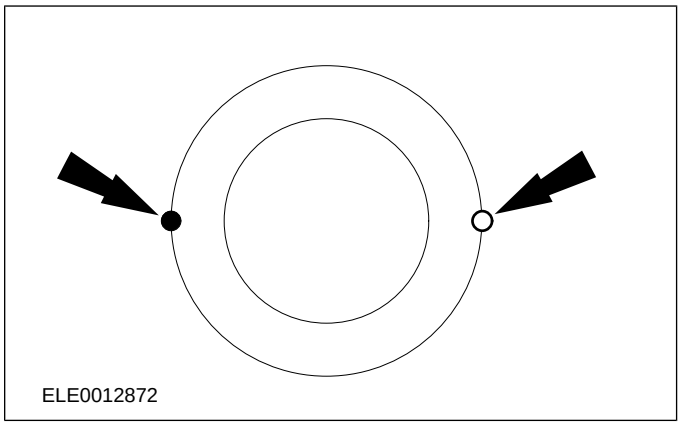
5. **NOTE:Check the universal joints during re - indexing. If a universal joint feels stiff or gritty, install new universal joints.**

   Scribe alignment marks on the driveshaft and the drive pinion flange. Disconnect the driveshaft, rotate it one - half turn and reconnect it. Circular drive pinion flanges can be turned by one - quarter increments to fine tune the runout condition; half - round drive pinion flanges are limited to two positions. Check the runout at the rear of the driveshaft. If it is still over 0.89 mm, mark the high point and proceed to the following step. If the runout is no longer excessive, check for vibration at the road test speed. If vibration is still present, reindex the driveshaft slip - yoke on the transmission output shaft one half - turn and road test the vehicle. If the vibration persists, proceed to the following Step.

6. Excessive driveshaft runout may originate in the driveshaft itself or in the drive pinion flange. To determine which, compare the two high points marked in previous steps. If the marks are close together, within about 25 mm, a new driveshaft must be installed and the vehicle road tested.


ELE0012871

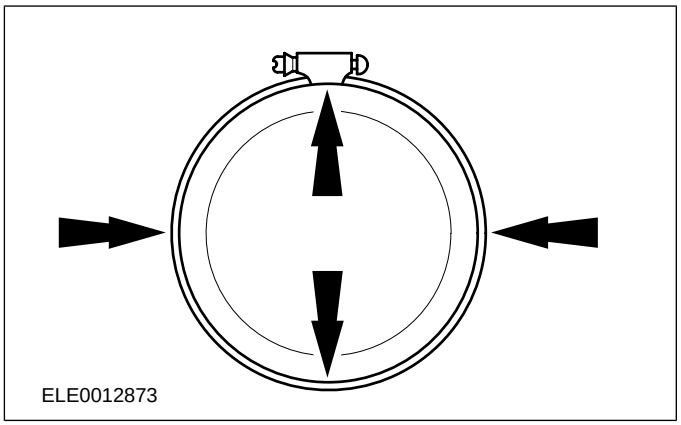
If the marks are on opposite sides of the driveshaft, the yoke or drive pinion flange is responsible for the vibration.


ELE0012872

When installing a new drive pinion flange, the driveshaft runout must not exceed 0.89 mm. When runout is within limits, recheck for vibration at road speed. If vibration persists, balance the driveshaft.

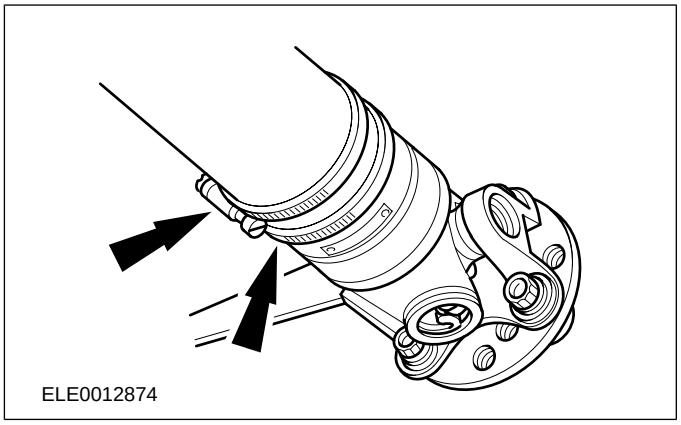
7. To balance the driveshaft, install one or two hose clamps on the driveshaft, near the rear. Position of the hose clamp head(s) can be determined by trial - and - error.
8. Mark the rear of the driveshaft into four approximately equal sectors and number the marks 1 through 4. Install a hose clamp on the driveshaft with its head at position No. 1.

DIAGNOSIS AND TESTING

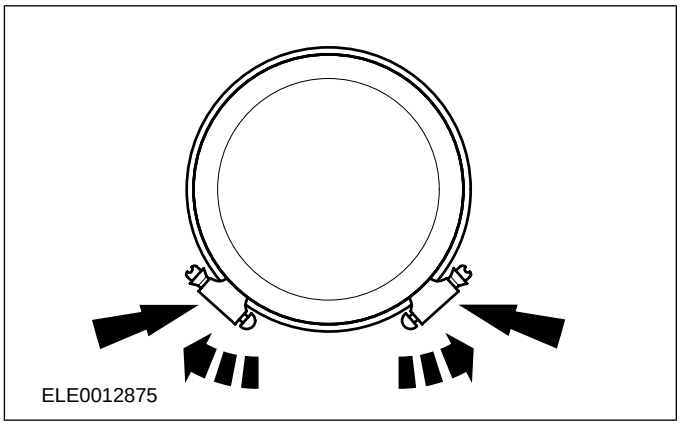

ELE0012873

Check for vibration at road speed. Recheck with the clamp at each of the other positions to find the position that shows minimum vibration. If two adjacent positions show equal improvement, position the clamp head between them.

9. If the vibration persists, add a second clamp at the same position and recheck for vibration.


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If no improvement is noted, rotate the clamps in opposite directions, equal distances from the best position determined in the previous step. Separate the clamp heads about 13 mm and recheck for vibration at the road speed.


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Repeat the process with increasing separation until the best combination is found or the vibration is reduced to an acceptable level.

10. Install the wheels and road test the vehicle (vibration noticeable on the vehicle lift may not be evident during the road test). If the vibration is still not acceptable, install a new axle driveline vibration damper first (if equipped).

Driveshaft Vibrates

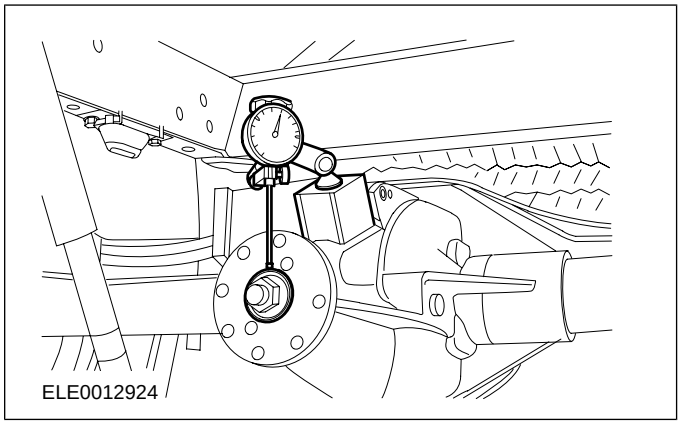
1. Road test the vehicle to determine the critical vibration points. Note the road speed, the engine rpm, and the gearshift lever positions at which the vibration occurs.
2. Stop the vehicle, place the gearshift lever in neutral and run the engine through the critical speed ranges determined in previous step.
3. If no vibration is felt, balance the driveshaft.

Drive Pinion Flange Runout Check

CAUTION:Drive pinion bearing preload must be reset if the drive pinion nut has been loosened or removed for drive pinion flange reindexing or renewal.

1. Raise and support the vehicle on a two post lift that supports the rear axle.
2. Remove the driveshaft.

   REFER to:Driveshaft (205-01 Driveshaft, Removal and Installation).
3. Check the drive pinion flange for damage.
4. Position a dial indicator gauge with magnetic base on the drive pinion flange.


ELE0012924

DIAGNOSIS AND TESTING

If the drive pinion flange runout exceeds 0.25 mm, remove the drive pinion flange, reindex the drive pinion flange one - half turn on the drive pinion and install it. REFER to:

Drive Pinion Flange and Drive Pinion Seal - VIN Plate Axle Code: A/B/C/D/G/M/P/X/Y (205-02A Rear Drive Axle/Differential, In-vehicle Repair), Drive Pinion Flange and Drive Pinion Seal (205-02 Rear Drive Axle/Differential, In-vehicle Repair).

5. Check the runout again. If necessary, rotate the drive pinion flange until an acceptable runout is obtained. If the drive pinion flange runout is still more than 0.25 mm, install a new drive pinion flange.
6. If excessive runout is still evident after installation of a new drive pinion flange, install a new ring gear set. Repeat the above checks until the runout is within specifications.
7. Install the driveshaft.

   REFER to:Driveshaft (205-01 Driveshaft, Removal and Installation).

Tooth Contact Pattern Check - Gearset

1. To check the gear tooth contact, paint the gear teeth with the special marking compound. A mixture that is too wet will run and smear; a mixture that is too dry cannot be pressed out from between the teeth.
2. Use a box wrench on the ring gear bolts as a lever to rotate the ring gear several complete revolutions in both directions or until a clear tooth contact pattern is obtained.
3. Certain types of gear tooth contact patterns on the ring gear indicate incorrect adjustment. Incorrect adjustment can be corrected by readjusting the ring gear or the drive pinion.

Contact Pattern Location

In general, acceptable ring gear tooth patterns must have the following characteristics:

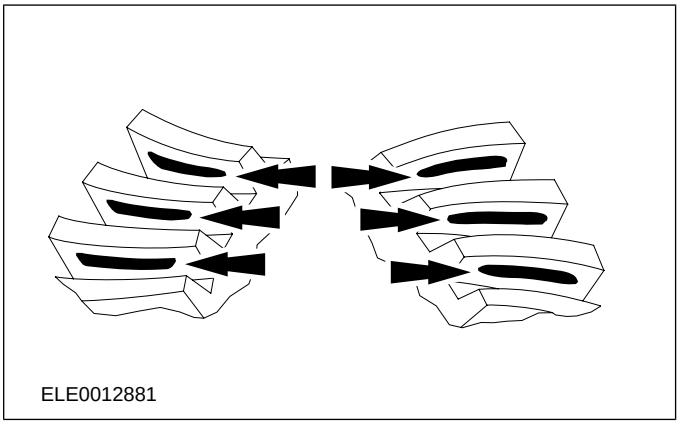
– Drive pattern on the drive side ring gear well centered on the tooth.

– Coast pattern in the coast side ring gear well centered on the tooth.

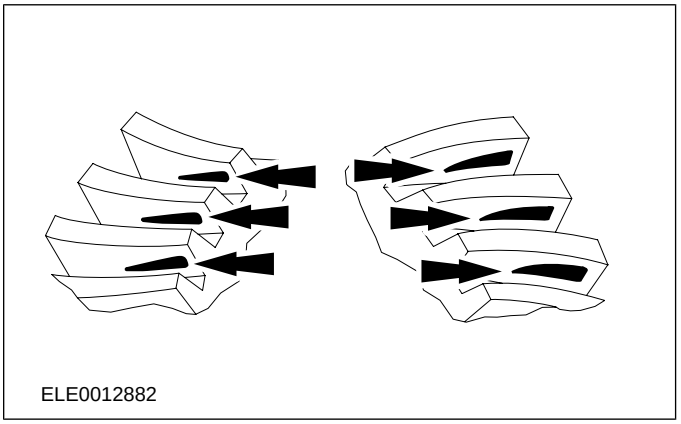
– Clearance between the pattern and the top of the tooth.

– No hard lines where the pressure is high.

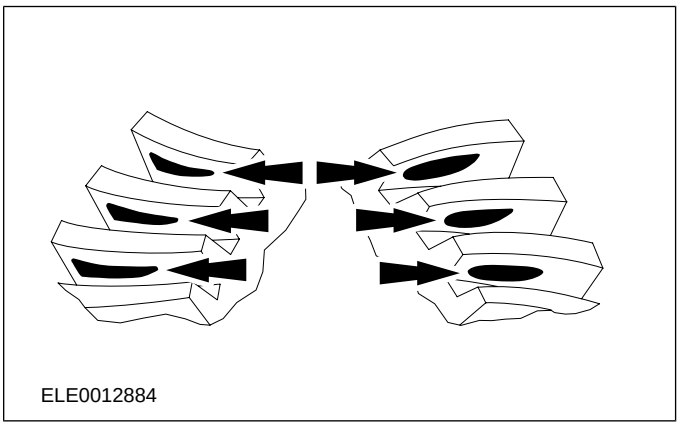
Acceptable ring gear tooth patterns for all axles.



Correct backlash with a thinner drive pinion position shim.

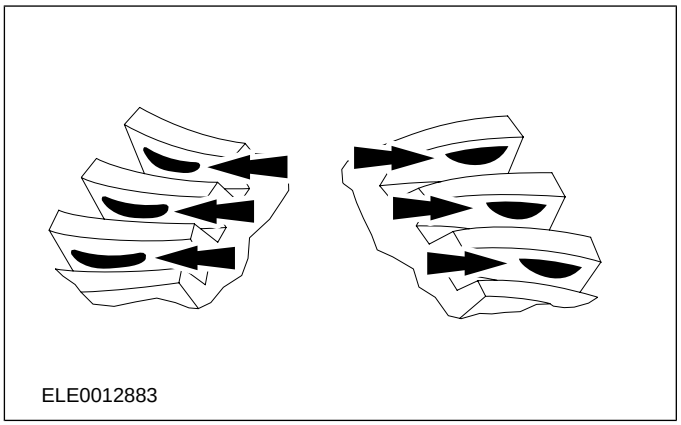


Correct backlash with a thicker drive pinion position shim required.



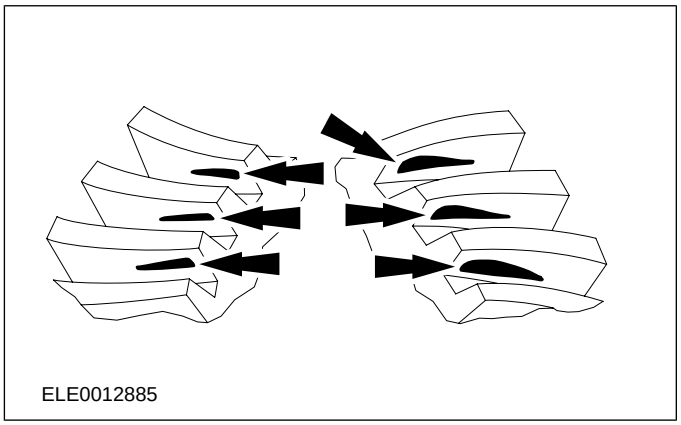
Correct drive pinion position shim that requires a decrease in backlash.

DIAGNOSIS AND TESTING



ELE0012883

Correct drive pinion position shim that requires an increase in backlash.



ELE0012885

SECTION 205-01 Driveshaft

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 205-01-2

DIAGNOSIS AND TESTING

Driveshaft..... 205-01-3

REMOVAL AND INSTALLATION

Driveshaft..... (15 514 0) 205-01-4

DISASSEMBLY AND ASSEMBLY

Driveshaft Center Bearing..... (15 564 4) 205-01-8

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Grease	SAM-1C-9111-A

Torque Specifications

Description	Nm	lb-ft	lb-in
Driveshaft center bearing retaining bolts	22	16	-
Driveshaft to transmission output shaft flange bolts (5 speed transmission)	115	85	-
Driveshaft to transmission output shaft flange bolts (6 speed transmission)	175	129	-
Driveshaft to drive pinion flange bolts	80	59	-
Driveshaft yoke retaining bolt	45	33	-

DIAGNOSIS AND TESTING

Driveshaft

REFER to Section 205-00 [Driveline System - General Information].

REMOVAL AND INSTALLATION

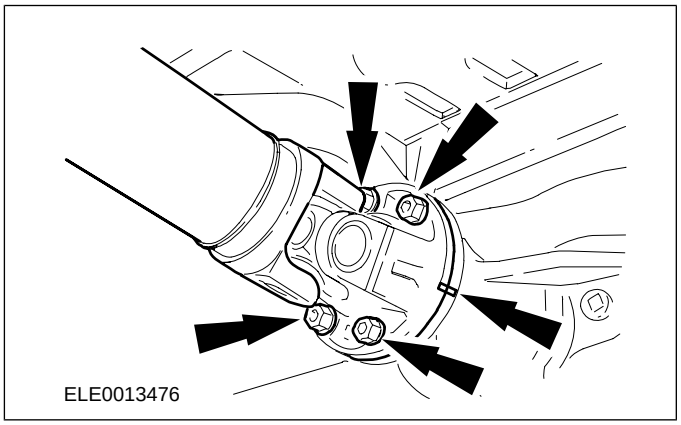
Driveshaft (15 514 0)

1. **Raise and support the vehicle.**

   For additional information, refer to:Jacking (100-02 Jacking and Lifting, Description and Operation) / Lifting (100-02 Jacking and Lifting, Description and Operation).

2. **NOTE:Mark the position of the driveshaft flange in relation to the drive pinion flange.**

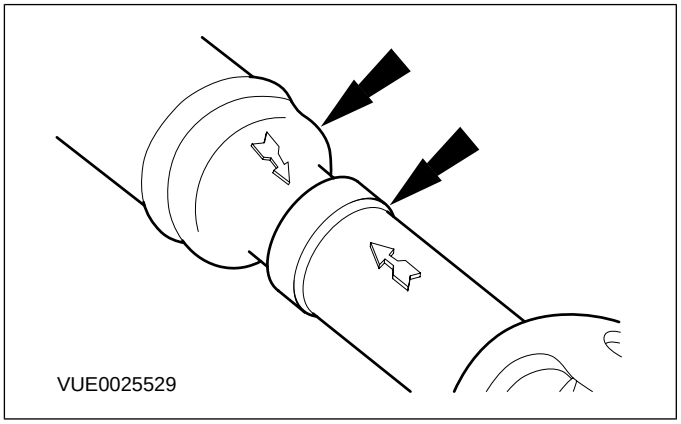
   Detach the driveshaft from the drive pinion flange and position it to one side.



3. **WARNING:Driveshafts without a sliding joint protective boot must have the rear section of the driveshaft removed to prevent accidental separation of the sliding joint. Failure to follow this instruction may result in personal injury.**

NOTE: Make sure that the alignment arrows are visible, outherwise make new alignment marks.

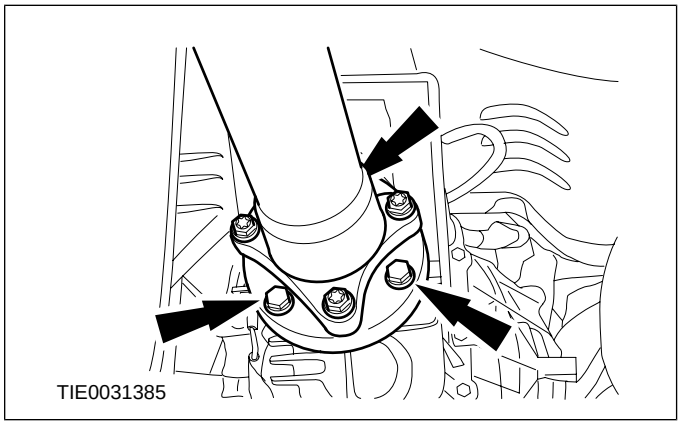
Remove the rear section of the driveshaft if necessary.



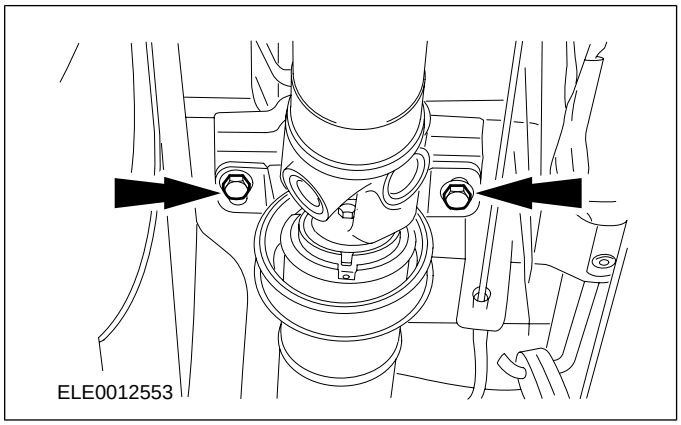
4. **NOTE:Mark the position of the driveshaft flange in relation to the transmission output shaft flange.**

   Detach the driveshaft from the transmission output shaft flange and position it to one side.

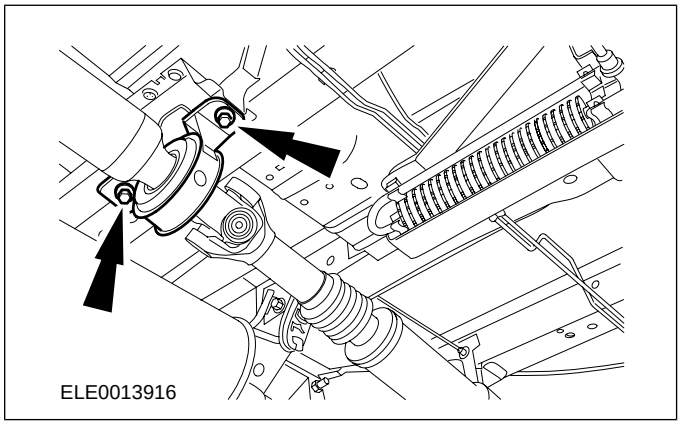
   - Discard the bolts.



5. **Remove the driveshaft front center bearing retaining bolts.**



6. **With the aid of another technician, remove the driveshaft rear center bearing retaining bolts and remove the driveshaft.**



REMOVAL AND INSTALLATION

Installation

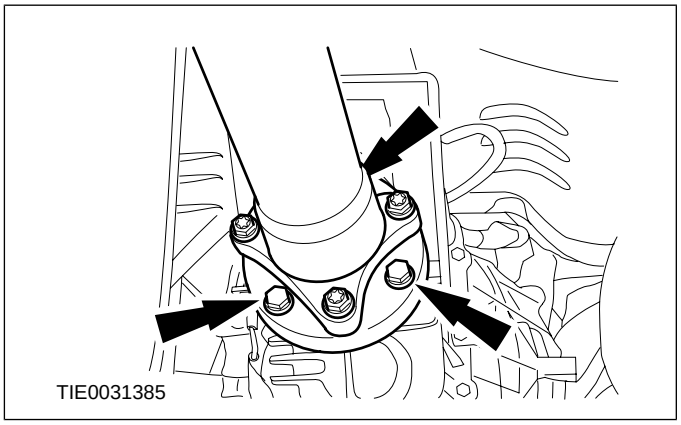
All vehicles

1. **NOTE:Align the mark on the driveshaft flange with the mark on transmission output shaft flange.**

NOTE: Install new driveshaft to transmission output shaft flange bolts.

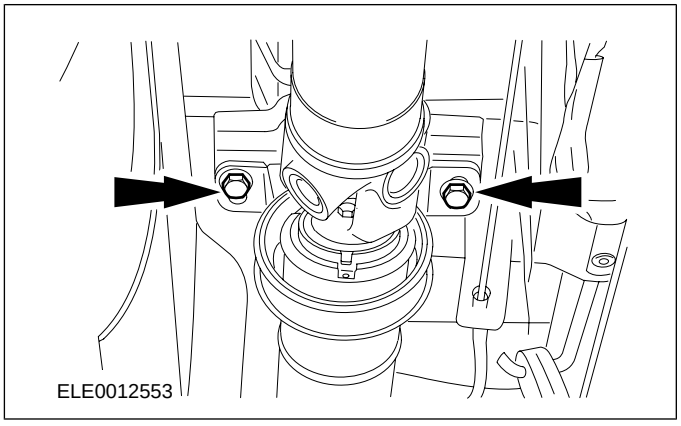
NOTE: Do not fully tighten the driveshaft to transmission output shaft flange bolts at this stage.

With the aid of another technician, attach the driveshaft to the transmission output shaft flange.



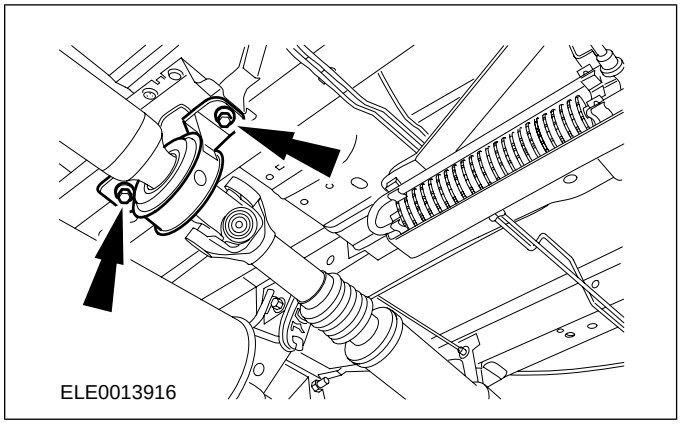
2. **NOTE:Do not fully tighten the driveshaft front center bearing retaining bolts at this stage.**

With the aid of another technician, install the driveshaft front center bearing retaining bolts.



3. **NOTE:Do not fully tighten the driveshaft rear center bearing retaining bolts at this stage.**

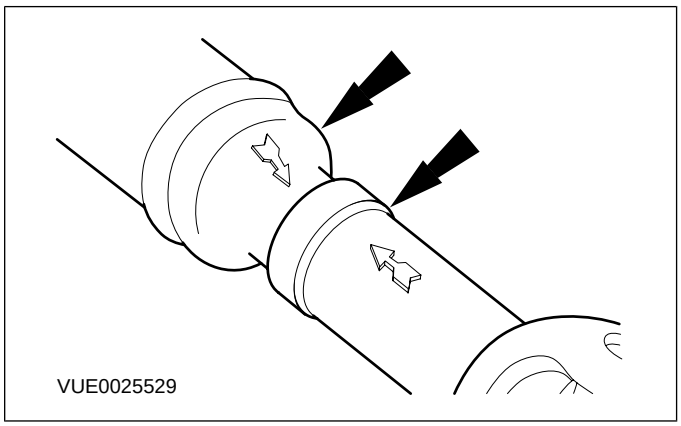
With the aid of another technician, install the driveshaft rear center bearing retaining bolts.



4. **WARNING:Driveshafts without a sliding joint protective boot must have the rear section of the driveshaft removed to prevent accidental separation of the sliding joint. Failure to follow this instruction may result in personal injury.**

NOTE: Make sure that the arrows are aligned.

Install the rear section of the driveshaft if necessary.

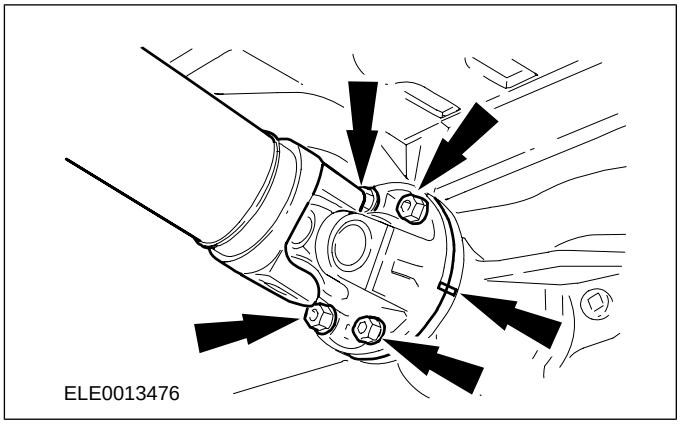


5. **NOTE:Align the mark on the driveshaft flange with the mark on the drive pinion flange.**

NOTE: Do not fully tighten the driveshaft to drive pinion flange bolts at this stage.

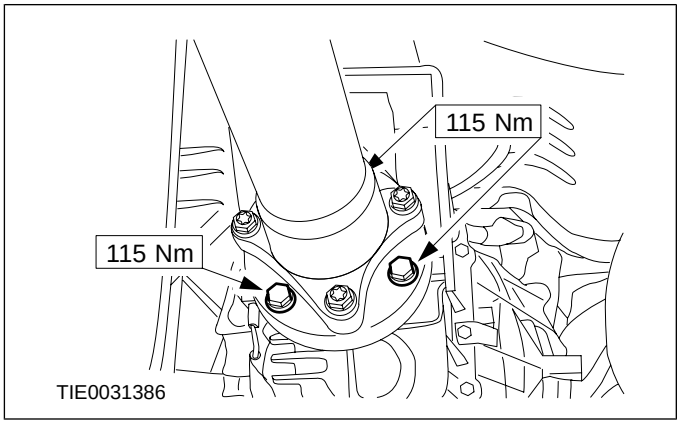
REMOVAL AND INSTALLATION

Attach the driveshaft to the drive pinion flange.



Vehicles with 5-speed manual transmission

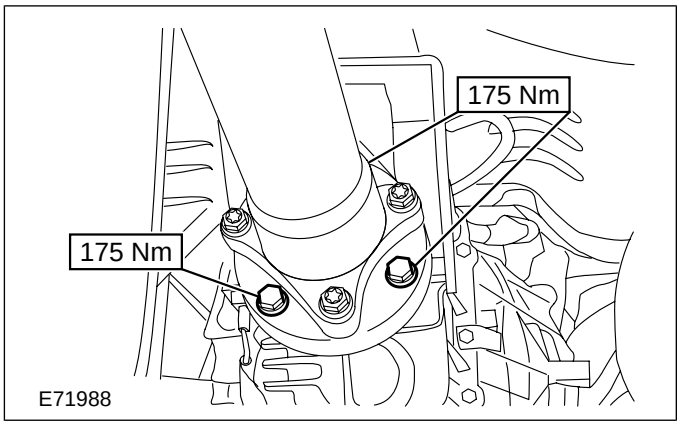
6. **Tighten the driveshaft to transmission output shaft flange bolts.**



Vehicles with 6-speed manual transmission

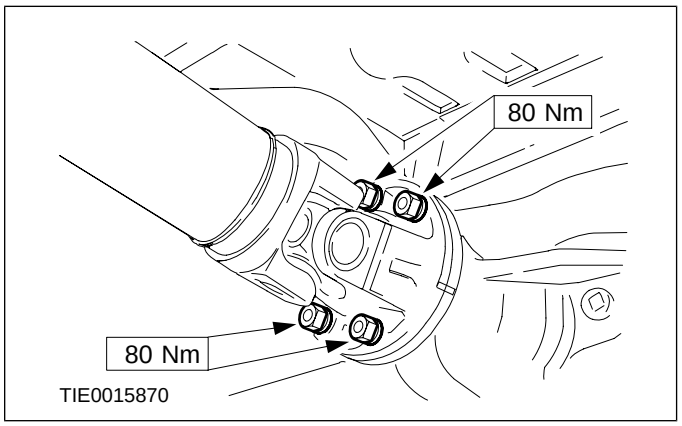
7.

8. **Tighten the driveshaft to transmission output shaft flange bolts.**



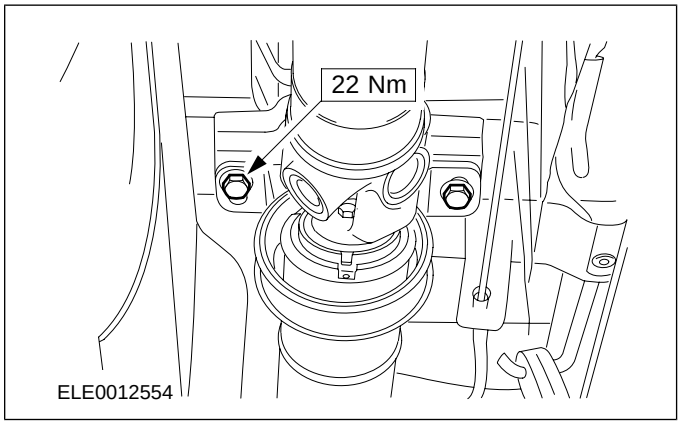
All vehicles

9. **Tighten the driveshaft to drive pinion flange bolts.**



10. **NOTE:Ensure that the centre bearing bracket is square to the centre line of the driveshaft tube forward of the bracket and the rubber is not distorted.**

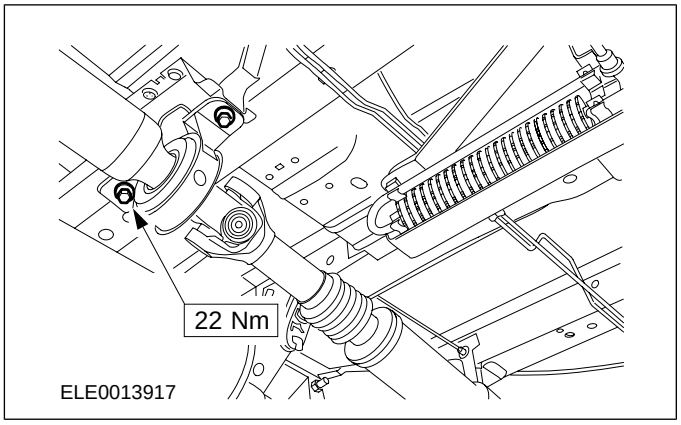
Tighten the driveshaft front center bearing retaining bolts.



11. **NOTE:Ensure that the centre bearing bracket is square to the centre line of the driveshaft tube forward of the bracket and the rubber is not distorted.**

REMOVAL AND INSTALLATION

Tighten the driveshaft rear center bearing retaining bolts.

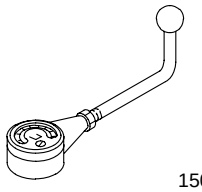
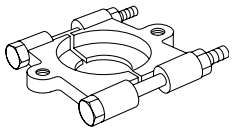
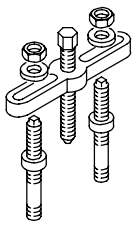
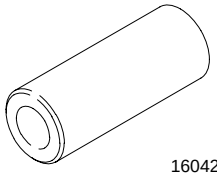


12. **Lower the vehicle.**

DISASSEMBLY AND ASSEMBLY

Driveshaft Center Bearing (15 564 4)

Special Tool(s)

 15041	Preload Gauge 205-067 (15-041)
 TI15091	Remover, Bearing/Gear 205-310 (15-091)
 15092	Remover, Bearing/Gear 205-311 (15-092)
 16042A	Adaptor for 308-111 308-111-01 (16-042A)

General Equipment

Torque wrench

Materials

Name	Specification
Grease	SAM-1C-911-A

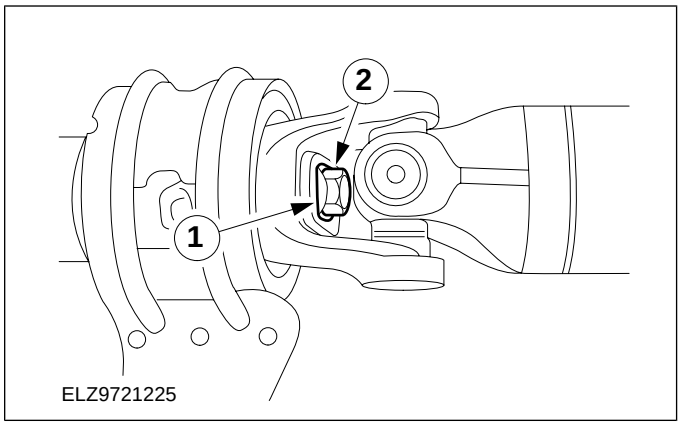
Disassembly

CAUTION:Do not clamp the driveshaft in a vise.

1. **NOTE:Make a note of the position of the spacer.**

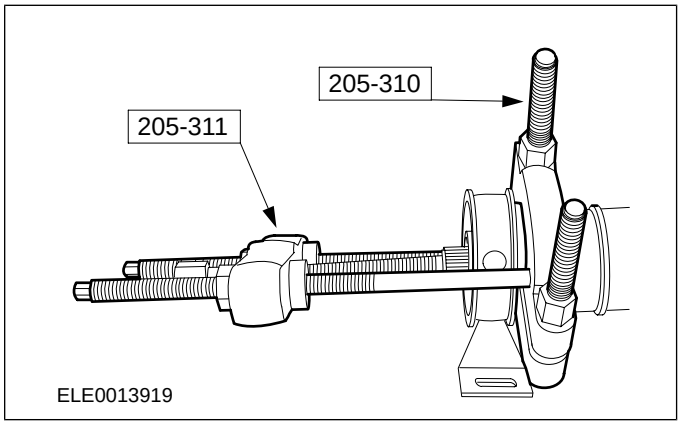
   Detach the driveshaft yoke from the driveshaft center bearing.

   1. Bend back the locking washer.
   2. Remove the retaining bolt.
   - Discard the locking washer.



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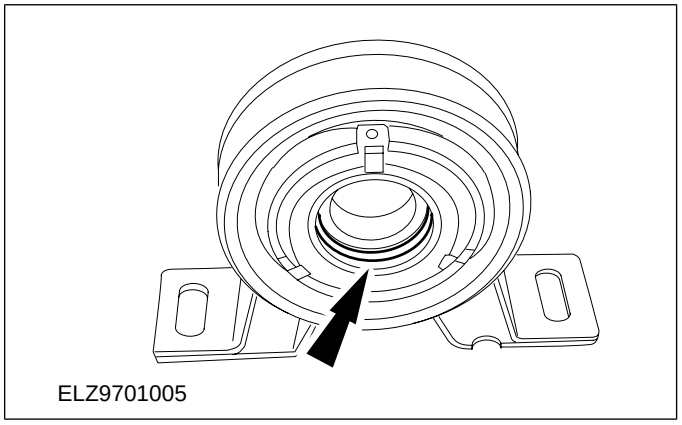
2. **Using the special tools, remove the driveshaft center bearing.**



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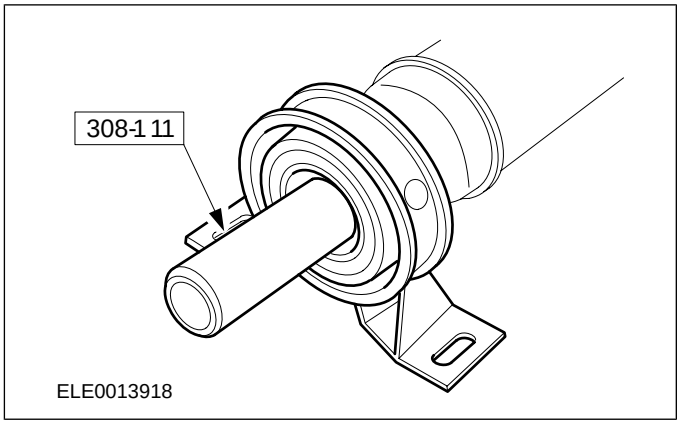
Assembly

1. **Lubricate the mating faces of the driveshaft center bearing with grease.**


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DISASSEMBLY AND ASSEMBLY

2. Using the special tool, install the driveshaft center bearing.



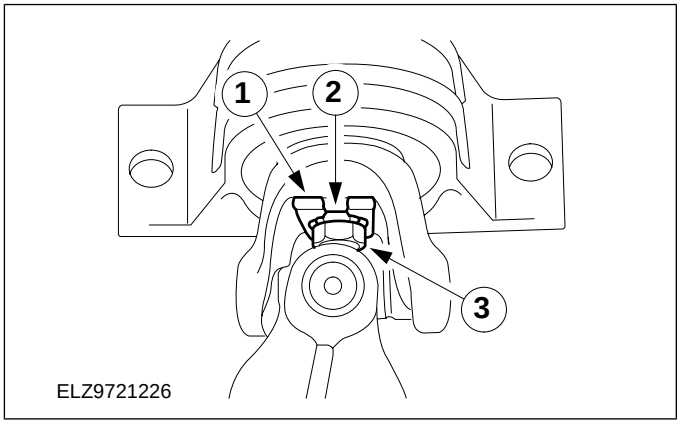
3. NOTE:The locating tang of the spacer must face towards the driveshaft center bearing.

NOTE: Install a new driveshaft yoke retaining bolt locking washer.

NOTE: Do not fully tighten the driveshaft yoke retaining bolt at this stage.

Attach the driveshaft yoke to the driveshaft center bearing.

1. Install the spacer.
2. Install the locking washer.
3. Install the retaining bolt.

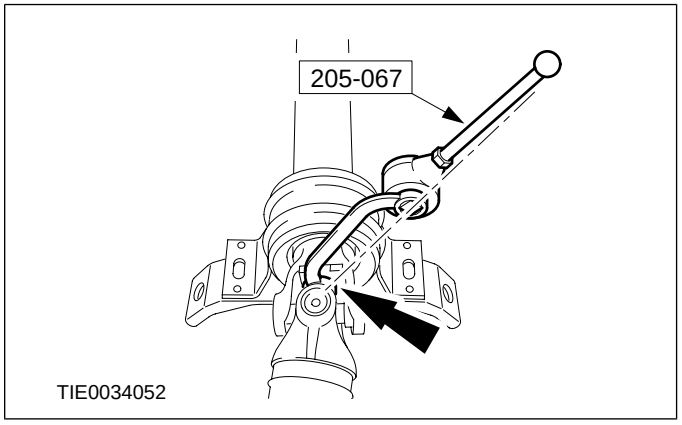


4. NOTE:The applied torque is dependant on the combined length of the ring spanner.

NOTE: To obtain the correct torque, the ring spanner and the torque wrench must be in a straight line.

Using a suitable torque wrench and a suitable 15/17 mm wrench, tighten the driveshaft yoke retaining bolt.

- If using a wrench of 205 mm in length, apply a torque of 5 Nm.
- If using a wrench of 185 mm in length, apply a torque of 5.3 Nm.
- If using a ring wrench of 165 mm in length, apply a torque of 5.6 Nm.



5. Lock the driveshaft yoke retaining bolt.

- Bend the locking washer upwards.

SECTION 205-02A Rear Drive Axle/Differential

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 205-02A-2

DESCRIPTION AND OPERATION

Rear Drive Axle and Differential..... 205-02A-4

DIAGNOSIS AND TESTING

Rear Drive Axle and Differential..... 205-02A-7

IN-VEHICLE REPAIR

Drive Pinion Flange and Drive Pinion Seal..... 205-02A-8
Drive Pinion Bearing Cups..... 205-02A-11
Drive Pinion..... 205-02A-13
Differential Case..... 205-02A-17

REMOVAL AND INSTALLATION

Axle Assembly..... 205-02A-28

DISASSEMBLY AND ASSEMBLY

Differential Case and Ring Gear..... 205-02A-33

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
SAE 75W-140 High performance rear axle oil	WSL-M2C192-A
Grease	WSD-M1C228-A
Thread-locking compound	WSK-M2G349-A7
Sealer	WSS-M4G320-A3

Capacities

	Litres
Rear axle oil	3.0

Clearance, Tolerance and Adjustments

Description	Specification
Drive pinion best height setting	a)
Drive pinion turning torque	a)
Ring gear backlash	0.127-0.228 mm
Ring rear backlash — maximum variation between teeth	0.100 mm

a) Refer to the procedure in this section.

Torque Specifications

Description	Nm	lb-ft	lb-in
Driveshaft to drive pinion flange bolts	80	59	–
Drive pinion flange locknut	340	252	–
Ring gear retaining bolts	177	130	–
Differential bearing cap retaining bolts	110	81	–
Differential housing cover retaining bolts	61	45	–
Axle shaft retaining bolts	134	99	–
Stabilizer bar retaining bolts	40	30	–
Oil filler plug	34	25	–
Brake backing plate retaining bolts	99	73	–
Parking brake cable to chassis retaining bolt	22	16	–
Spring U-bolt nuts	a)	–	–
Wheel speed sensor retaining bolt	8	–	71
Wheel speed sensor bracket retaining bolt	8	–	71
Brake load sensor proportioning valve bracket retaining bolts	15	11	–
Brake hose retaining bracket to axle housing retaining bolt	15	11	–
Shock absorber lower retaining nut and bolt	90	66	–

SPECIFICATIONS

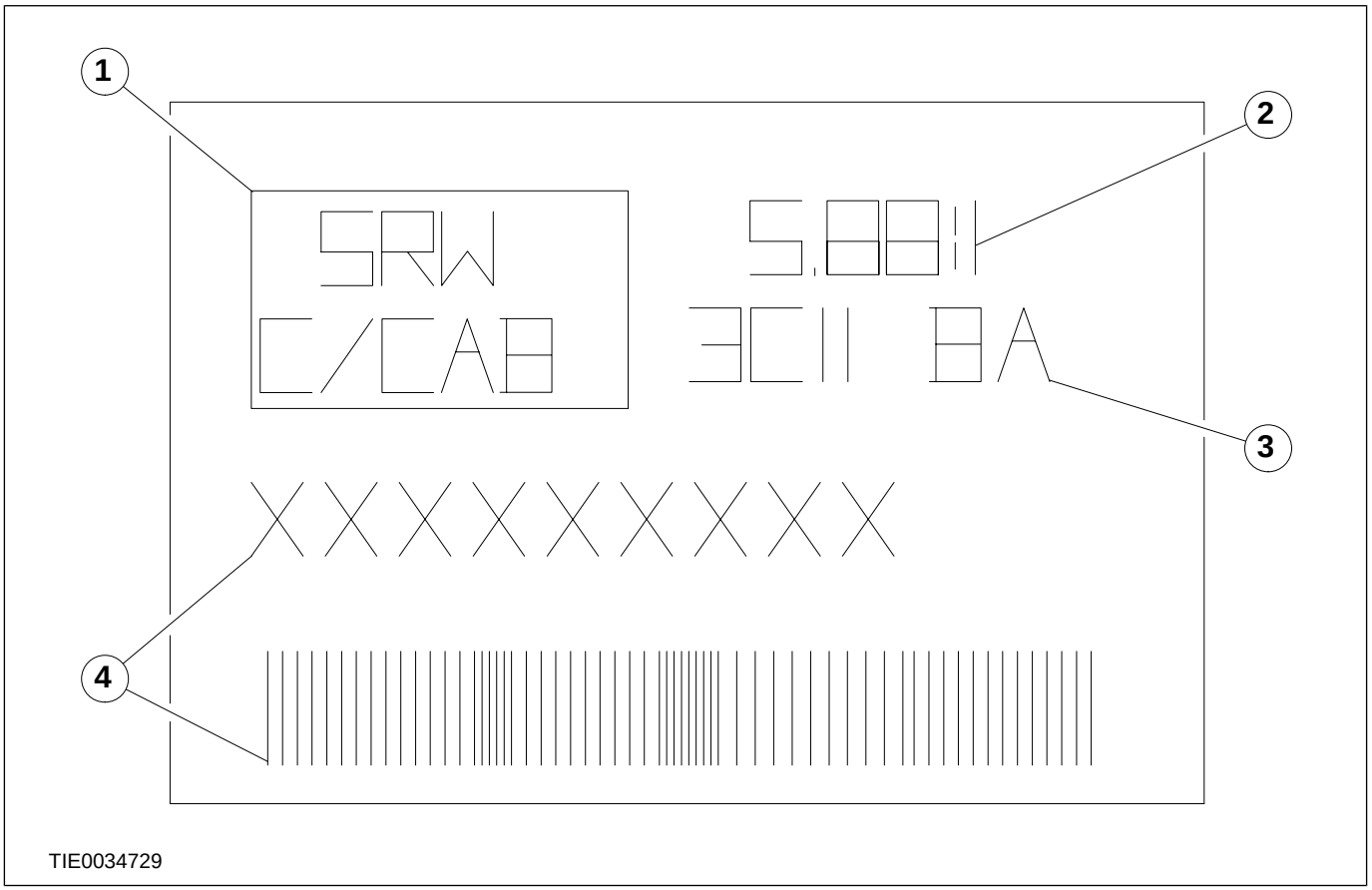
Description	Nm	lb-ft	lb-in
Wheel cylinder union	14	10	–
a) Refer to the procedure in this section.			

DESCRIPTION AND OPERATION

Rear Drive Axle and Differential

The axle identification label is located on the axle casing.

Axle Identification Label



TIE0034729

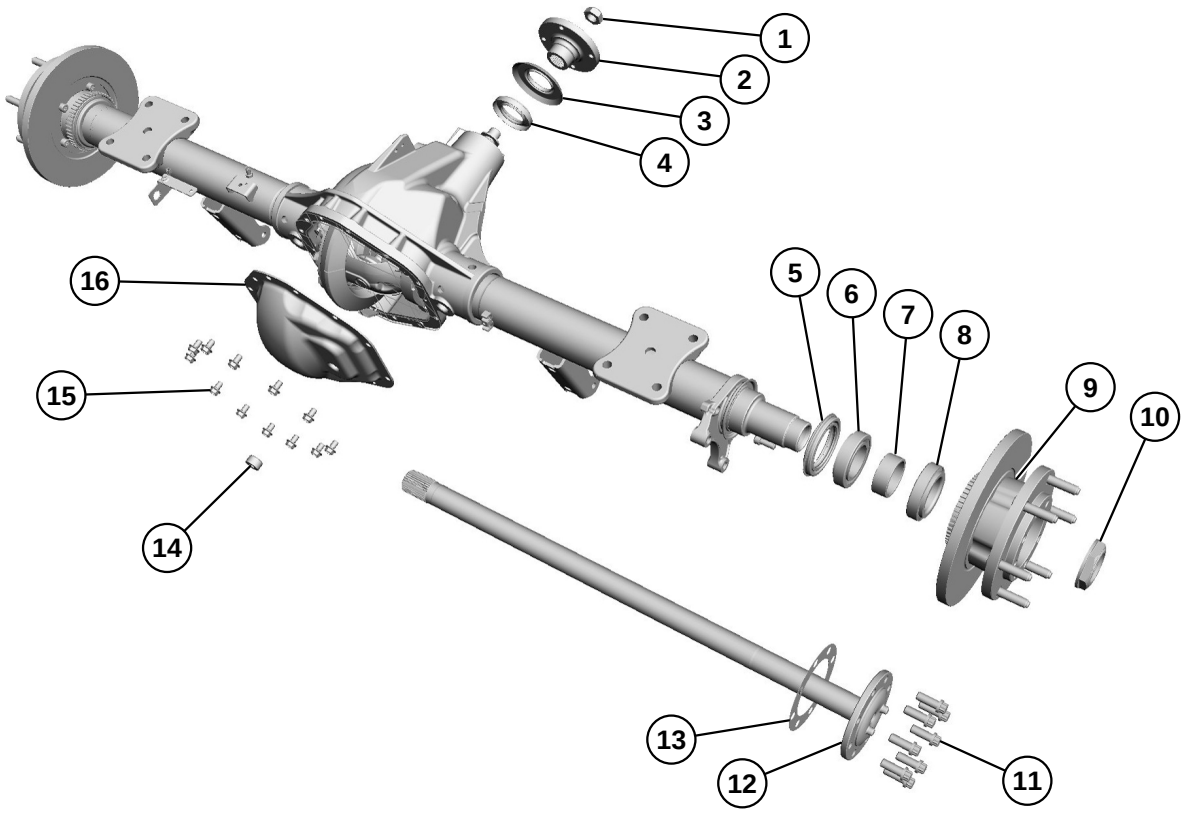
Item	Description
1	Color code identification
2	Axle ratio
3	Part number
4	Axle serial number and bar code

Color Code Identification

Variant	Color Code
Single rear wheels: Van, bus, kombi	Yellow
Single rear wheels: Chassis cab	Green
Twin rear wheels: Chassis cab	Blue

DESCRIPTION AND OPERATION

Full Floating Axle



Item	Description
1	Drive pinion locknut
2	Drive pinion flange
3	Drive pinion dust seal
4	Drive pinion seal
5	Wheel hub seal
6	Inner wheel hub bearing
7	Wheel hub bearing spacer

Item	Description
8	Outer wheel hub bearing
9	Wheel hub
10	Wheel hub locknut
11	Axle shaft retaining bolts
12	Axle shaft
13	Axle shaft gasket
14	Oil level plug

DESCRIPTION AND OPERATION

Item	Description
15	Differential cover retaining bolts
16	Differential cover

DIAGNOSIS AND TESTING

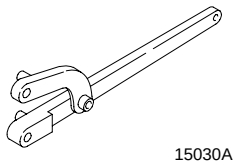
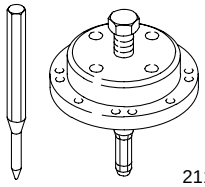
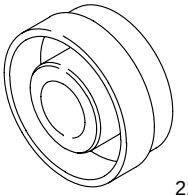
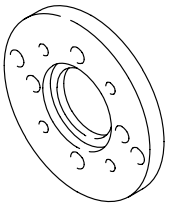
Rear Drive Axle and Differential

REFER to Section 205-00 [Driveline System - General Information].

IN-VEHICLE REPAIR

Drive Pinion Flange and Drive Pinion Seal

Special Tool(s)

 15030A	Flange Holding Wrench, Universal 205-072 (15-030A)
 21151	Remover, Crankshaft Rear Seal 303-336 (21-151)
 21159	Installer/Aligner, Front Cover Seal 303-373 (21-159)
 16055	Remover, Mainshaft Double Lip Seal 308-151 (16-055)

General Equipment

Two leg puller

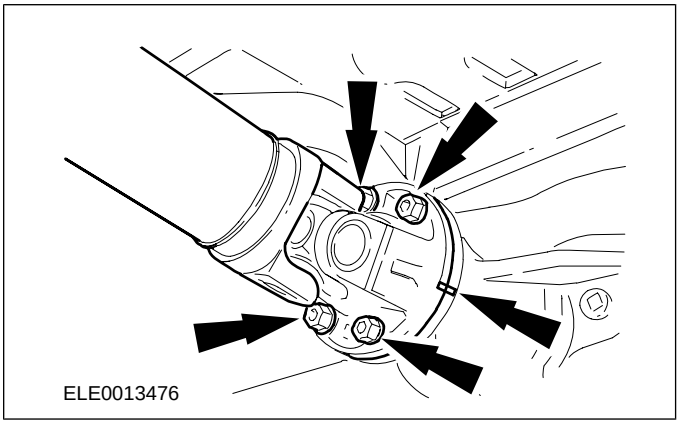
Materials

Name	Specification
SAE 75W-140 High performance rear axle oil	WSL-M2C192-A

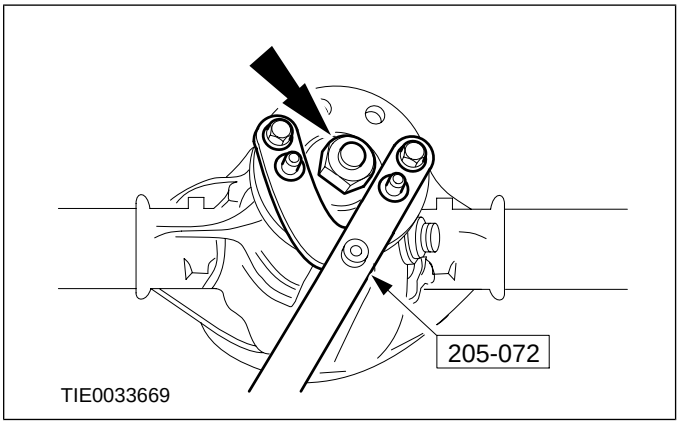
Removal

1. **Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].**
2. **NOTE:Mark the position of the driveshaft flange in relation to the drive pinion flange.**

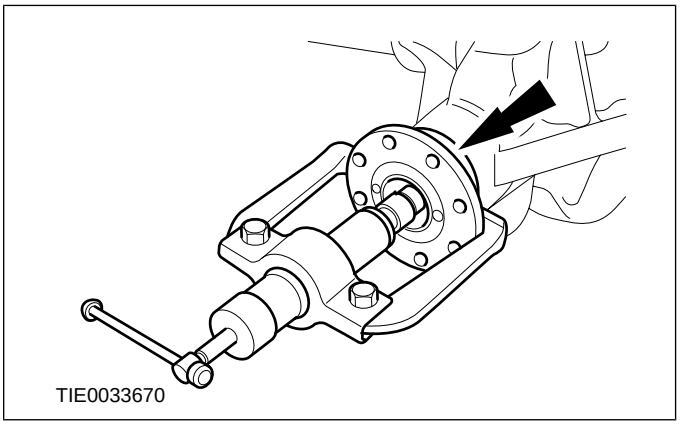
Detach the driveshaft from the drive pinion flange and position it to one side.



3. **Using the special tool, remove the drive pinion flange locknut and washer.**
   - Discard the washer.



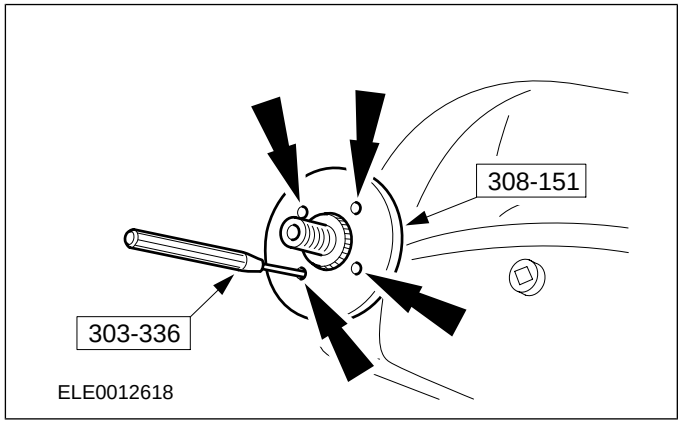
4. **Using a suitable two leg puller, remove the drive pinion flange.**



5. **Using the special tools, make pilot holes in the drive pinion seal.**

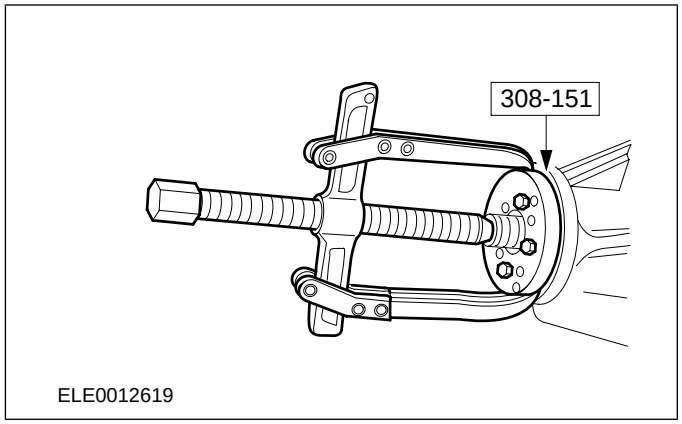
IN-VEHICLE REPAIR

- Secure the special tool to the drive pinion seal using four suitable self-tapping screws.



6. Using the special tool and a suitable two leg puller, remove the drive pinion seal.

- Discard the seal.

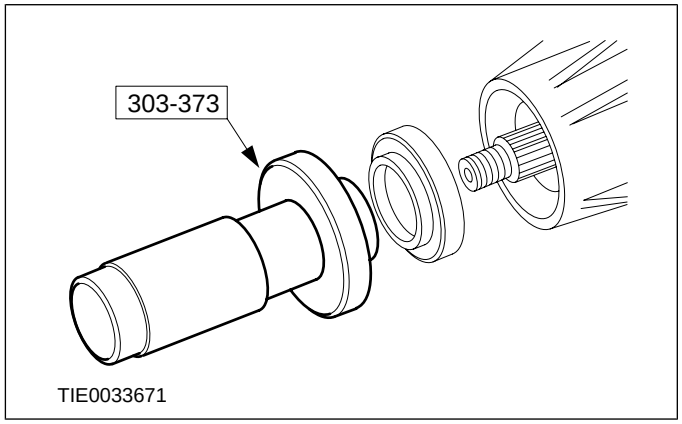


Installation

1. NOTE:Install a new drive pinion seal.

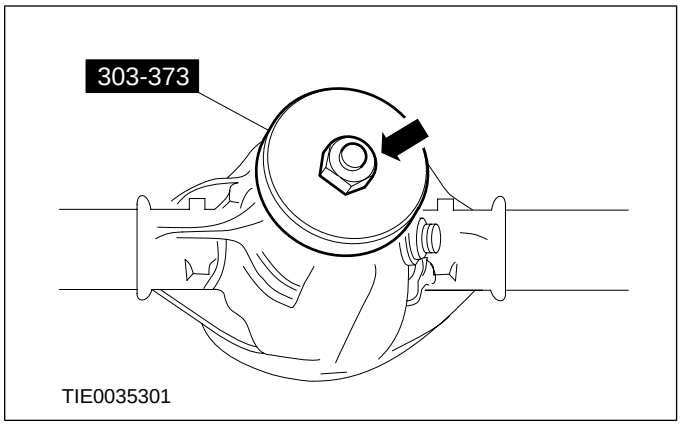
NOTE: Locate the drive pinion seal leaving a protrusion of 2 mm.

Using the special tool and a suitable drift, locate the drive pinion seal.



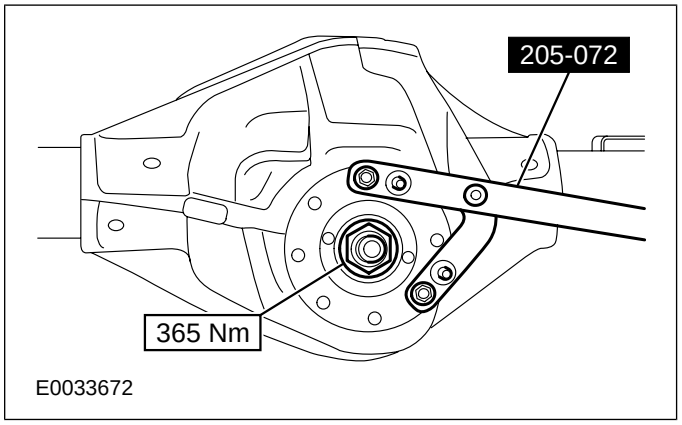
2. Using the special tool and the drive pinion locknut, install the drive pinion seal.

- Remove and discard the locknut.



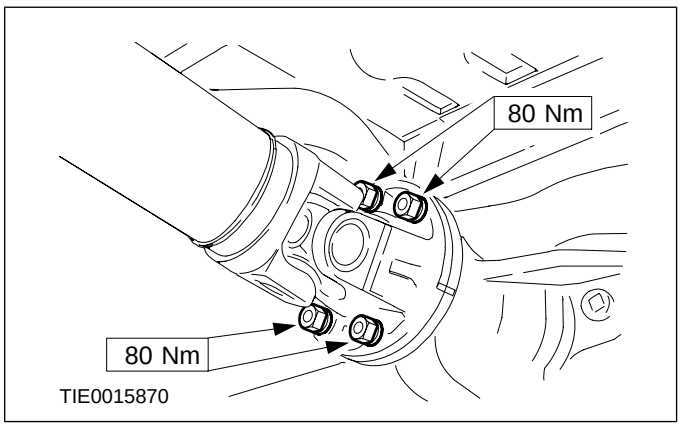
3. NOTE:Install a new drive pinion flange locknut and washer.

Using the special tool, install the drive pinion flange.



4. NOTE:Align the mark on the driveshaft flange with the mark on the drive pinion flange.

Attach the driveshaft to the drive pinion flange.



5. Check the rear axle oil level.

IN-VEHICLE REPAIR

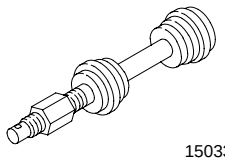
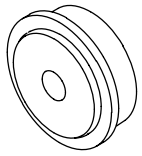
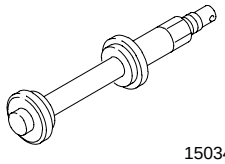
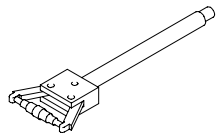
- Top up the rear axle with clean SAE 75W-140 high performance rear axle oil until the oil is level with the oil level filler hole.

6. **Lower the vehicle.**

IN-VEHICLE REPAIR

Drive Pinion Bearing Cups

Special Tool(s)

 15033	Installer, Differential Bearing Cone 205-066 (15-033)
 1503302A	Adapter for 205-066 205-066-02 (15-033-02A)
 15034	Installer, Differential Bearing Cone 205-073 (15-034)
 15074	Remover, Differential Bearing Cone 205-176 (15-074)

General Equipment

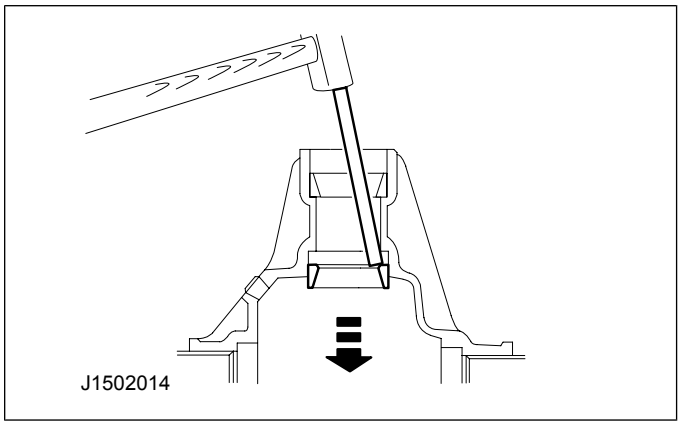
Soft metal drift

1. **Remove the drive pinion.**

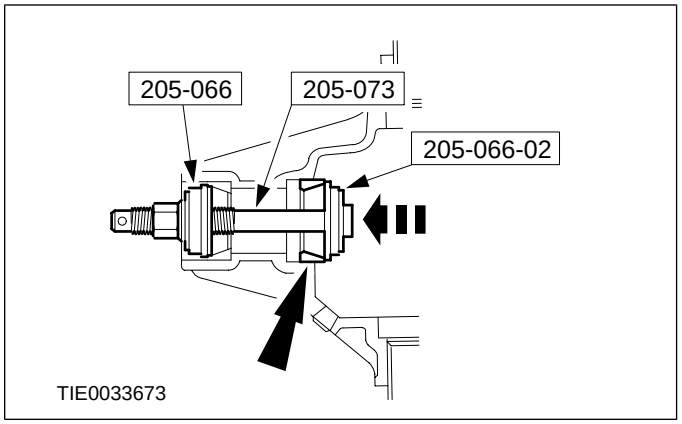
   For additional information, refer to Drive Pinion - VIN Plate Axle Code: E/F in this section.

2. **NOTE: Install a new drive pinion inner bearing cup before removing the drive pinion outer bearing cup.**

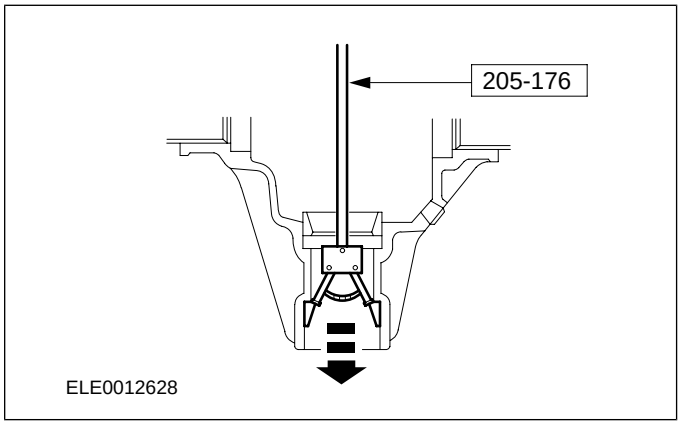
   Using a suitable soft metal drift, remove the drive pinion inner bearing cup.



3. **Using the special tools, install a new drive pinion inner bearing cup.**



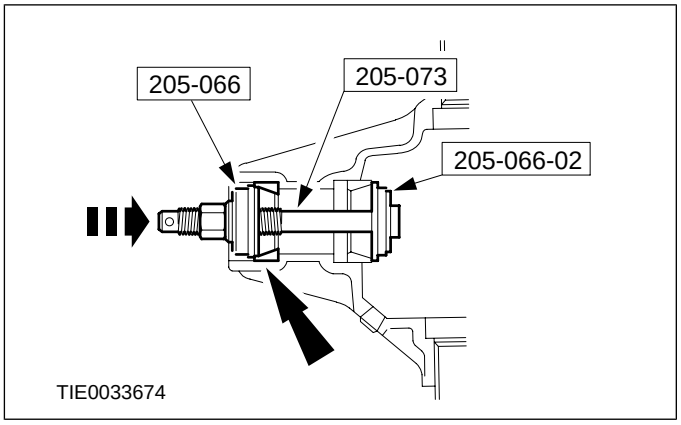
4. **Using the special tool, remove the drive pinion outer bearing cup.**



5. **NOTE: The larger diameter of the special tool should face the axle housing.**

IN-VEHICLE REPAIR

Using the special tools, install a new drive pinion outer bearing cup.



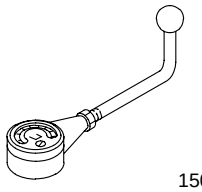
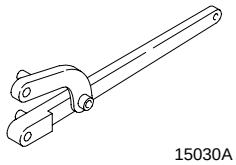
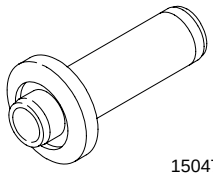
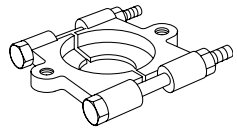
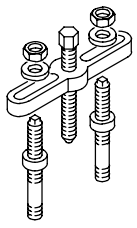
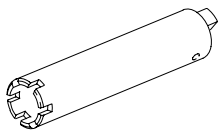
6. **Install the drive pinion.**

   For additional information, refer to Drive Pinion - VIN Plate Axle Code: E/F in this section.

IN-VEHICLE REPAIR

Drive Pinion

Special Tool(s)

 15041	Preload Gauge 205-067 (15-041)
 15030A	Universal Flange Holding Wrench 205-072 (15-030A)
 15047A	Installer, Drive Pinion Seal 205-077 (15-047A)
 TI15091	Remover, Bearing/Gear 205-310 (15-091)
 15092	Remover, Bearing/Gear 205-311 (15-092)
 IA17072	Socket, Bearing Retainer 307-325 (17-072)

Removal

1. **Remove the differential case.**

   For additional information, refer to:Differential Case (205-02 Rear Drive Axle/Differential, In-vehicle Repair).

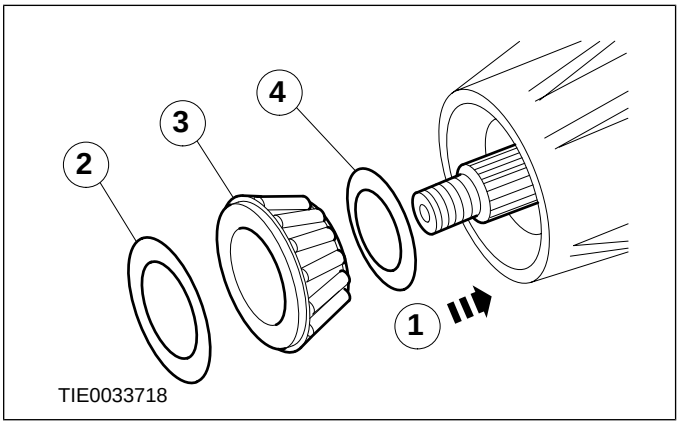
2. **Remove the drive pinion flange and drive pinion seal.**

   For additional information, refer to:Drive Pinion Flange and Drive Pinion Seal (205-02 Rear Drive Axle/Differential, In-vehicle Repair).

3. **NOTE:Measure and make a note of the removed shims thickness.**

   Remove the drive pinion.

   1. Use a soft-faced hammer, tap the drive pinion and remove it through the rear of the differential housing.
   2. Remove the thrust washer.
   3. Remove and discard the outer bearing cone.
   4. Remove the drive pinion outer bearing shims.

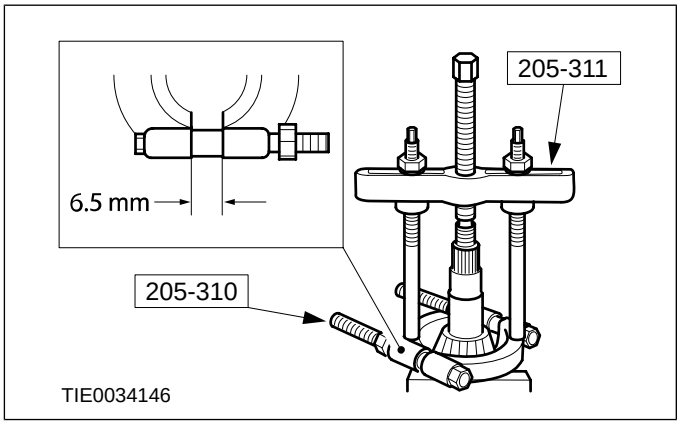


TIE0033718

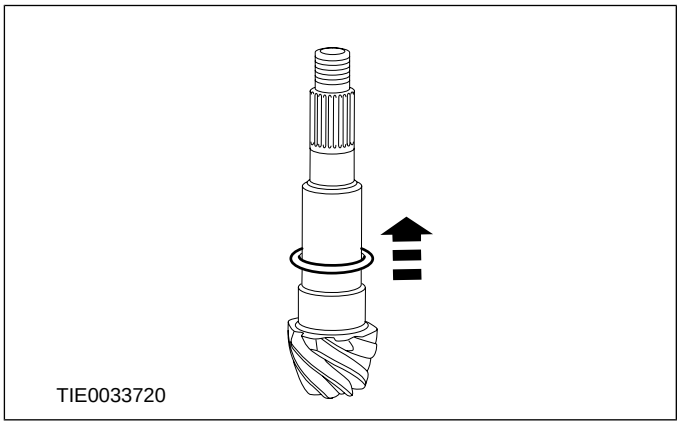
4. **Using the special tools, remove the drive pinion inner bearing cone.**

IN-VEHICLE REPAIR

- Discard the bearing cone.

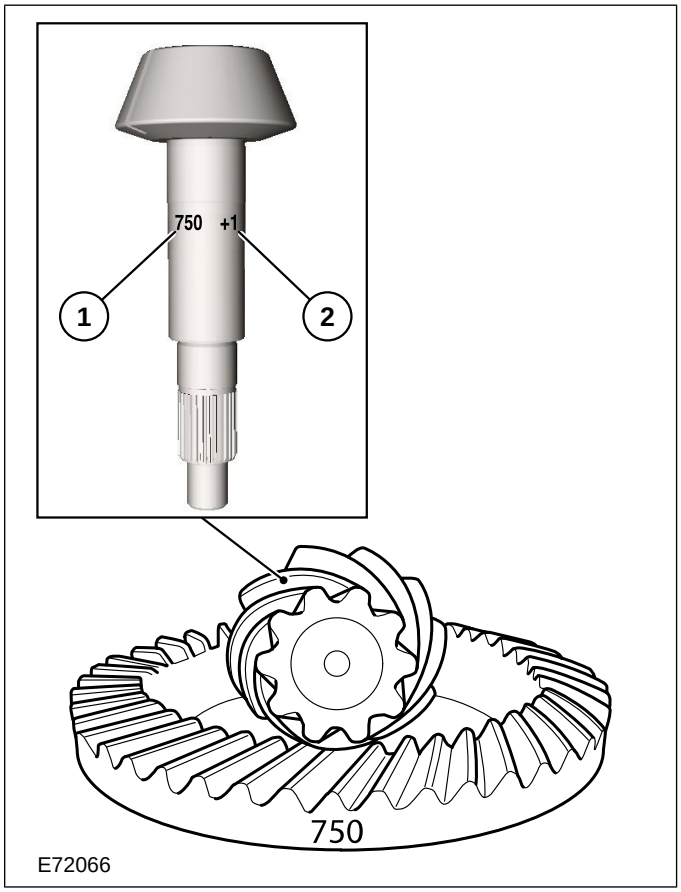


5. Remove the drive pinion inner bearing shim(s).



6. Note the numbers etched on the drive pinion:

1. Matched pair number – this number will also be found on the differential ring gear.
2. Best height setting number.



Installation

1. NOTE:The best height setting number is etched on the drive pinion.

Calculate the required inner bearing shim thickness. Note the best height setting figure etched on both the old and new drive pinion and adjust the new shim thickness by adding or subtracting the value shown in the table from the original inner bearing shim thickness to compensate for the difference of these two figures.

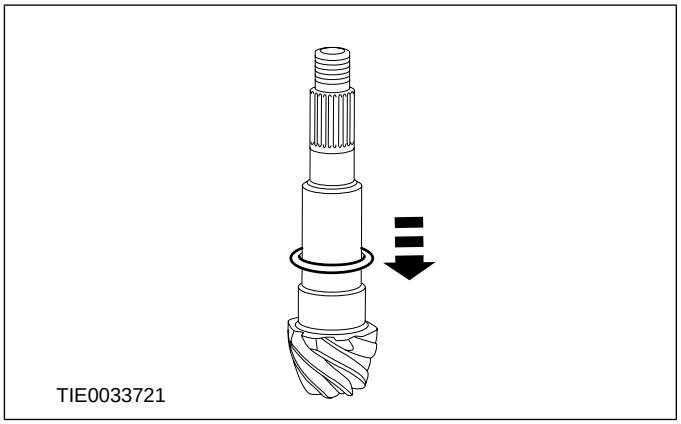
Pinion Shim Adjustment (inches)

Old Pinion Marking	New Pinion Marking								
	-10	-8	-5	-3	0	+3	+5	+8	+10
+10	+0.020	+0.018	+0.015	+0.013	+0.010	+0.007	+0.005	+0.002	0
+8	+0.018	+0.016	+0.013	+0.011	+0.008	+0.005	+0.003	0	-0.002
+5	+0.015	+0.013	+0.010	+0.008	+0.005	+0.002	0	-0.003	-0.005
+3	+0.013	+0.011	+0.008	+0.006	+0.003	0	-0.002	-0.005	-0.007
0	+0.010	+0.008	+0.005	+0.003	0	-0.003	-0.005	-0.008	-0.010

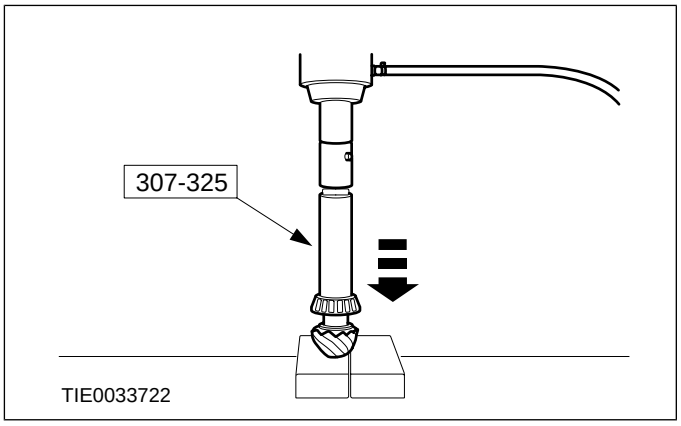
IN-VEHICLE REPAIR

Old Pinion Marking	New Pinion Marking								
	-10	-8	-5	-3	0	+3	+5	+8	+10
-3	+0.007	+0.005	+0.002	0	-0.003	-0.006	-0.008	-0.011	-0.013
-5	+0.005	+0.003	0	-0.002	-0.005	-0.008	-0.010	-0.013	-0.015
-8	+0.002	0	-0.003	-0.005	-0.008	-0.011	-0.013	-0.016	-0.018
-10	0	-0.002	-0.005	-0.007	-0.010	-0.013	-0.015	-0.018	-0.020

2. Install the inner bearing shim(s).



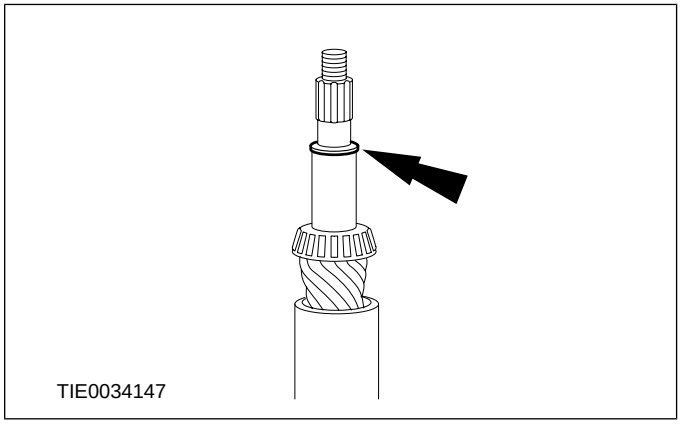
3. Using the special tool, install the drive pinion inner bearing cone.



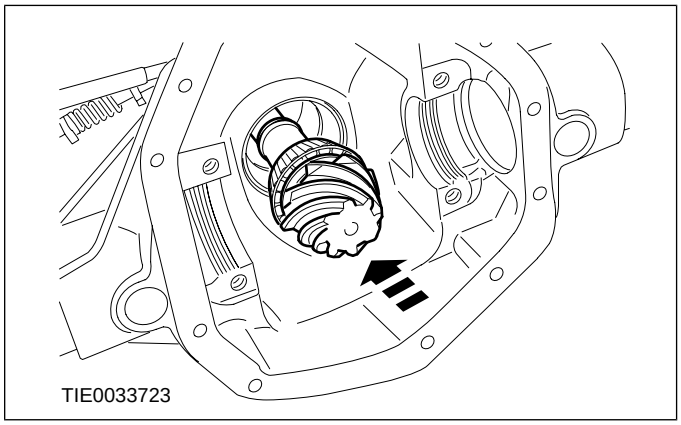
4. NOTE:The original outer bearing shim pack value must be increased or decreased by the same value as the adjustment made to the inner bearing shim pack.

If the inner bearing shim pack has been increased, the outer bearing shim pack must be decreased by the same amount. If the inner bearing shim pack has been decreased, the outer bearing shim pack must be increased by the same amount.

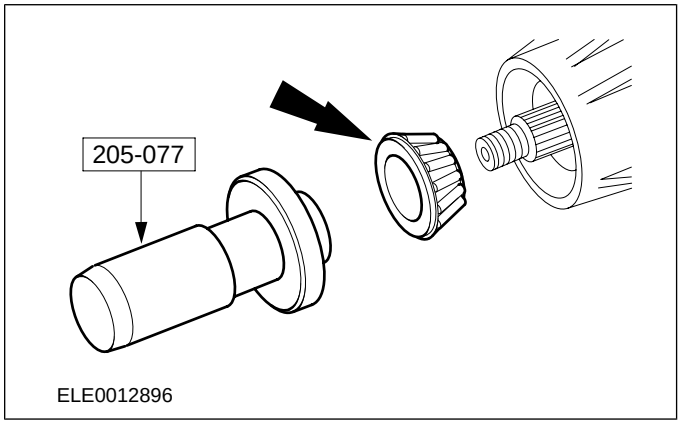
Install an outer bearing shim pack.



5. Install the drive pinion.



6. Using the special tool, install the drive pinion outer bearing cone.

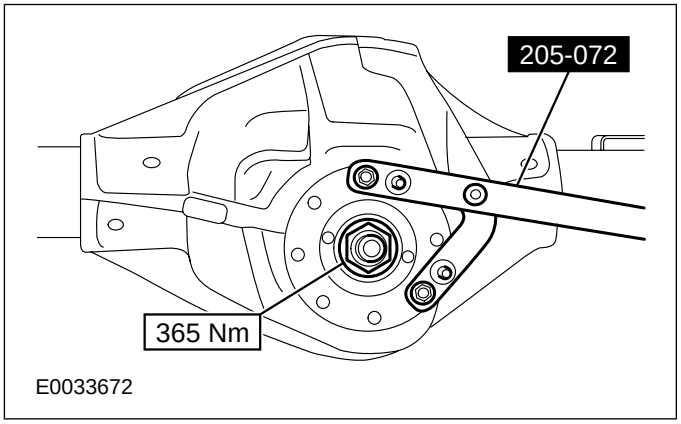


IN-VEHICLE REPAIR

7. **NOTE:Do not install the drive pinion seal at this stage.**

NOTE: Do not install a new drive pinion flange locknut at this stage.

Using the special tool, install the thrust washer and drive pinion flange.

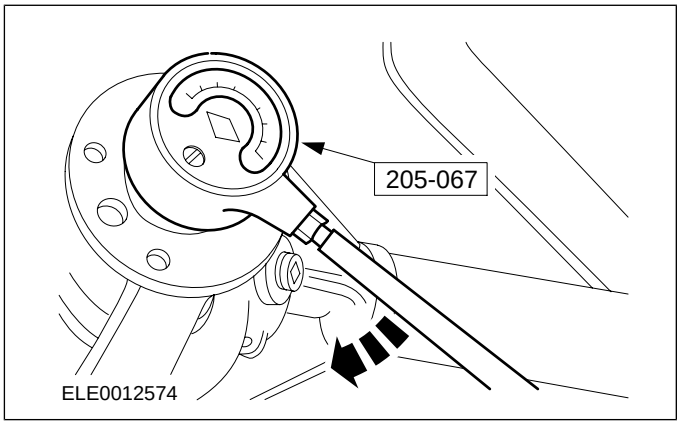


8. **NOTE:The turning torque value should be between 2.8 Nm and 5.8 Nm.**

NOTE: If the measured turning torque value exceeds specification increase the outer bearing shim pack thickness as necessary. If the measured turning torque value is lower than specification decrease the outer bearing shim pack thickness as necessary.

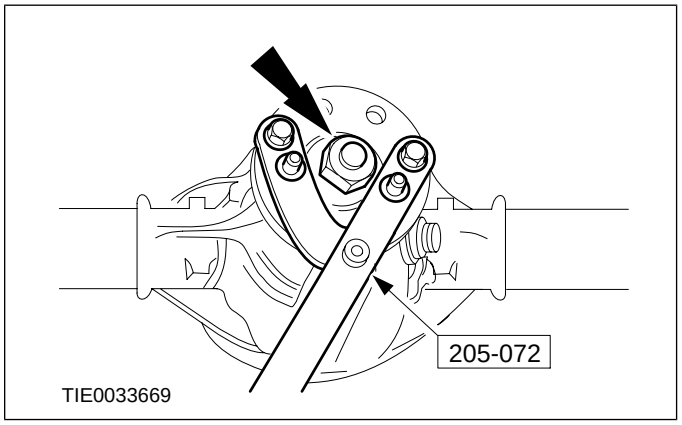
Using the special tool, measure the drive pinion turning torque.

- Adjust the outer bearing shim pack to obtain the drive pinion turning torque specification.



9. **Using the special tool, remove the drive pinion flange.**

- Discard the locknut.



10. **Install the drive pinion flange and drive pinion seal.**

For additional information, refer to:Drive Pinion Flange and Drive Pinion Seal (205-02 Rear Drive Axle/Differential, In-vehicle Repair).

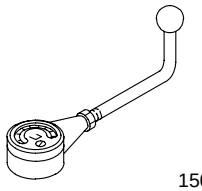
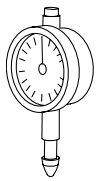
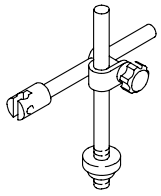
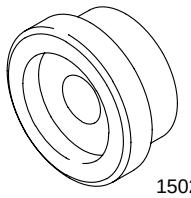
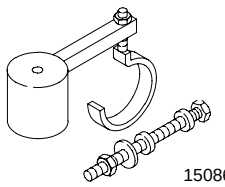
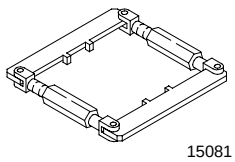
11. **Install the differential case.**

For additional information, refer to:Differential Case (205-02 Rear Drive Axle/Differential, In-vehicle Repair).

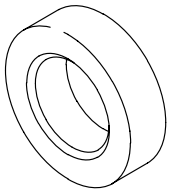
IN-VEHICLE REPAIR

Differential Case

Special Tool(s)

 15041	Preload Gauge 205-067 (15-041)
 15046	Dial Indicator Gauge 205-069 (15-046)
 15022A	Holding Fixture, Dial Indicator Gauge 205-070 (15-022A)
 1502651	Adapter for 205-071 (Thrust Pad) 205-071-02 (15-026-51)
 15086	Remover/Installer, Pivot Bushing 205-297
 15081	Spreader, Differential Housing 205-542

Special Tool(s)

 14047	Gauge, Differential Dummy Bearing 205-544

General Equipment

Soft faced hammer
Separator tool

Materials

Name	Specification
Thread-locking compound	WSK-M2G349-A7
SAE 75W-140 High performance rear axle oil	WSL-M2C192-A
Sealer	WSS-M4G320-A3

Removal

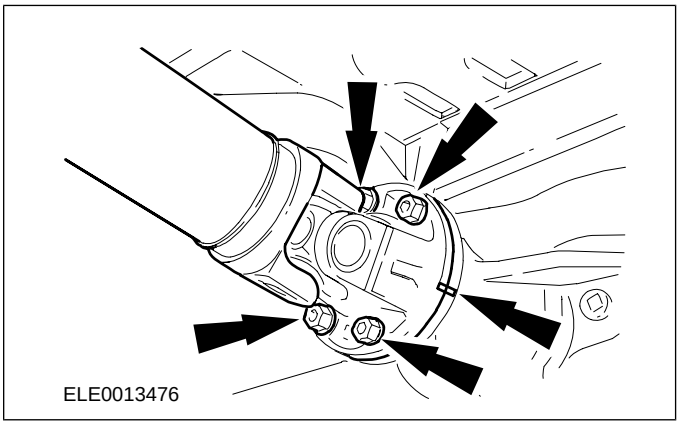
All vehicles

1. **Raise and support the vehicle. For additional information, refer to:(100-02 Jacking and Lifting)**

   Jacking (Description and Operation), Lifting (Description and Operation).

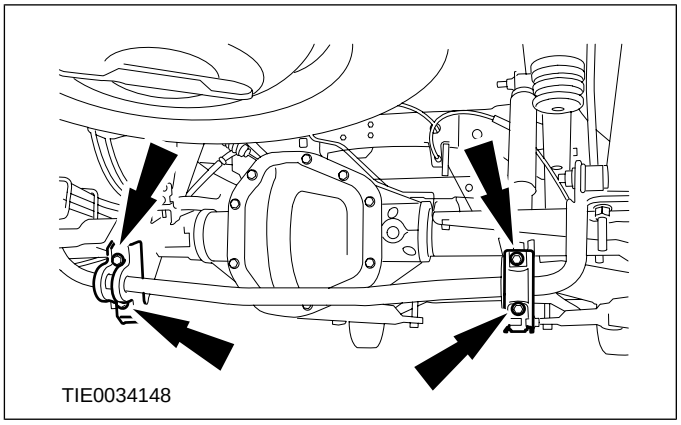
2. **NOTE:Mark the position of the drive shaft flange in relation to the drive pinion flange.**

   Detach the drive shaft from the differential pinion flange and secure it to one side.

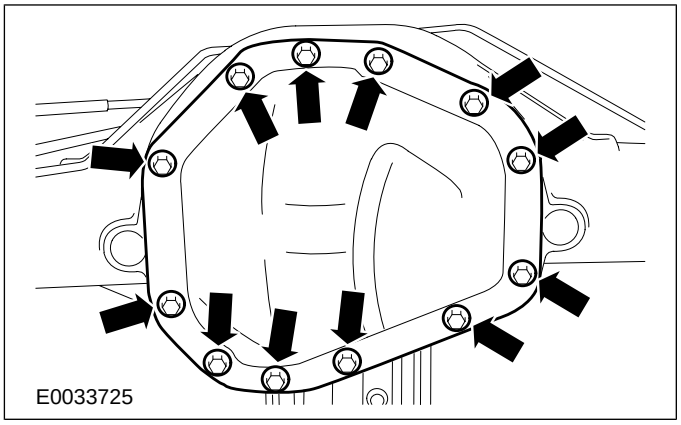

ELE0013476

IN-VEHICLE REPAIR

3. **Detach the stabilizer bar (if equipped) from the axle housing and secure it to the chassis.**


TIE0034148

4. **Remove the differential housing cover.**
   - Allow the oil to drain into a suitable container.


E0033725

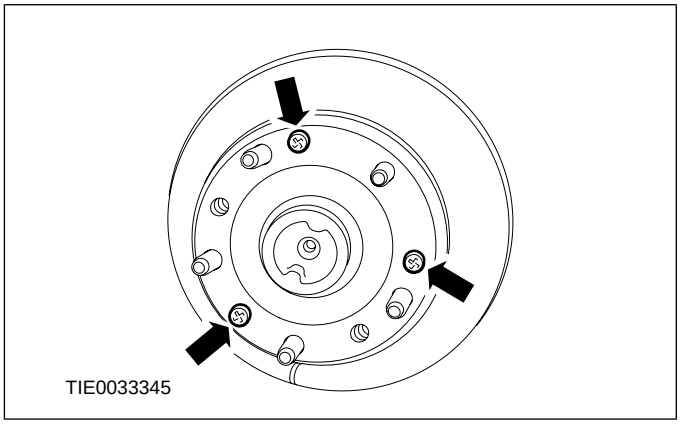
Vehicles with single rear wheels

5. **Remove the rear wheels and tires.**

   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

6. **NOTE: Mark the position of the axle shaft in relation to the brake drum.**

   Remove the axle shaft retaining screws on both sides.

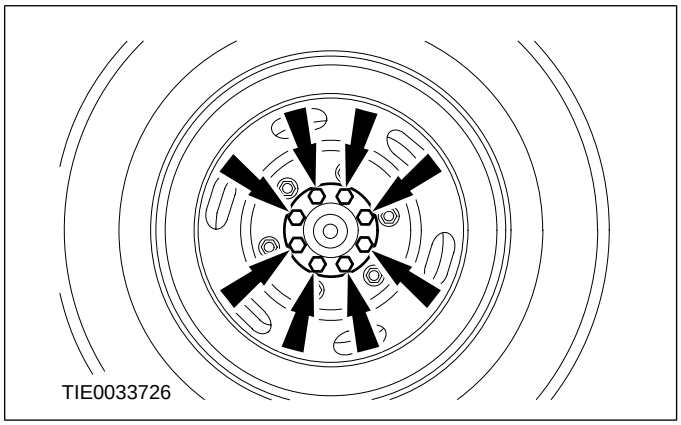

TIE0033345

Vehicles with twin rear wheels

7. **⚠ CAUTION: The axle shaft retaining bolts can be re-used three times, mark the retaining bolts.**

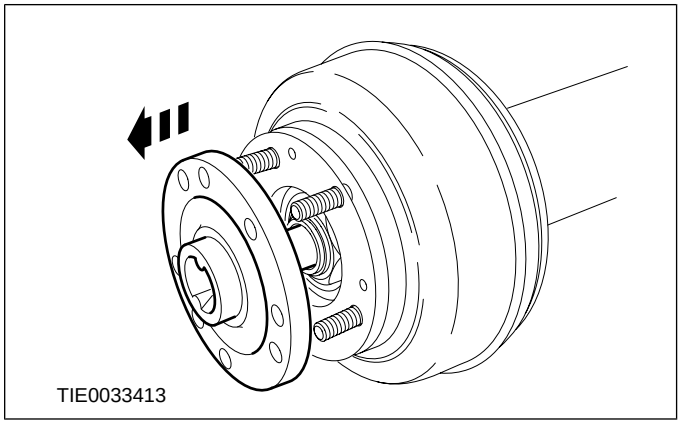
NOTE: Mark the position of the axle shaft in relation to the wheel hub.

Remove the axle shaft retaining bolts.


TIE0033726

All vehicles

8. **Remove the axle shafts (single rear wheel axle shown).**
   - Discard the gasket.


TIE0033413

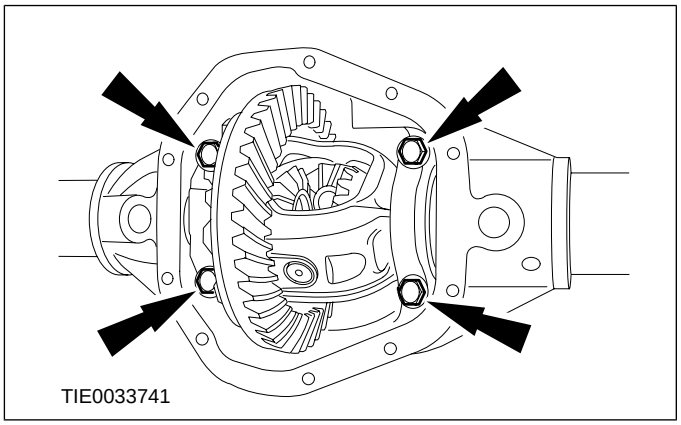
9. **CAUTIONS:**

   ⚠ The differential case bearing caps are marked to the axle housing. Make a note of the positions of the differential case bearing caps to aid installation.

   ⚠ Support the differential case.

IN-VEHICLE REPAIR

Remove the differential case bearing caps.

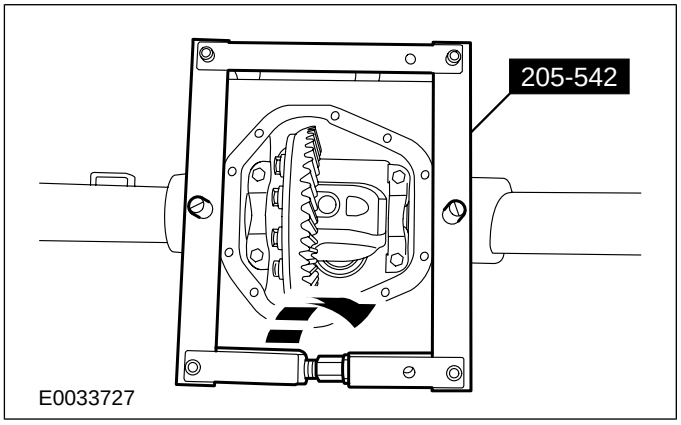


10. **CAUTIONS:**

    Support the differential case.

    Do not overstretch the differential housing.

    Using the special tool, spread the differential housing until one of the differential case bearing outer shims is free to move (approximately two and one-half turns).

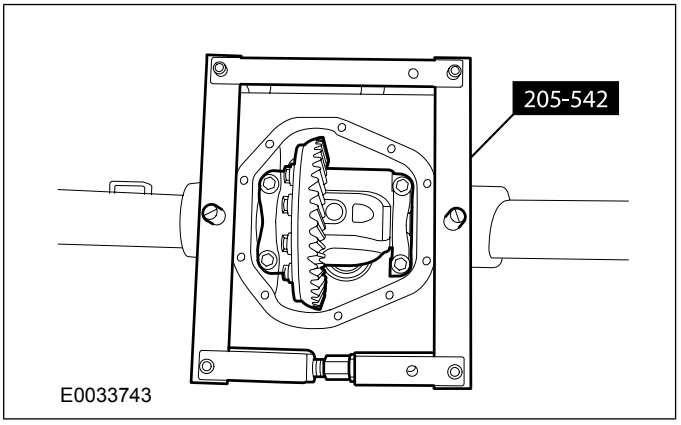


11. **NOTE:If necessary, use two suitable tire levers to loosen the differential case, taking care not to damage the differential assembly.**

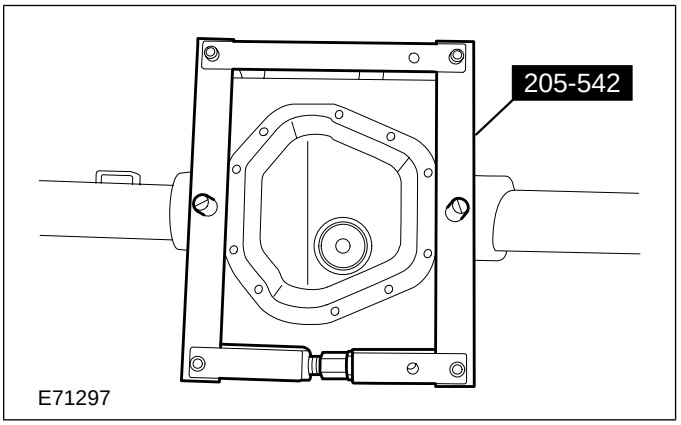
NOTE: Make a note of which side the differential bearing shims are removed to aid installation.

Remove the differential case.

- Remove the differential case bearing outer shims.

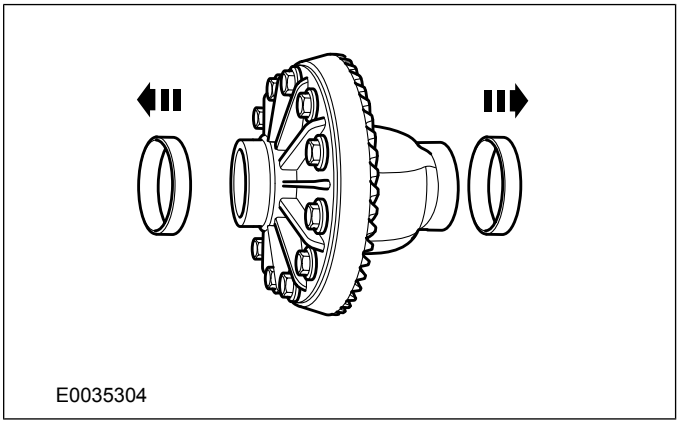


12. **Remove the special tool.**



13. **Remove the differential case bearing cups.**

- Discard the bearing cups.

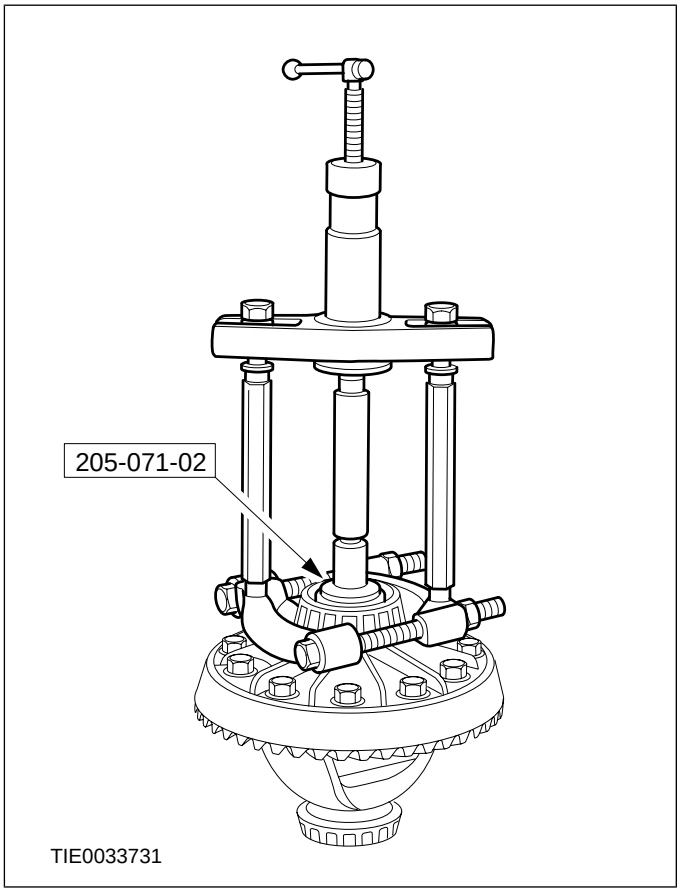


14. **Using the special tool and a suitable separator tool, remove the differential case bearing cones on both sides.**

- Remove the differential case bearing inner shims.

IN-VEHICLE REPAIR

- Discard the bearing cones.



15. ⚠**CAUTION:Use vise jaw protectors.**

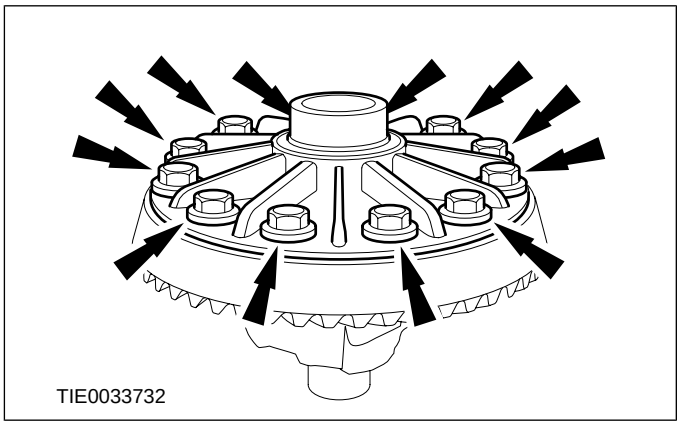
NOTE: Only remove the ring gear if a new ring gear or drive pinion is being installed. Both components are matched pairs.

NOTE: Clamp the differential case in a suitable vise.

NOTE: Leave three equally spaced ring gear retaining bolts loosely installed.

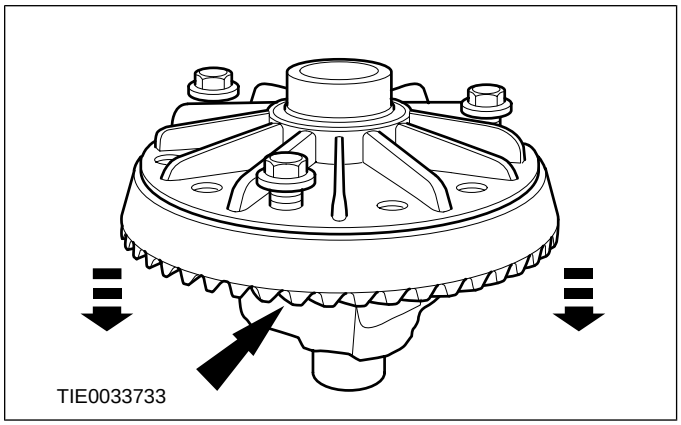
Remove nine ring gear retaining bolts.

- Discard the bolts.



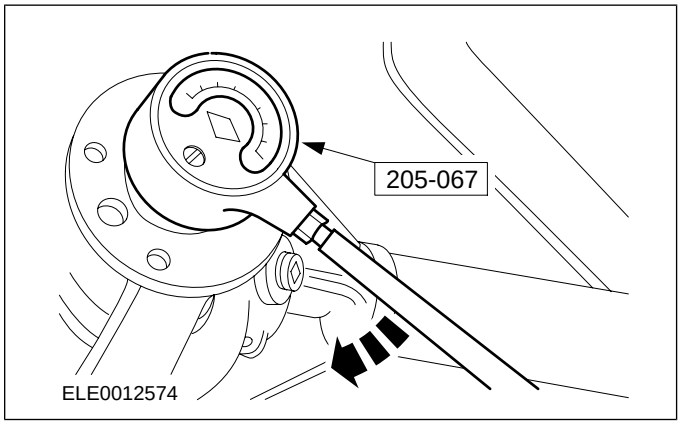
16. **Using a soft faced hammer, tap the three ring gear retaining bolts to loosen the ring gear.**

- Remove and discard the ring gear and retaining bolts.



17. **NOTE:Only carry out this step if a new differential ring gear and pinion is not being installed.**

Using the special tool, measure and note the drive pinion turning value.



18. **If a new ring gear is being installed, remove the drive pinion.**

For additional information, refer to:Drive Pinion (205-02 Rear Drive Axle/Differential, In-vehicle Repair).

Installation

All vehicles

1. **If a new ring gear is being installed, install a new drive pinion.**

For additional information, refer to:Drive Pinion (205-02 Rear Drive Axle/Differential, In-vehicle Repair).

IN-VEHICLE REPAIR

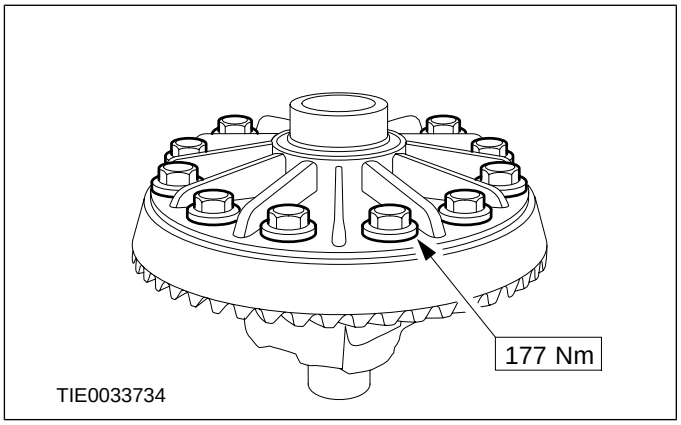
2. **⚠CAUTION:Use vise jaw protectors.**

NOTE: Clamp the differential case in a vise.

NOTE: Install new ring gear retaining bolts.

NOTE: Tighten the bolts in a diagonal sequence.

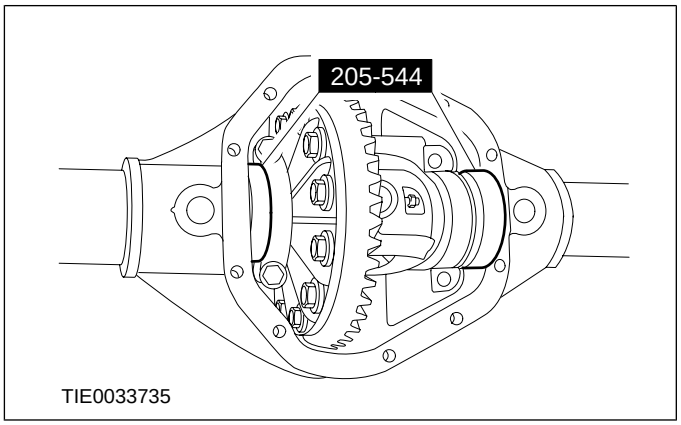
Install the ring gear.



3. **⚠CAUTION:Support the differential case.**

NOTE: Install the differential case without shims.

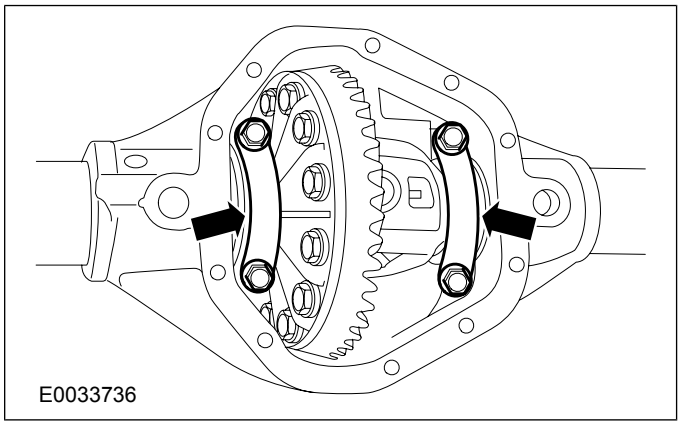
Install the special tools to the differential case trunnions and install the differential case.



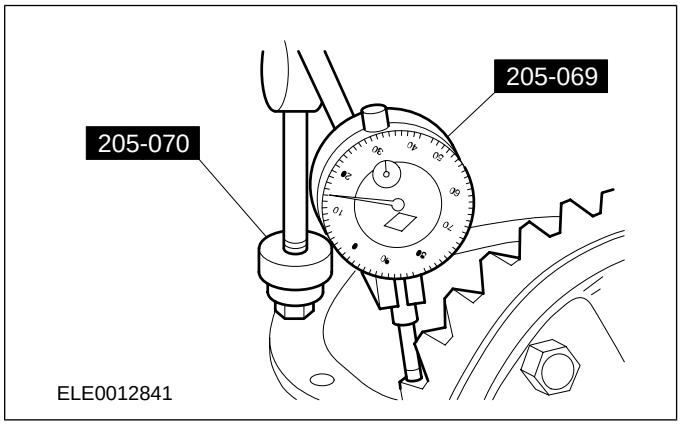
4. **NOTE:Turn each differential case bearing cap 180° to make sure that the outer shim gap can be measured**

NOTE: Do not fully tighten the differential case bearing cap retaining bolts at this stage.

Install the differential case bearing caps.



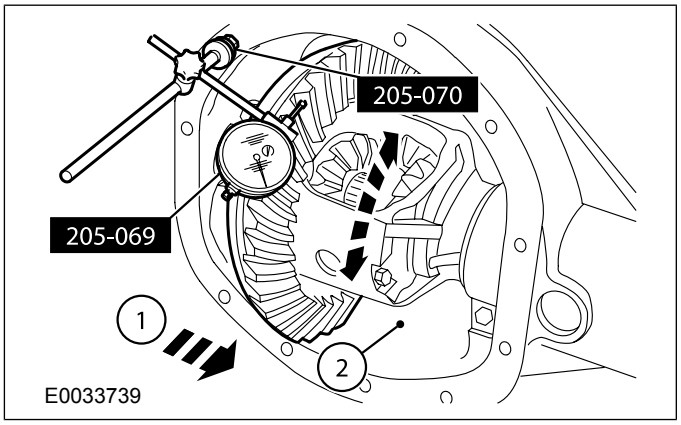
5. **Install the special tools and position the plunger of the dial indicator gauge at right angles to one gear tooth (drive side) on the ring gear.**



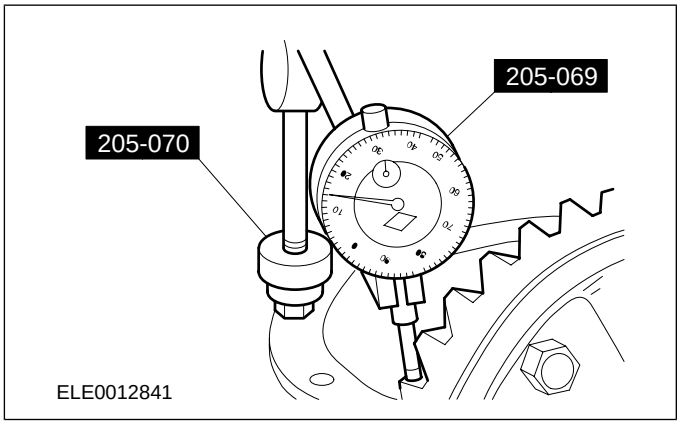
6. **Using the special tools and two sets of feeler gauges, adjust the ring gear backlash.**
   1. Move the differential case fully towards the pinion.
   2. Insert a feeler gauge pack on the RH side until a backlash of between 0.127 mm and 0.228 mm is obtained.
   - Insert a feeler gauge pack on the LH side until all axial movement is removed.

IN-VEHICLE REPAIR

- Note the the feeler gauge pack values.

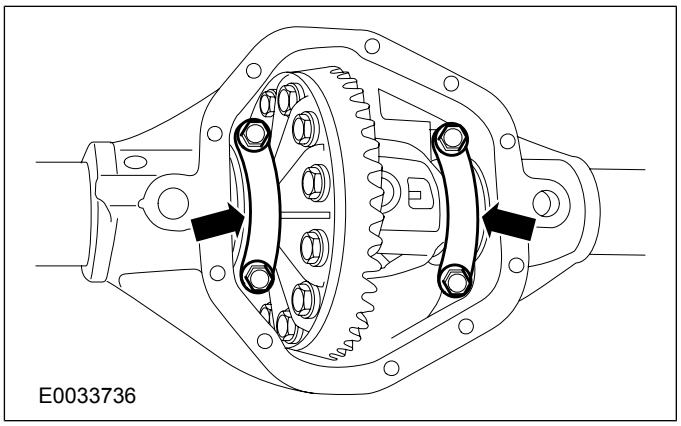


7. Remove the special tools.



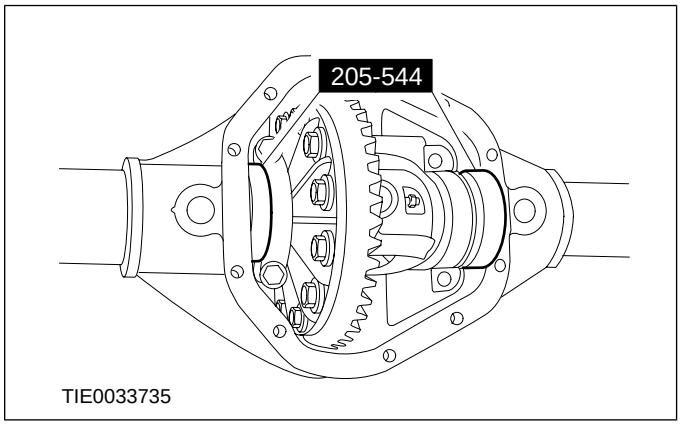
8. ⚠CAUTION:Support the differential case.

Remove the differential case bearing caps.

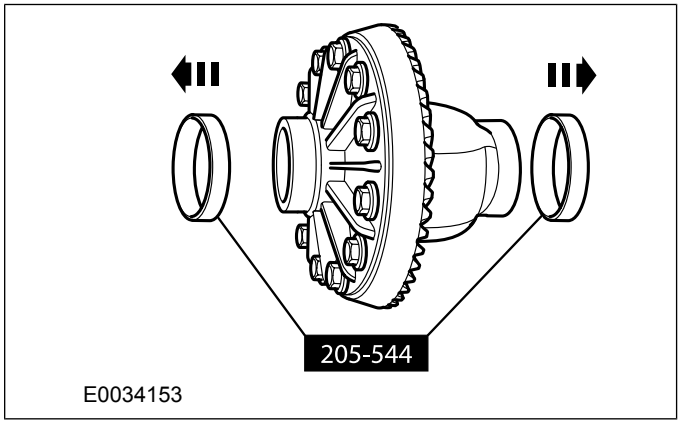


9. ⚠CAUTION:Support the differential case.

Remove the differential case.

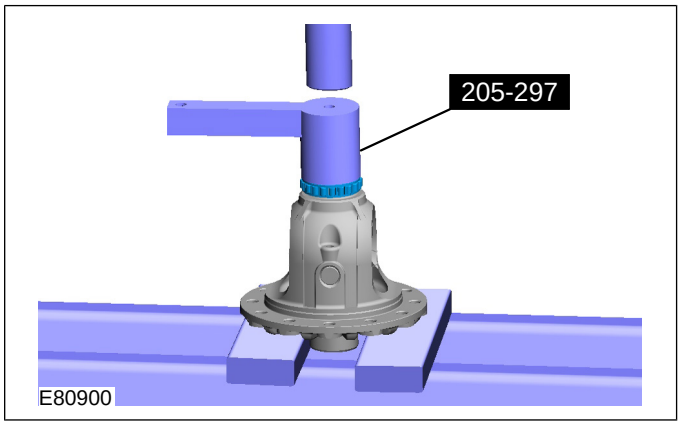


10. Remove the special tools.



11. NOTE:Install new differential bearing cones.

Using the special tool, install the differential case bearing cones together with a 0,84 mm shim on both sides.



12. Using the shiming table, determine the outer shims.

IN-VEHICLE REPAIR

Shiming Table

Measured Gap (mm)	Inboard Shim Size (mm)	Calculated Shim Size (mm)	Shim Size to install (mm)
1.27	0.84	2.7178	2.67
1.2954	0.84	2.7432	2.67
1.3208	0.84	2.7686	2.67
1.3462	0.84	2.794	2.79
1.3716	0.84	2.8194	2.79
1.397	0.84	2.8448	2.79
1.4224	0.84	2.8702	2.79
1.4478	0.84	2.8956	2.79
1.4732	0.84	2.921	2.92
1.4986	0.84	2.9464	2.92
1.524	0.84	2.9718	2.92
1.5494	0.84	2.9972	2.92
1.5748	0.84	3.0226	2.92
1.6002	0.84	3.048	3.05
1.6256	0.84	3.0734	3.05
1.651	0.84	3.0988	3.05
1.6764	0.84	3.1242	3.05
1.7018	0.84	3.1496	3.05
1.7272	0.84	3.175	3.18
1.7526	0.84	3.2004	3.18
1.778	0.84	3.2258	3.18
1.8034	0.84	3.2512	3.18
1.8288	0.84	3.2766	3.18
1.8542	0.84	3.302	3.3
1.8796	0.84	3.3274	3.3
1.905	0.84	3.3528	3.3
1.9304	0.84	3.3782	3.3
1.9558	0.84	3.4036	3.3
1.9812	0.84	3.429	3.43
2.0066	0.84	3.4544	3.43
2.032	0.84	3.4798	3.43
2.0574	0.84	3.5052	3.43
2.0828	0.84	3.5306	3.43

IN-VEHICLE REPAIR

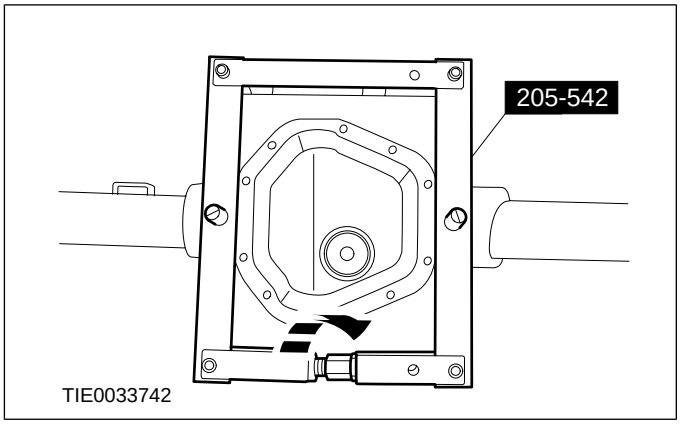
Measured Gap (mm)	Inboard Shim Size (mm)	Calculated Shim Size (mm)	Shim Size to install (mm)
2.1082	0.84	3.556	3.56
2.1336	0.84	3.5814	3.56
2.159	0.84	3.6068	3.56
2.1844	0.84	3.6322	3.56
2.2098	0.84	3.6576	3.56
2.2352	0.84	3.683	3.68
2.2606	0.84	3.7084	3.68
2.286	0.84	3.7338	3.68
2.3114	0.84	3.7592	3.68
2.3368	0.84	3.7846	3.68
2.3622	0.84	3.81	3.81
2.3876	0.84	3.8354	3.81
2.413	0.84	3.8608	3.81
2.4384	0.84	3.8862	3.81
2.4638	0.84	3.9116	3.81
2.4892	0.84	3.937	3.94
2.5146	0.84	3.9624	3.94

13. **CAUTIONS:**

⚠Support the differential case.

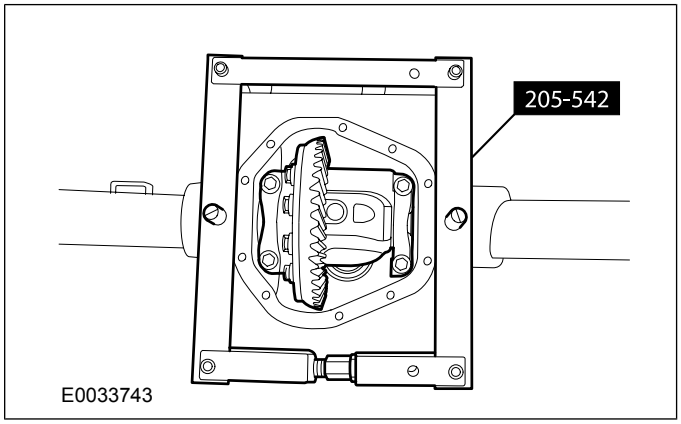
⚠Do not overstretch the differential housing.

Using the special tool, spread the differential housing by approximately two and one-half turns.



14. **NOTE:Install new differential case bearing cups.**

Install the differential case together with the differential case bearing outer shims.

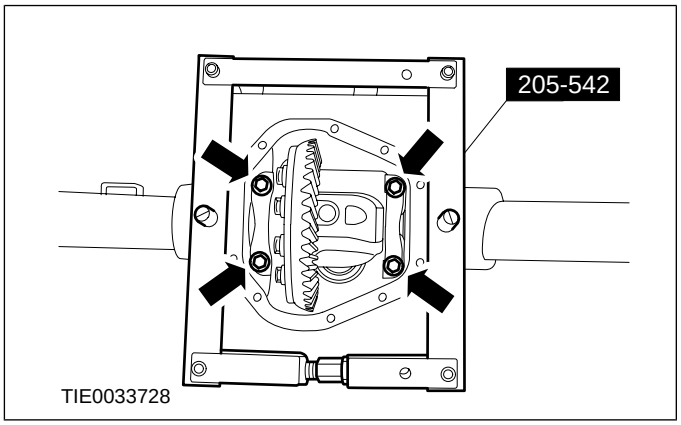


15. **⚠CAUTION:The differential case bearing caps are marked to the axle housing. Make sure they are installed in their original position.**

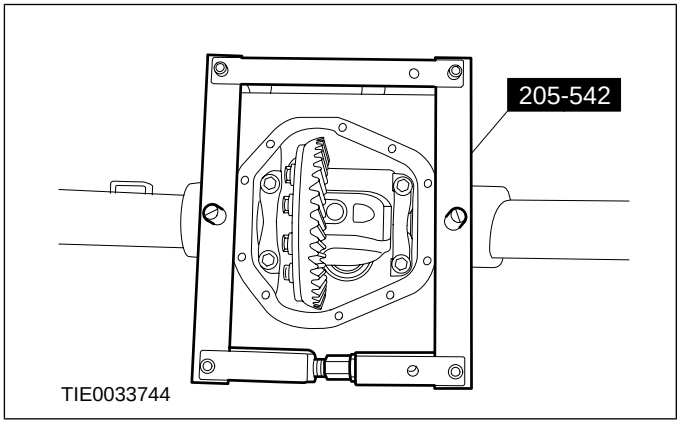
NOTE: Do not fully tighten the differential case bearing cap retaining bolts at this stage.

IN-VEHICLE REPAIR

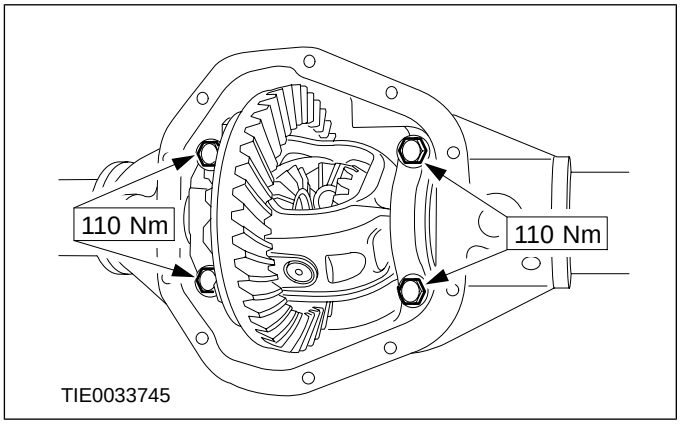
Install the differential case bearing caps.



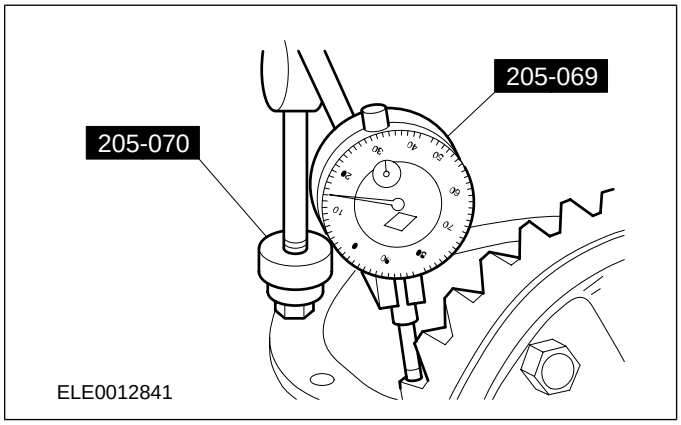
16. **Remove the special tool.**



17. **Tighten the differential case bearing cap bolts.**



18. **Using the special tools, check that the ring gear backlash is between 0.127 mm and 0.228 mm.**

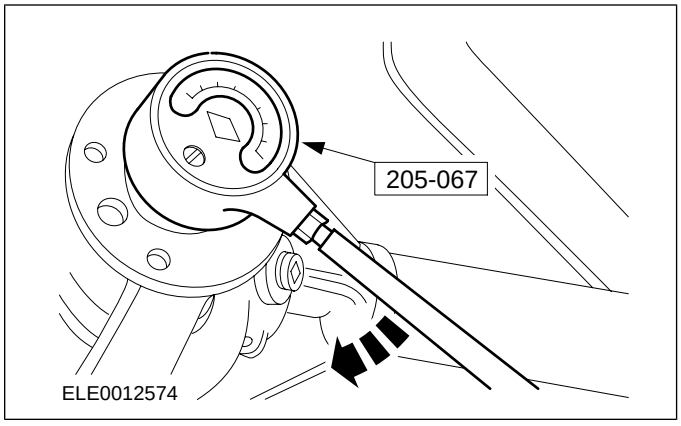


19. **NOTE:If the drive pinion bearing turning value is out of specification, the differential case bearing outer shims must be adjusted by equal amounts on both sides.**

NOTE: Rotate the special tool by more than ten revolutions before reading the turning value.

Using the special tool, measure the drive pinion turning value.

- The turning value with the differential case installed should be 0.5 Nm to 1.13 Nm above the previously noted pinion turning value without the differential case.



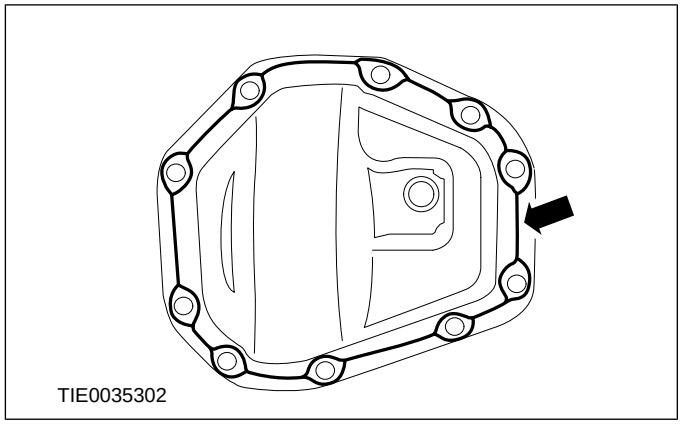
20. **Check the gear contact pattern contained in diagnosis and testing and adjust the shim packs as necessary.**

For additional information, refer to:Driveline System (205-00 Driveline System - General Information, Diagnosis and Testing).

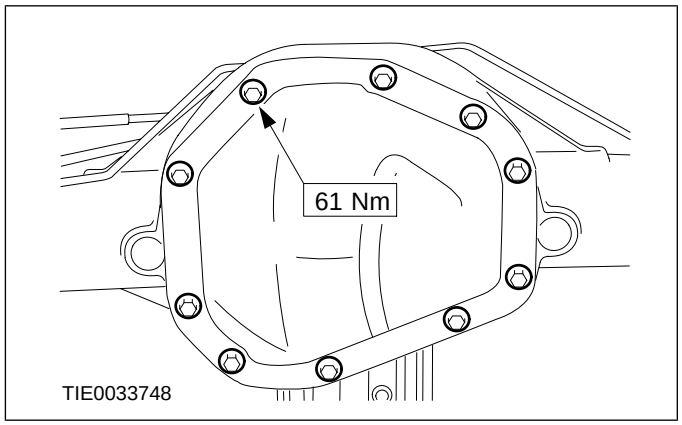
21. **NOTE:Install the differential cover within 2 minutes of applying the sealer.**

IN-VEHICLE REPAIR

Apply 4 -5 mm bead of sealer to the differential housing cover.

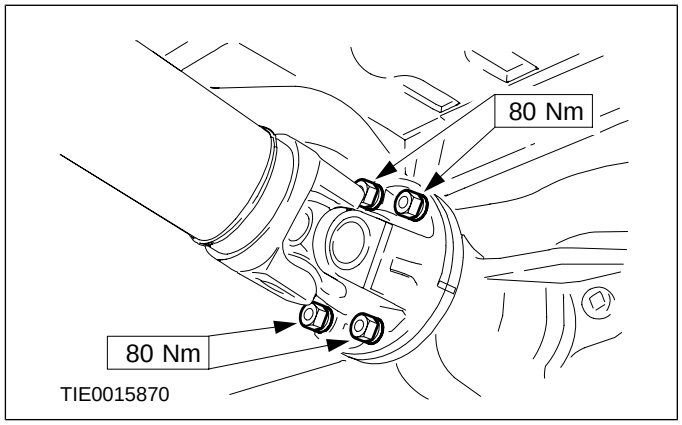


22. Install the differential housing cover.



23. NOTE:Align the mark on the drive shaft flange with the mark on the drive pinion flange.

Attach the drive shaft to the drive pinion flange.

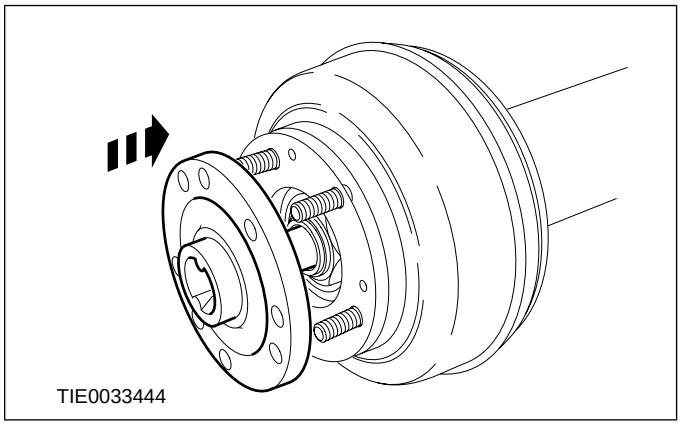


Vehicles with single rear wheels

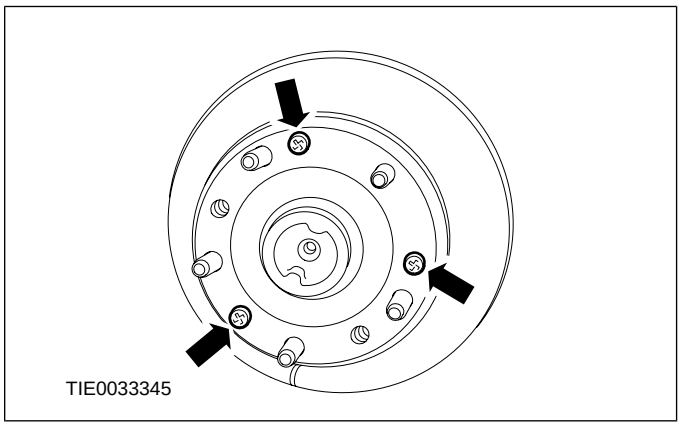
24. NOTE:Install a new axle shaft gasket.

NOTE: Align the mark on the axle shaft with the mark on the brake drum.

Install the axle shafts.



25. Install the axle shaft retaining screws.



26. Install the rear wheels and tires.

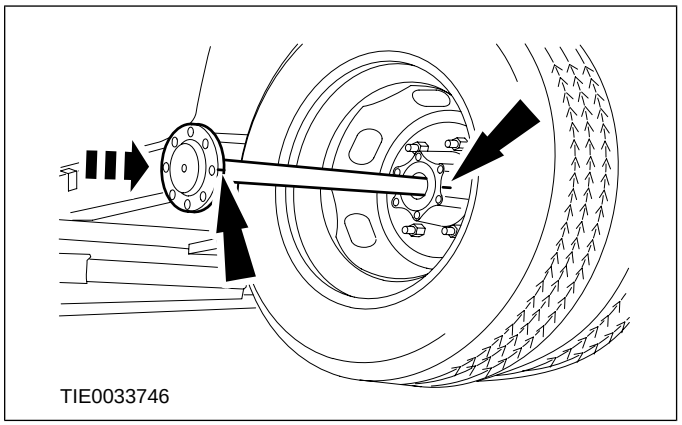
For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

Vehicles with twin rear wheels

27. NOTE:Install a new axle shaft gasket.

NOTE: Align the mark on the axle shaft with the mark on the wheel hub.

Install the axle shafts.

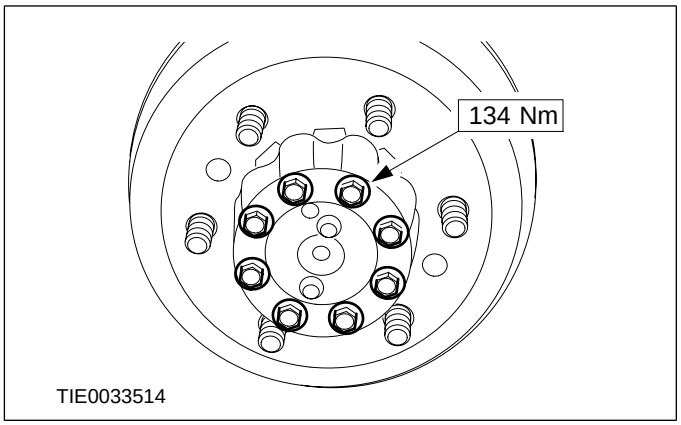


IN-VEHICLE REPAIR

28. **⚠CAUTION:The axle shaft retaining bolts can be re-used three times, inspect the markings on the retaining bolts and install new retaining bolts if necessary.**

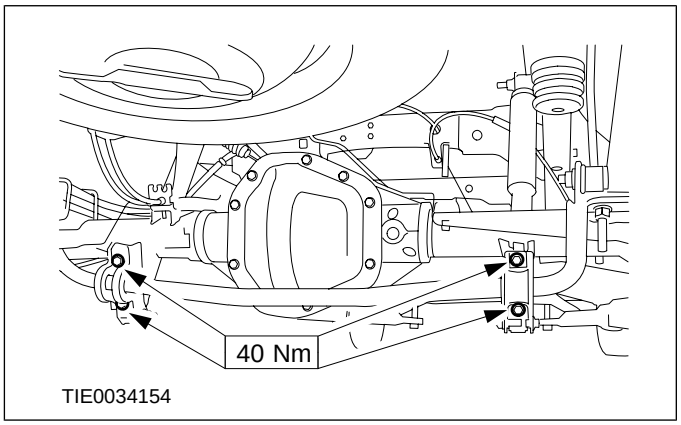
    Coat the threads of the axle shaft retaining bolts with thread-locking compound.

29. **Install the axle shaft retaining bolts (wheel and tire shown removed for clarity).**



All vehicles

30. **Attach the stabilizer bar (if equipped) to the axle housing.**



31. **Fill the rear axle with clean SAE 75W-140 high performance rear axle oil until the oil is level with the oil level filler hole.**

32. **Lower the vehicle.**

REMOVAL AND INSTALLATION

Axle Assembly

General Equipment

Brake hose clamp
Trolley jack

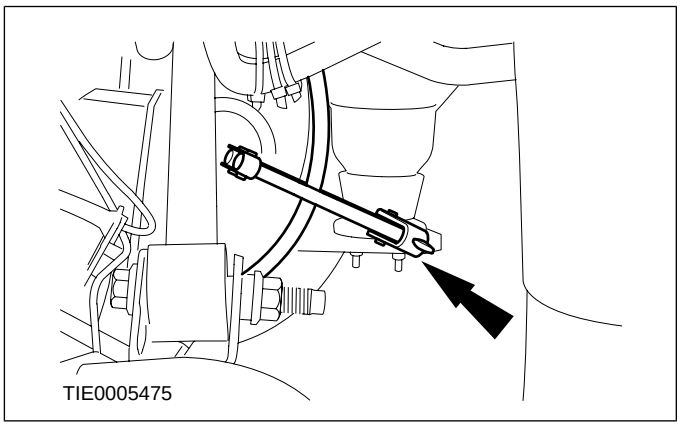
Removal

1. **CAUTION:If brake fluid is spilt on the paintwork, the affected area must be immediately washed down with cold water.**

   Remove the wheel hubs.

   For additional information, refer to:Wheel Hub (205-02 Wheel Hubs and Bearings - Full Floating Axle, Removal and Installation).

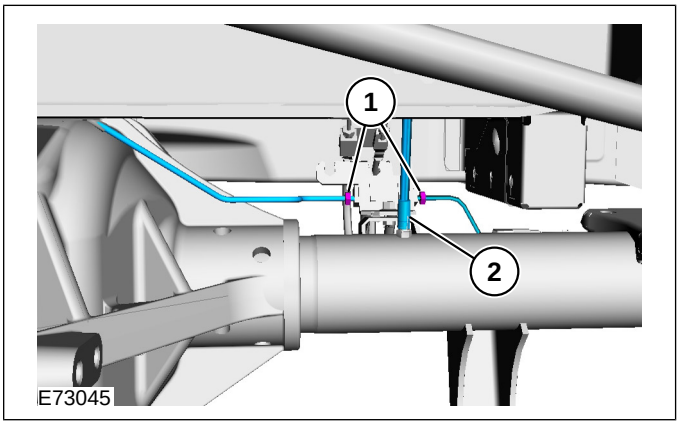
2. **Using a suitable brake hose clamp, clamp the brake hoses.**



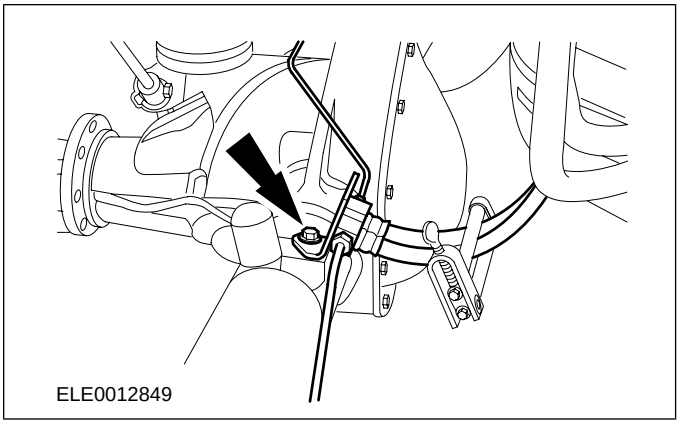
3. **CAUTION:Cap the brake tubes to prevent fluid loss or dirt ingress.**

   Disconnect the brake tubes and the axle housing vent.

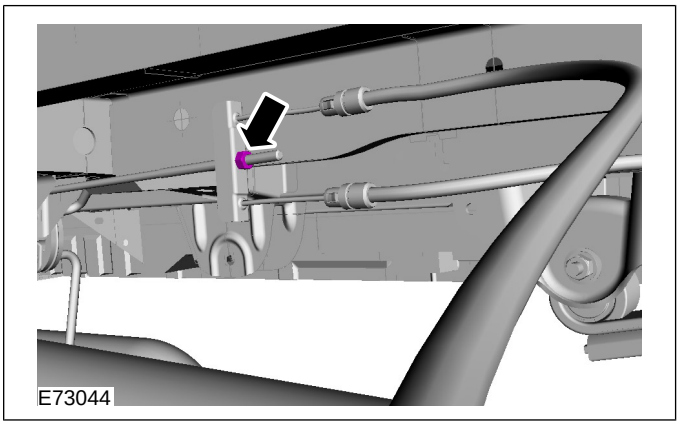
   1. Disconnect the brake tubes from the brake hose retaining bracket.
   2. Disconnect the rear axle housing vent from the rear axle.



4. **Detach the brake hose retaining bracket from the axle housing.**

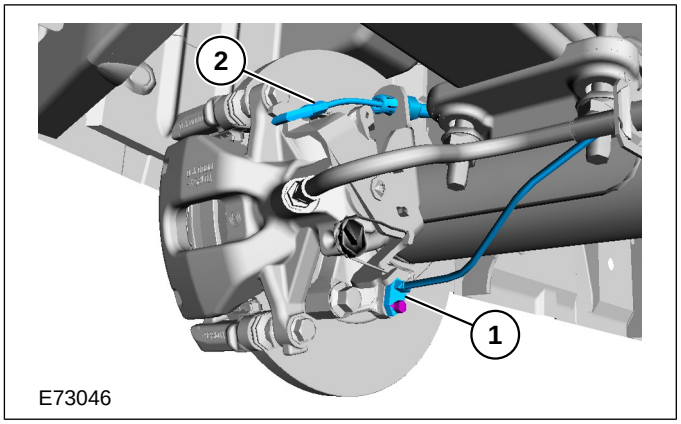


5. **Loosen the park brake cables.**

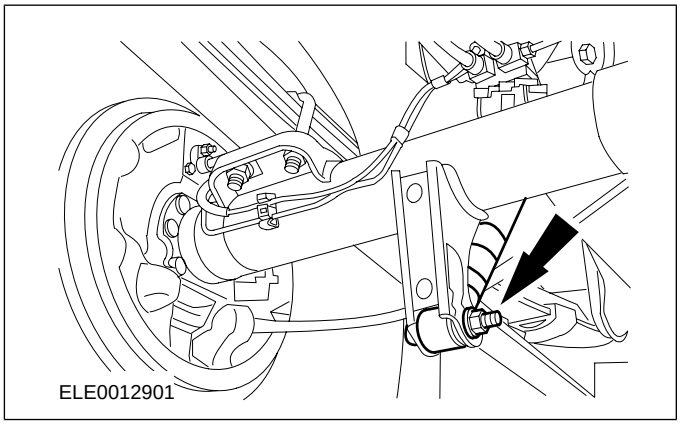


REMOVAL AND INSTALLATION

6. Detach the rear wheel speed sensors and the parking brake cables on both sides.

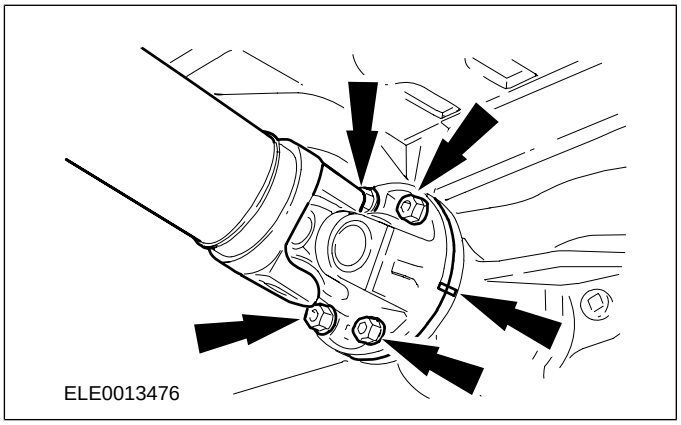


7. Detach the shock absorbers from the axle housing.



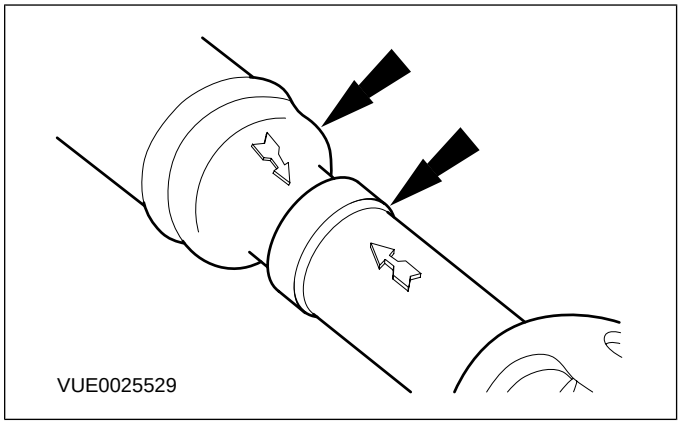
8. NOTE:Mark the position of the driveshaft flange in relation to the drive pinion flange.

   Detach the driveshaft from the drive pinion flange and position it to one side.

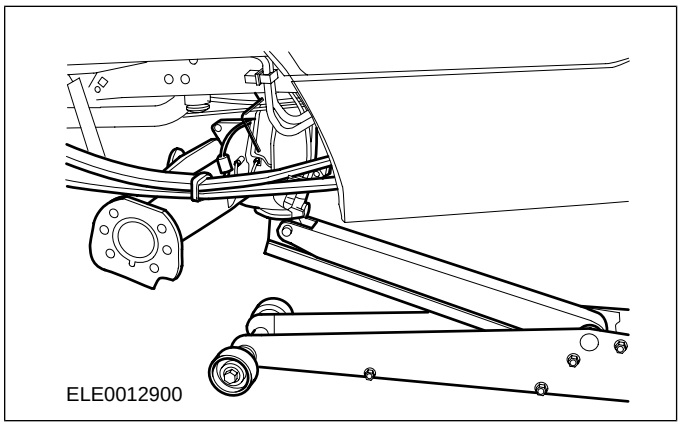


9. WARNING:Driveshafts without a sliding joint protective boot must have the rear section of the driveshaft removed to prevent accidental seperation of the sliding joint. Failure to follow this instruction may result in personal injury.

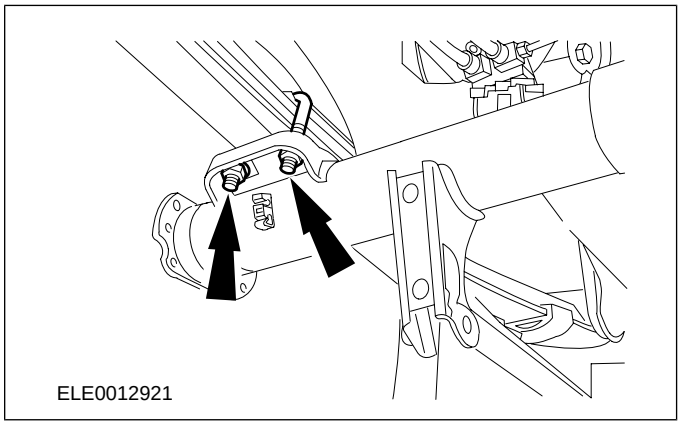
   Remove the rear section of the driveshaft if necessary.



10. Using a suitable trolley jack, support the axle assembly.



11. Remove the spring U-bolts.
    - Discard the nuts.

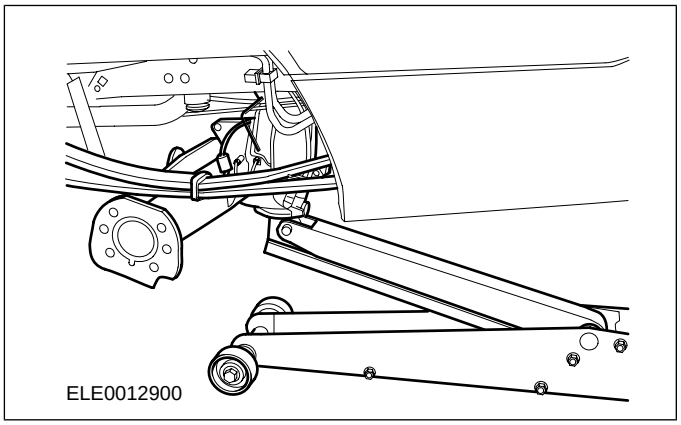


12. Remove the axle assembly.

REMOVAL AND INSTALLATION

Installation

1. **Using a suitable trolley jack, locate the axle assembly under the vehicle.**



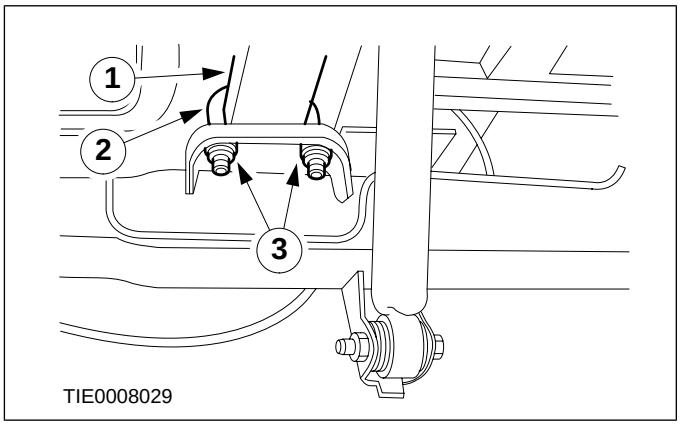
2. **NOTE:Final tightening of the rear suspension components should be carried out when the vehicle weight is on the road wheels.**

NOTE: Install new spring U-bolt nuts.

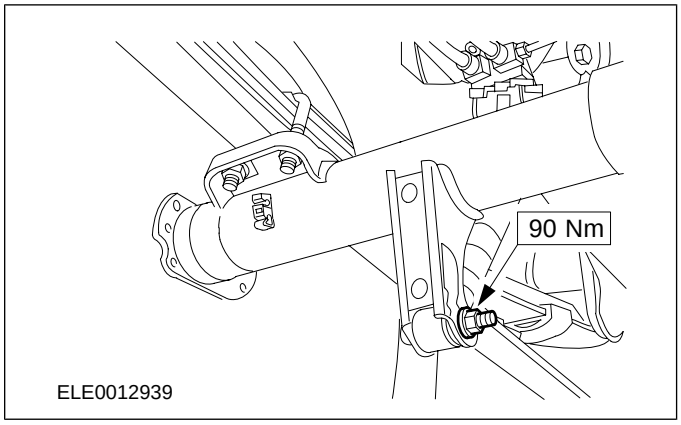
NOTE: Do not fully tighten the spring U-bolt nuts at this stage.

Install the spring U-bolts.

1. Locate the spring to the rear axle assembly.
2. Install the guide plate and U-bolts.
3. Install the nuts.

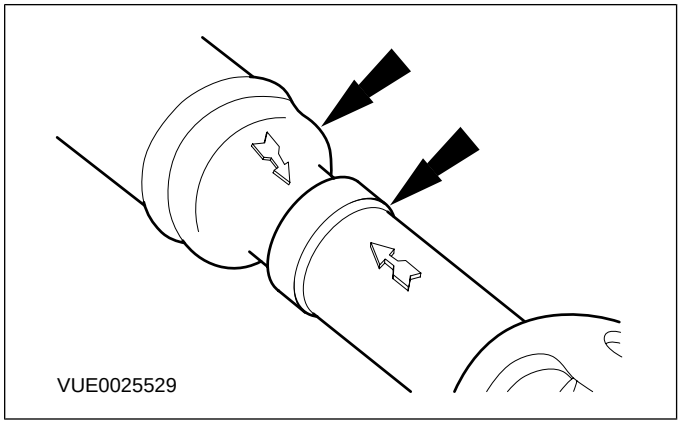


3. **Attach the shock absorbers to the axle housing.**



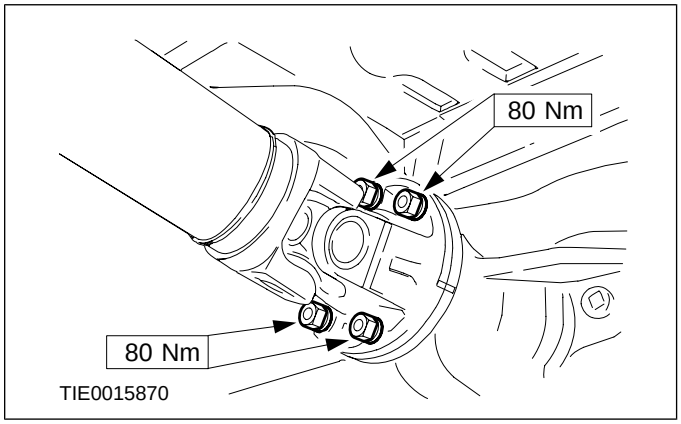
4. **NOTE:Make sure that the arrows are aligned.**

Install the rear section of the driveshaft if necessary.



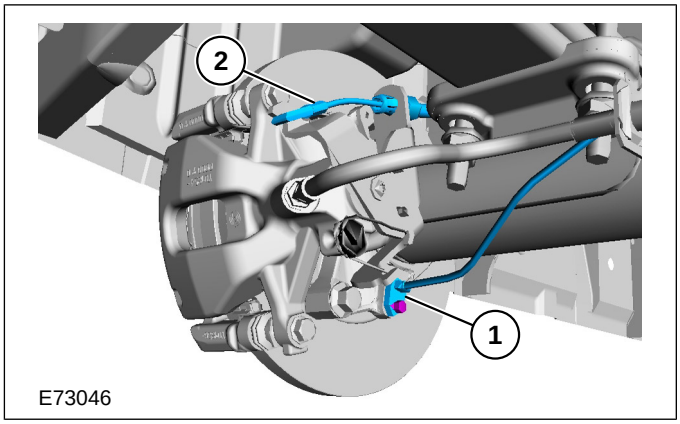
5. **NOTE:Align the mark on the driveshaft flange with the mark on the drive pinion flange.**

Attach the driveshaft to the drive pinion flange.



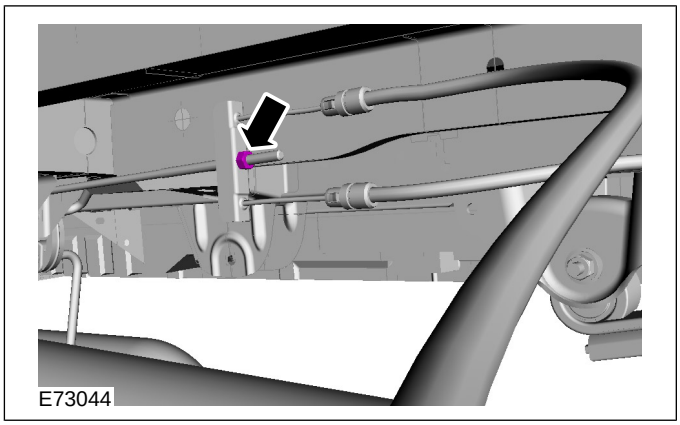
REMOVAL AND INSTALLATION

6. Attach the rear wheel speed sensors and the parking brake cables on both sides.

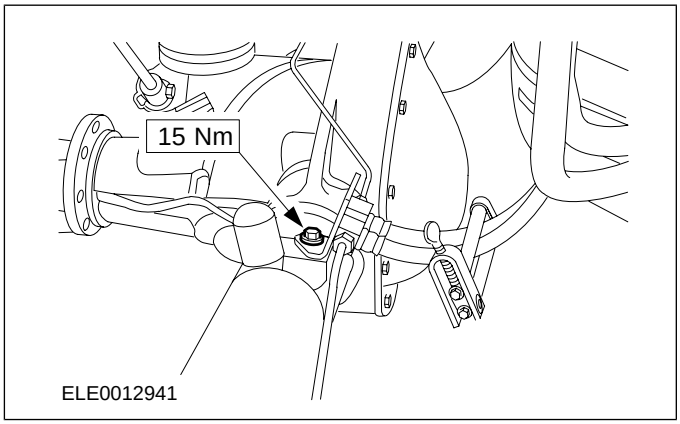


7. Adjust the parking brake cable.

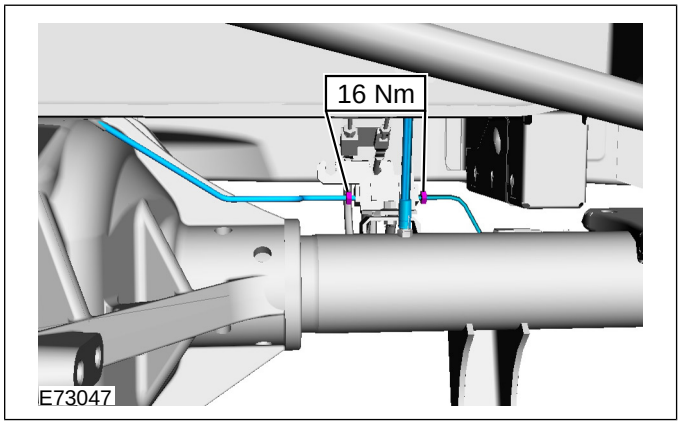
   For additional information, refer to: Parking Brake Cable Adjustment - Vehicles With: Rear Disc Brakes (206-05 Parking Brake and Actuation, General Procedures).



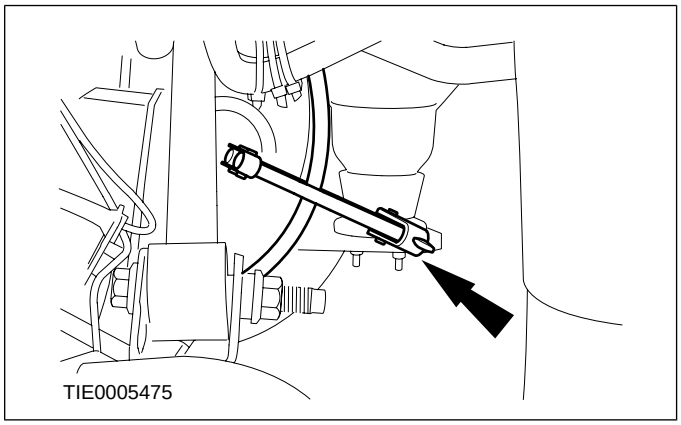
8. Attach the brake hose retaining bracket to the axle housing.



9. Connect the brake tubes to the brake hose retaining bracket and attach the axle housing vent.



10. Remove the brake hose clamp, from the brake hose.



11. Install the wheel hubs.

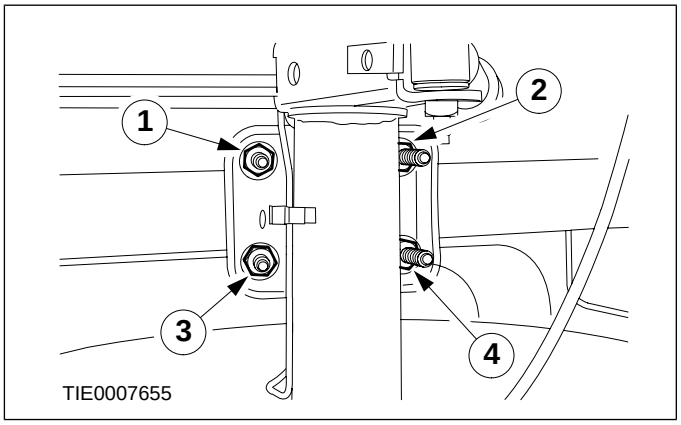
    For additional information, refer to: Wheel Hub (205-02 Wheel Hubs and Bearings - Full Floating Axle, Removal and Installation).

12. Tighten the spring U-bolt nuts in the sequence shown in seven stages.

- Stage 1: Tighten nuts 1 through 4 to 25 Nm.
- Stage 2: Tighten nuts 1 through 4 to 50 Nm.
- Stage 3: Tighten nuts 1 through 4 to 75 Nm.
- Stage 4: Tighten nuts 1 through 4 to 100 Nm.
- Stage 5: Tighten nuts 1 through 4 to 125 Nm.
- Stage 6: Tighten nuts 1 through 4 to 150 Nm.

REMOVAL AND INSTALLATION

- Stage 7: Tighten nuts 1 through 4 to 175 Nm.



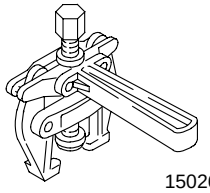
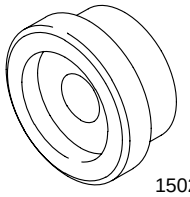
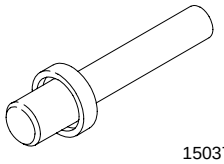
13. **Bleed the brake system.**

    For additional information, refer to:Brake System Bleeding (206-00 Brake System - General Information, General Procedures).

DISASSEMBLY AND ASSEMBLY

Differential Case and Ring Gear

Special Tool(s)

 15026A	Remover, Differential Bearing 205-071 (15-026A)
 1502651	Adaptor for 205-071 (Thrust Pad) 205-071-02 (15-026-51)
 15037	Installer, Differential Bearing 205-082 (15-037)

General Equipment

Soft faced hammer

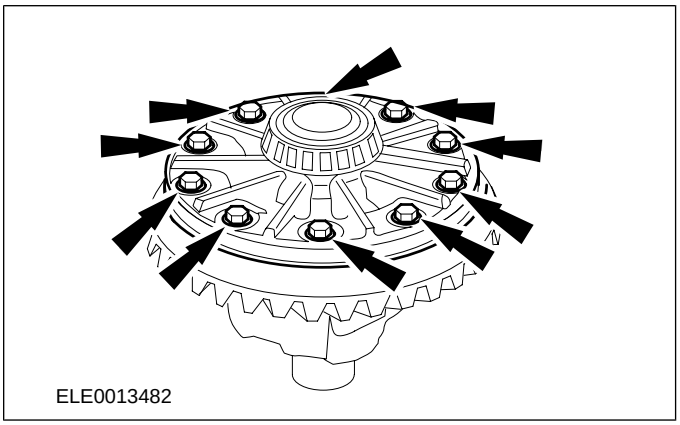
Materials

Name	Specification
SAE 75W-140 High performance rear axle oil	WSL-M2C192-A

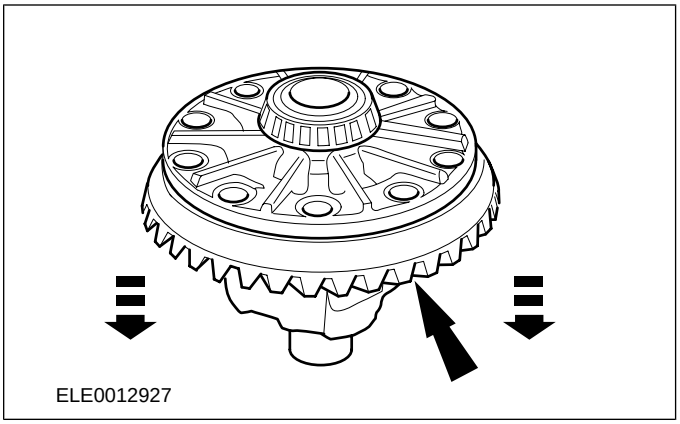
Disassembly

1. **CAUTION:The limited-slip differential must not be dismantled. It is serviced as an assembly.**

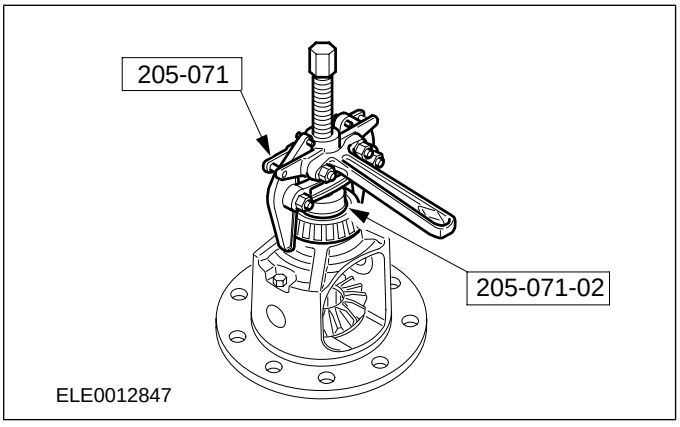
Remove and discard the ring gear retaining bolts.



2. **Using a soft faced hammer, remove the ring gear.**

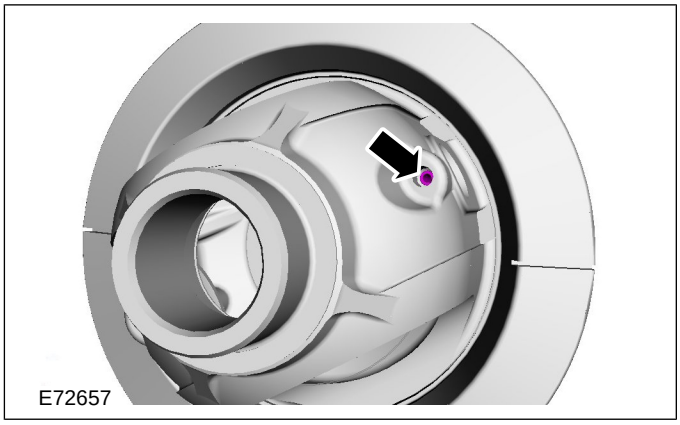


3. **Using the special tools, remove the differential bearing cones.**

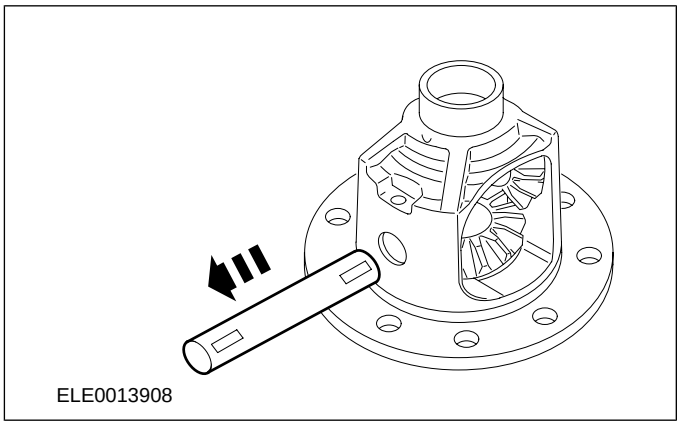


DISASSEMBLY AND ASSEMBLY

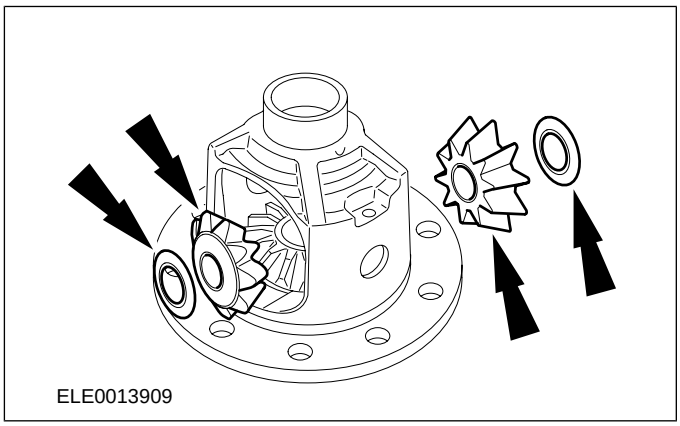
4. Remove and discard the differential pinion shaft lock pin.



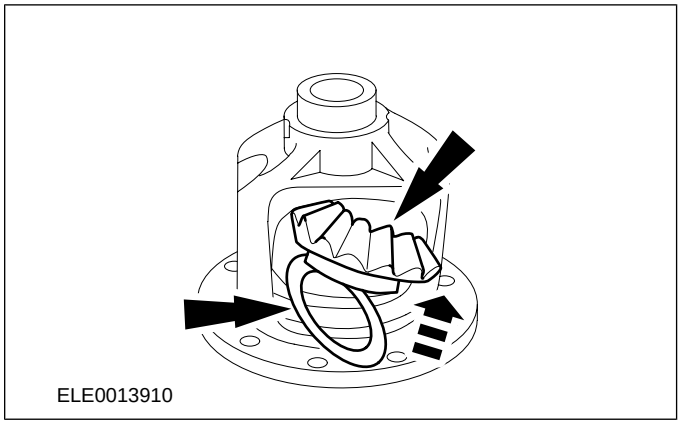
5. Remove the differential pinion shaft.



6. Rotate and remove the differential pinion gears and the differential pinion thrust washers.

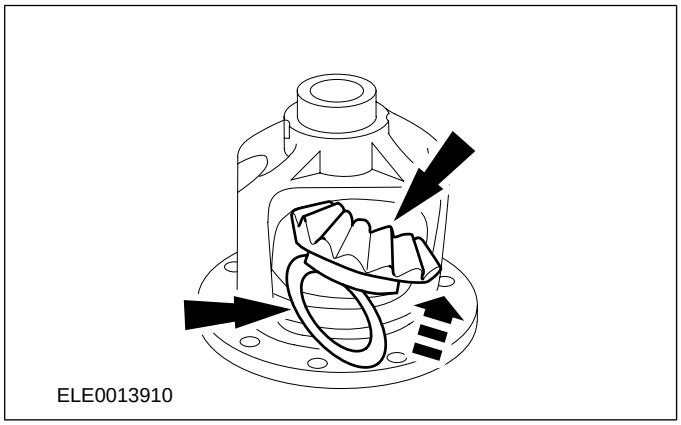


7. Remove the differential pinion side gears and the differential pinion thrust washers.

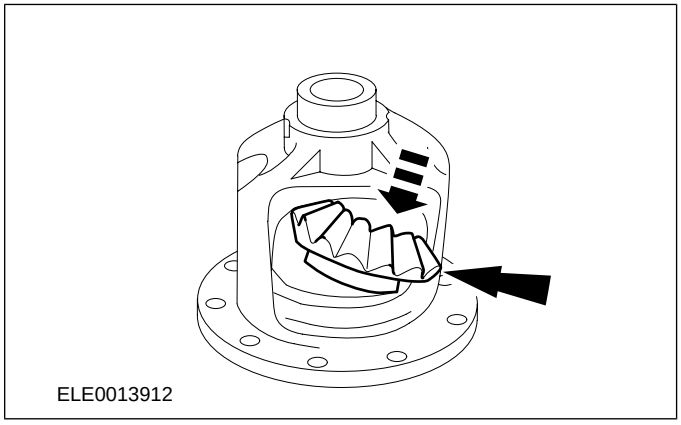


Assembly

1. Lubricate the differential side gear thrust washers and the differential side gears with SAE 75W-140 high performance rear axle oil.
2. Assemble the differential side gear thrust washers to the differential side gears.



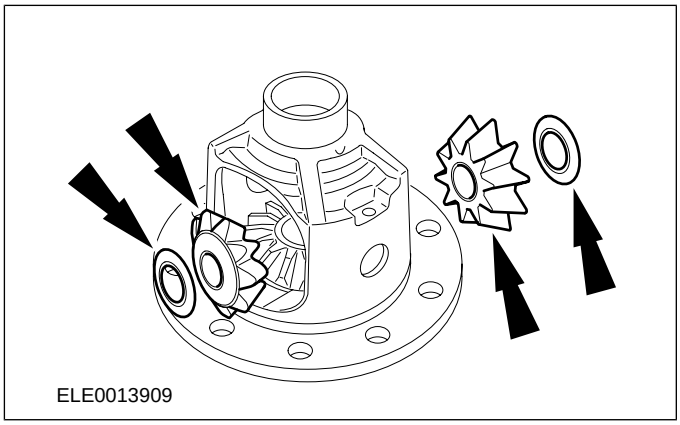
3. Position the differential side gears.



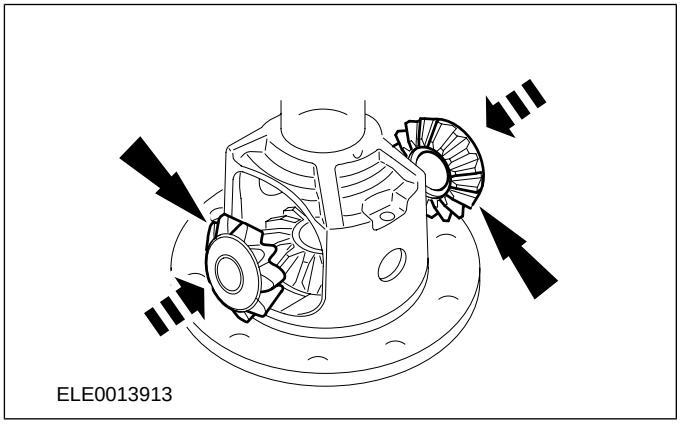
DISASSEMBLY AND ASSEMBLY

4. **Lubricate the differential pinion thrust washers and the differential pinion gears with SAE 75W-140 high performance rear axle oil.**

5. **Assemble the differential pinion thrust washers to the differential pinion gears.**

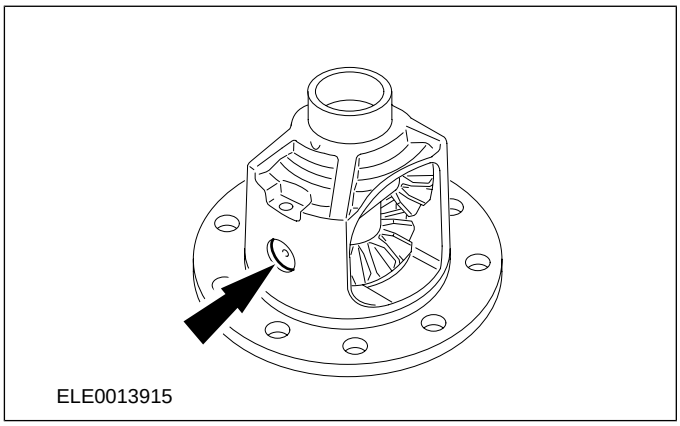


6. **Engage the differential pinion gears to the differential side gears.**
   - Rotate the differential pinion gears to align with the differential pinion shaft hole in the differential case.



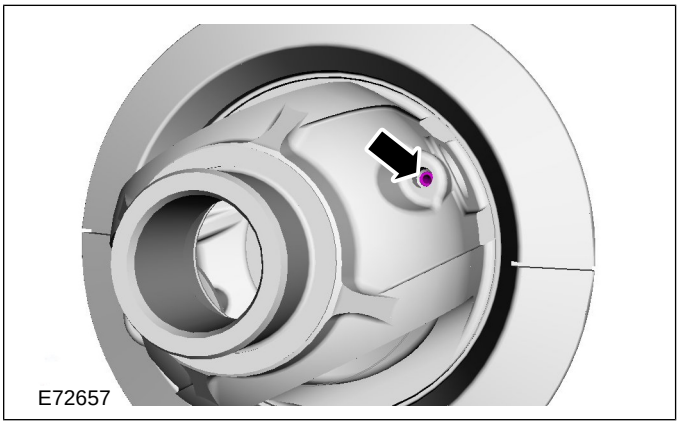
7. **NOTE:Align the bore in the differential pinion shaft with the hole in the differential case.**

   Install the differential pinion shaft.

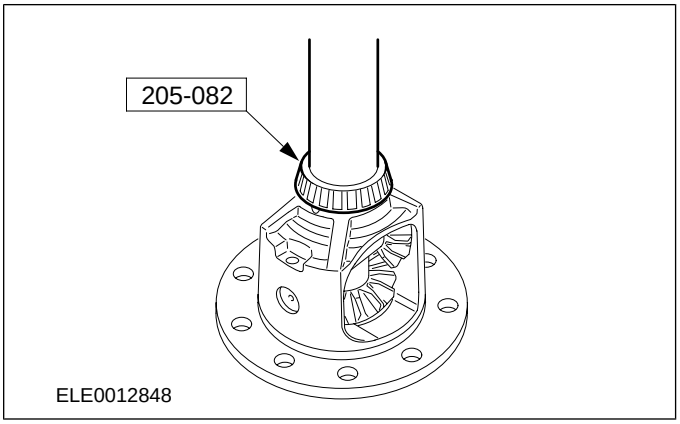


8. **NOTE:Install a new locking pin.**

   Install the differential pinion shaft lock bolt finger tight.

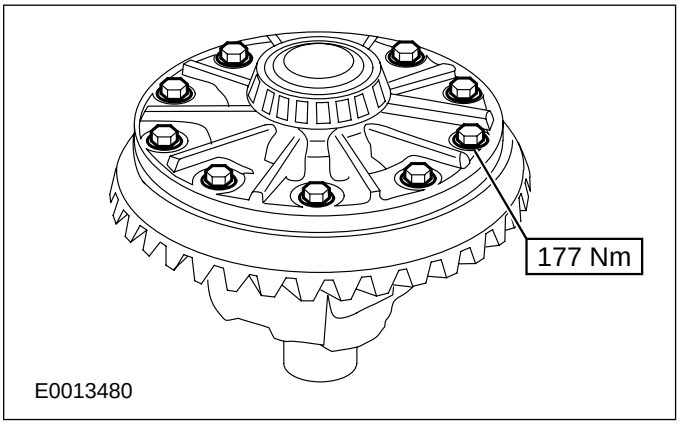


9. **Using the special tool, install the differential bearing cones.**



10. **NOTE:Install new ring gear retaining bolts.**

    Install the ring gear.
    - Tighten the bolts diagonally.



SECTION 205-02B Wheel Hubs and Bearings - Full Floating Axle

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 205-02B-2

DIAGNOSIS AND TESTING

Wheel Hubs and Bearings..... 205-02B-3

REMOVAL AND INSTALLATION

Axle Shaft — Vehicles With: Single Rear Wheels..... 205-02B-4
Wheel Hub..... 205-02B-5
Wheel Bearings, Wheel Hub Seal and Wheel Bearing Cups..... 205-02B-6

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Grease	WSD-M1C228-A
Thread-locking compound	WSK-M2G349-A7

Torque Specifications

Description	Nm	lb-ft	lb-in
Wheel hub retaining nut	425	314	-
Axle shaft retaining bolts (vehicles with twin rear wheels)	134	99	-
Axle shaft retaining screws (vehicles with single rear wheels)	4	-	35

DIAGNOSIS AND TESTING

Wheel Hubs and Bearings

REFER to Section 205-00 [Driveline System - General Information].

REMOVAL AND INSTALLATION

Axle Shaft — Vehicles With: Single Rear Wheels

Materials	
Name	**Specification**
SAE 75W-140 High performance rear axle oil	WSL-M2C192-A

Removal

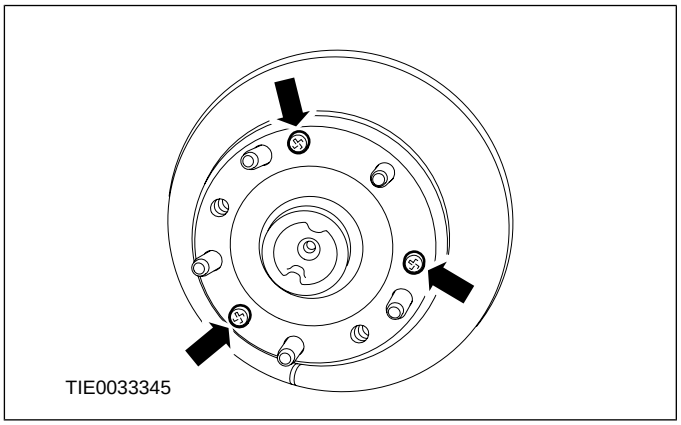
1. **Remove the rear wheel and tire.**

   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

2. **NOTE:Mark the position of the axle shaft in relation to the wheel hub.**

   Remove the axle shaft.

   - Remove and discard the gasket.

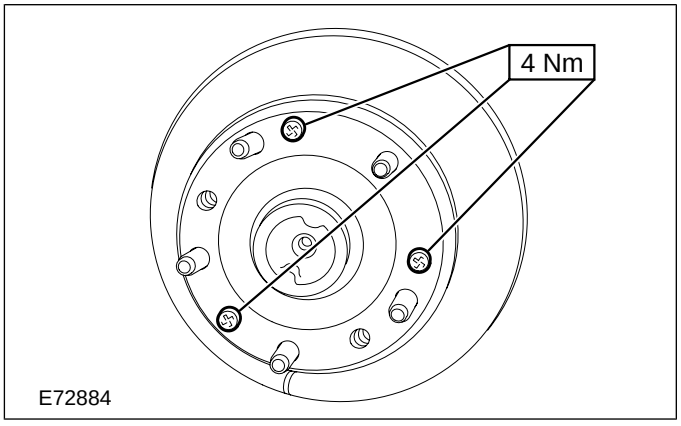


Installation

1. **⚠CAUTION:Install a new gasket.**

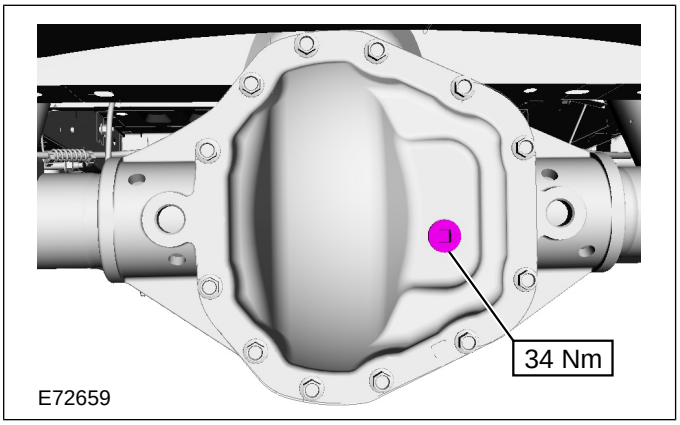
NOTE: Align the mark on the axle shaft with the mark on the wheel hub.

Install the axle shaft.



2. **Check the rear axle oil level.**

   - Top up the rear axle with SAE 75W-140 high performance rear axle oil until the oil is level with the oil level filler hole.



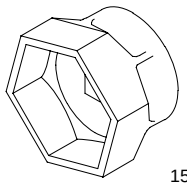
3. **Install the rear wheel and tire.**

   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

REMOVAL AND INSTALLATION

Wheel Hub

Special Tool(s)

 15062	Socket, Axle Nut (65 mm) 205-121

Removal

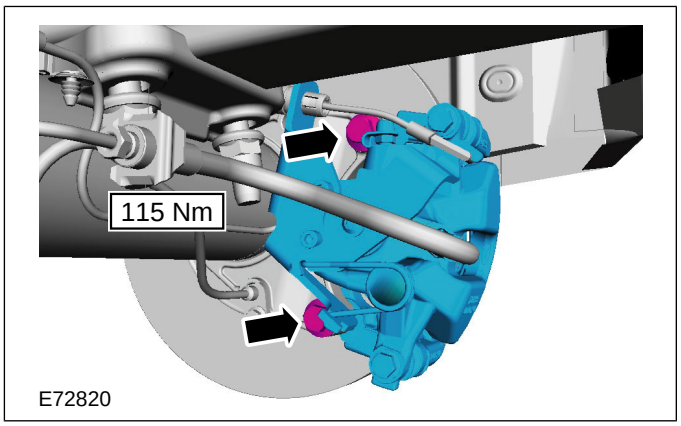
1. **Remove the axle shaft.**

   For additional information, refer to:Axle Shaft - Vehicles With: Single Rear Wheels (205-02 Wheel Hubs and Bearings - Full Floating Axle, Removal and Installation).

2. **WARNING:Make sure that no load is placed on the brake hose.**

   Detach the brake caliper anchor plate from the rear axle.

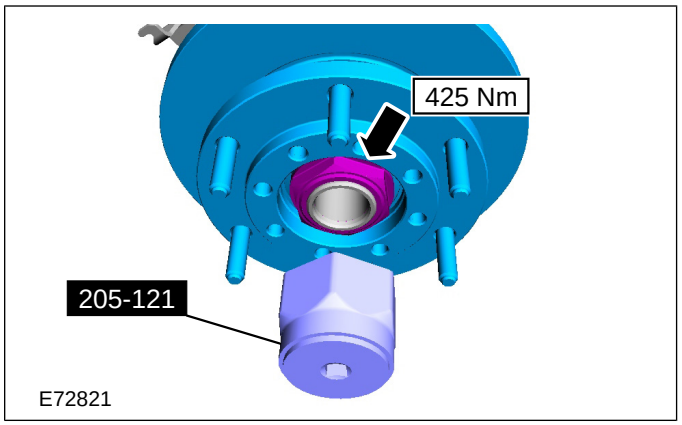
   - Secure the brake caliper to one side.



3. **NOTE:RHS nut has a blue nylock ring.**

   Remove the RHS wheel hub.

   - Discard the wheel hub retaining nut.

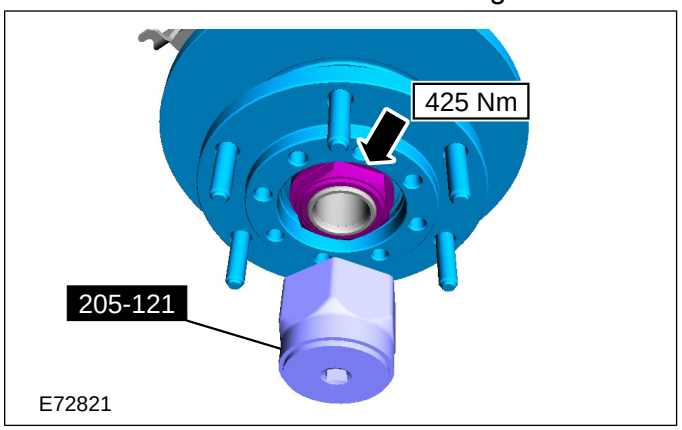


4. **NOTE:The component has a left-hand thread.**

NOTE:LHS nut has a yellow nylock ring.

Remove the LHS wheel hub.

- Discard the wheel hub retaining nut.



Installation

1. **CAUTION:Install new wheel hub retaining nuts.**

NOTE: Make sure that the threads are clean, free of foreign material and lubricant.

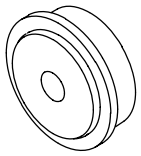
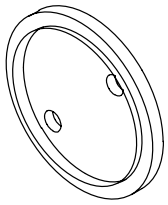
To install, reverse the removal procedure.

2. **WARNING:Depress the brake pedal.**

REMOVAL AND INSTALLATION

Wheel Bearings, Wheel Hub Seal and Wheel Bearing Cups

Special Tool(s)

 1503302A	Adapter for 205-066 205-066-02
 21191	Installer, Crankshaft Rear Seal 303-440

General Equipment

Soft metal drift
Wooden blocks

Materials

Name	Specification
Grease	WSD-M1C228-A

Removal

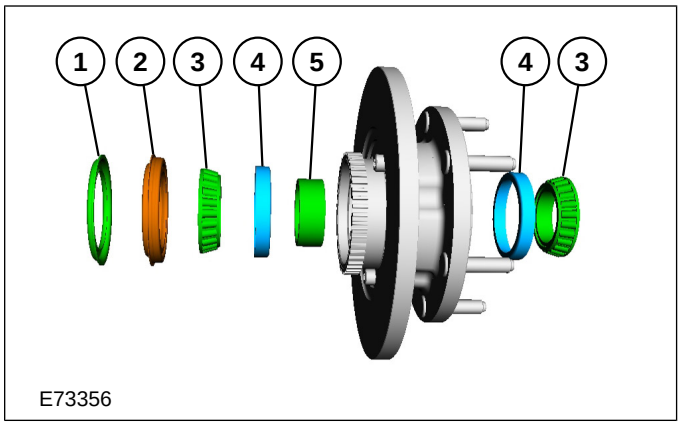
1. **Remove the wheel hub.**

   For additional information, refer to:Wheel Hub (205-02 Wheel Hubs and Bearings - Full Floating Axle, Removal and Installation).

2. **NOTE:Support the wheel on suitable wooden blocks.**

   Remove the wheel bearings

   1. Remove the wheel hub dust cap.
   2. Remove the wheel hub seal.
   3. Remove the wheel bearing cones.
   4. Using a suitable soft metal drift, remove the outer wheel bearing cups.
   5. Remove the wheel bearing spacer.

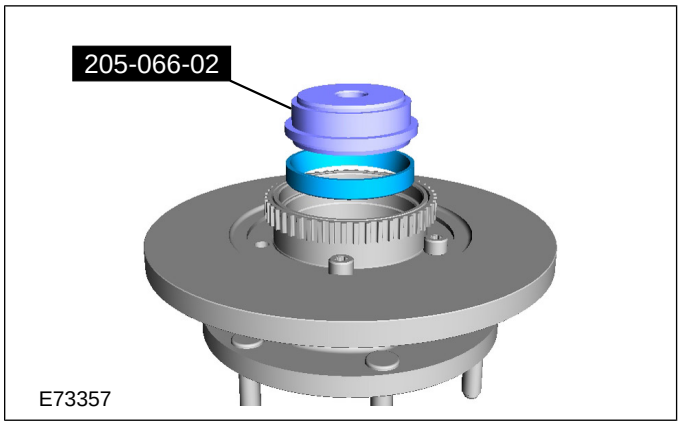


Installation

1. **CAUTION:Make sure the wheel bearing cup is fully seated.**

NOTE: Support the wheel hub on suitable wooden blocks.

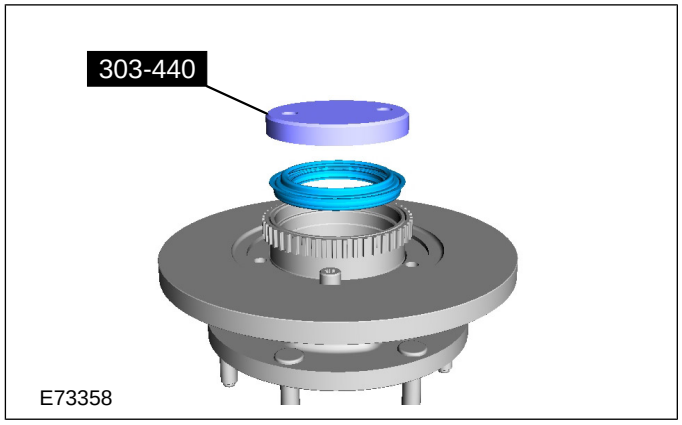
Using the special tool and a suitable press, install the wheel bearing cups.



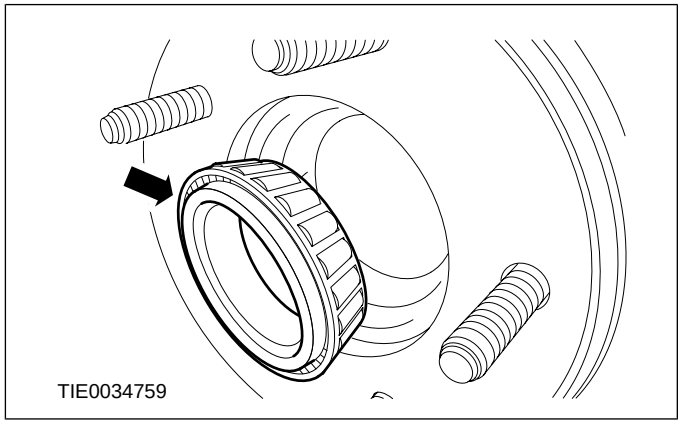
2. **Coat the inner wheel bearing cone with grease.**
3. **Install the inner wheel bearing cone.**
4. **CAUTION:Make sure the wheel hub seal is fully seated.**

REMOVAL AND INSTALLATION

Using the special tool, install the wheel hub seal.



5. **Install the wheel hub dust cap.**
6. **Install the wheel bearing spacer.**
7. **Coat the outer wheel bearing cone with grease.**
8. **Install the outer wheel bearing cone.**



9. **Install the wheel hub.**

   For additional information, refer to:Wheel Hub (205-02 Wheel Hubs and Bearings - Full Floating Axle, Removal and Installation).

SECTION 206-00 Brake System - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 206-00-2
Vehicle Unladen Ride Height — Van and Kombi - Rear Wheel Drive 206-00-2
Vehicle Unladen Ride Height — Chassis Single Cab and Chassis Double Cab - Rear Wheel Drive 206-00-2
Vehicle Unladen Ride Height – Van, bus and Kombi - Front Wheel Drive 206-00-3
Vehicle Unladen Ride Height — Chassis Single Cab and Chassis Double Cab - Front Wheel Drive 206-00-4

DESCRIPTION AND OPERATION

Brake System 206-00-5

DIAGNOSIS AND TESTING

Brake System 206-00-6
Inspection and Verification 206-00-6
Symptom Chart 206-00-6
Pinpoint Tests 206-00-10
Component Tests 206-00-27

GENERAL PROCEDURES

Brake System Leak Check 206-00-30
Brake Load Sensor Proportioning Valve Adjustment ..... (12 136 0) 206-00-31
Brake Disc Runout Check ..... (12 221 0) 206-00-32
Check 206-00-32
Brake System Bleeding ..... (12 141 0) 206-00-34
Brake System Pressure Bleeding ..... (12 141 0) 206-00-35

SPECIFICATIONS

Vehicle Unladen Ride Height — Van and Kombi - Rear Wheel Drive

Model	Rear axle to chassis frame distance (mm)
3000, short wheelbase, low roof	187
3000, short wheelbase, medium roof	185
3000, medium wheelbase, medium roof	184
3000, medium wheelbase, high roof	183
3000, long wheelbase, medium roof	184
3000, long wheelbase, high roof	183
3300, short wheelbase, low roof	202
3300, short wheelbase, medium roof	200
3300, medium wheelbase, medium roof	184
3300, medium wheelbase, high roof	183
3300, long wheelbase, medium roof	184
3300, long wheelbase, high roof	183
3500, medium wheelbase, medium roof	189
3500, medium wheelbase, high roof	188
3500, long wheelbase, medium roof	189
3500, long wheelbase, high roof	188
3500, long wheelbase, twin rear wheel, extended frame, high roof	178
3500, long wheelbase, extended frame, high roof	180

Vehicle Unladen Ride Height — Chassis Single Cab and Chassis Double Cab - Rear Wheel Drive

Model	Rear axle to chassis frame distance (mm)
3000, short wheelbase, Chassis single cab	209
3000, medium wheelbase, Chassis single cab	211
3000, medium wheelbase, Chassis double cab	204
3300, short wheelbase, Chassis single cab	209
3300, medium wheelbase, Chassis single cab	211
3300, medium wheelbase, Chassis double cab	205
3300, long wheelbase, Chassis single cab	206
3300, long wheelbase, Chassis double cab	202
3500, medium wheelbase, Chassis single cab	211
3500, medium wheelbase, twin rear wheels, Chassis single cab	232
3500, long wheelbase, twin rear wheels, Chassis single cab	226
3500, long wheelbase, Chassis single cab	206

SPECIFICATIONS

Model	Rear axle to chassis frame distance (mm)
3500, long wheelbase, extended frame, twin rear wheels, Chassis single cab	224
3500, long wheelbase, extended frame, Chassis single cab	204
3500, medium wheelbase, twin rear wheels, Chassis double cab	225
3500, medium wheelbase, Chassis double cab	205
3500, long wheelbase, twin rear wheels, Chassis double cab	222
3500, long wheelbase, Chassis single cab	202
3500, long wheelbase, extended frame, twin rear wheels, Chassis double cab	220
3500, long wheelbase, extended frame, Chassis double cab	200

Vehicle Unladen Ride Height – Van, bus and Kombi - Front Wheel Drive

Model	Rear axle to chassis frame distance (mm)
2600, short wheelbase, low roof, van and kombi	141
2600, short wheelbase, medium roof, van and kombi	139
2800, short wheelbase, low roof, van and kombi	141
2800, short wheelbase, medium roof, van and kombi	139
2800, short wheelbase, medium roof, bus	128
2800, medium wheelbase, low roof, van and kombi	138
2800, medium wheelbase, medium roof, van and kombi	136
3000, short wheelbase, low roof, van and kombi	146
3000, short wheelbase, medium roof, van and kombi	145
3000, medium wheelbase, low roof, van and kombi	143
3000, medium wheelbase, medium roof, van and kombi	142
3000, medium wheelbase, high roof, van and kombi	141
3000, long wheelbase, medium roof, van and kombi	141
3000, long wheelbase, high roof, van and kombi	140
3300, short wheelbase, low roof, van and kombi	201
3300, short wheelbase, medium roof, van and kombi	200
3300, medium wheelbase, low roof, van and kombi	184
3300, medium wheelbase, medium roof, van and kombi	183
3300, medium wheelbase, high roof, van and kombi	183
3300, long wheelbase, medium roof, van and kombi	183
3300, long wheelbase, high roof, van and kombi	182
3500, medium wheelbase, low roof, van and kombi	184

SPECIFICATIONS

Model	Rear axle to chassis frame distance (mm)
3500, medium wheelbase, medium roof, van and kombi	183
3500, medium wheelbase, high roof, van and kombi	183
3500, long wheelbase, medium roof, van and kombi	183
3500, long wheelbase, high roof, van and kombi	182

Vehicle Unladen Ride Height — Chassis Single Cab and Chassis Double Cab - Front Wheel Drive

Model	Rear axle to chassis frame distance (mm)
3000, short wheelbase, low roof, Chassis single cab	161
3000, medium wheelbase, low roof, Chassis single cab	159
3300, short wheelbase, low roof, Chassis single cab	222
3300, medium wheelbase, low roof, Chassis single cab	215
3300, long wheelbase, low roof, Chassis single cab	210
3500, medium wheelbase, low roof, Chassis single cab	215
3500, long wheelbase, low roof, Chassis single cab	210
3500, long wheelbase, extended frame, low roof, Chassis single cab	209

Torque Specifications

Description	Nm	lb-ft	lb-in
Brake load sensor proportioning valve setting screw	17	13	-

DESCRIPTION AND OPERATION

Brake System

NOTE: Brake friction materials inherently generate noise and heat in order to dissipate energy. As a result, occasional squeal is possible. This condition may be amplified by severe operating conditions, such as cold, heat, rain, snow, salt and mud.

The braking system is of a diagonally split, dual circuit design.

The hydraulic system has separate circuits for each pair of diagonally opposite wheels (left front, right rear and right front, left rear). The brake pads and brake shoes are all asbestos-free.

The parking brake control operates the rear brakes through a cable system.

The brake master cylinder is of a tandem design and is linked to a brake booster which reduces the brake pedal effort. The tandem design will make sure that in the event of one brake circuit failing the other will remain fully operational. The brake booster actuating rod is connected directly to the brake pedal.

The brake load sensing proportioning valve is connected to the chassis and controls the brake fluid pressure to each rear wheel depending on vehicle load. This will always make sure that braking effort at the front wheels is always greater than that at the rear wheels.

DIAGNOSIS AND TESTING

Brake System

Inspection and Verification

NOTE: Before carrying out any diagnosis, make sure that the brake system warning indicator operates correctly.

1. Verify the customer concern, carrying a road test with the customer if necessary.

   REFER to:Road/Roller Testing (100-00 General Information, Description and Operation).
2. Visually inspect for obvious signs of mechanical damage.

Visual Inspection Chart

Mechanical
– Tire pressure(s) – Wheels and tires – Brake line(s)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• The brakes pull or drift	• Brake pads or brake shoes. • Front brake disc(s). • Brake caliper(s). • Wheel alignment.	• GO to Pinpoint Test A.
	• Wheel bearing(s)	• CHECK or INSTALL new wheel bearings as necessary. REFER to: Front Suspension (204-01 Front Suspension, Diagnosis and Testing), Rear Suspension (204-02 Rear Suspension, Diagnosis and Testing).
• The red brake warning indicator is always on	• Brake fluid level.	• FILL the brake system to specification. INSPECT the brake lines for leaks.
	• Brake master cylinder primary piston cup.	• INSTALL a new brake master cylinder. REFER to:Brake Master Cylinder (206-06 Hydraulic Brake Actuation, Removal and Installation).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Parking brake control.	• RELEASE and ADJUST the parking brake cable. REFER to:(206-05 Parking Brake and Actuation) Parking Brake Cable Adjustment - Vehicles With: Rear Drum Brakes (General Procedures), Parking Brake Cable Adjustment - Vehicles With: Rear Disc Brakes (General Procedures).
	• Circuit. • Anti-lock braking system (ABS).	• GO to Pinpoint Test B.
• Vibration when brakes are applied	• Grease or fluid on brake pads or brake shoes; glazed linings. • Brake drum contact surface.	• GO to Pinpoint Test C.
	• Brake caliper retaining bolts.	• TIGHTEN the brake caliper bolts.
	• Insufficient grease on sliding parts.	• APPLY grease as necessary.
	• Foreign material or scratches on front brake disc contact surfaces.	• INSTALL a new brake disc. REFER to: Brake Disc - RWD (206-03 Front Disc Brake, Removal and Installation), Brake Disc - FWD (206-03 Front Disc Brake, Removal and Installation), Brake Disc - FWD (206-04 Rear Disc Brake, Removal and Installation), Brake Disc - RWD (206-04 Rear Disc Brake, Removal and Installation).
	• Loose wheel hub nuts.	• TIGHTEN or INSTALL new wheel hub nuts.
	• Wheel bearings.	• CHECK or INSTALL new wheel bearings as necessary. REFER to: Front Wheel Bearing (204-01 Front Suspension, Removal and Installation), Wheel Bearings, Wheel Hub Seal and Wheel Bearing Cups (205-02 Wheel Hubs and Bearings - Full Floating Axle, Removal and Installation).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Wheel and tire imbalance.	• CHECK and BALANCE the wheels and tires as necessary.
• The brake pedal goes down fast	• Leak in brake system.	• GO to Pinpoint Test D.
	• Air in the brake system.	• BLEED the brakes. REFER to:(206-00 Brake System - General Information) Brake System Bleeding (General Procedures), Brake System Pressure Bleeding (General Procedures).
	• Brake master cylinder.	• INSTALL a new brake master cylinder. REFER to:Brake Master Cylinder (206-06 Hydraulic Brake Actuation, Removal and Installation).
	• Brake pads and brake shoes.	• INSPECT the brake pads and brake shoes. REPAIR or INSTALL new brake pads or brake shoes as necessary. REFER to: Brake Pads (206-03 Front Disc Brake, Removal and Installation), Brake Pads (206-04 Rear Disc Brake, Removal and Installation), Brake Shoes (206-02 Drum Brake, Removal and Installation).
• The brake pedal eases down slowly	• Air in the brake system.	• BLEED the brakes. REFER to:(206-00 Brake System - General Information) Brake System Bleeding (General Procedures), Brake System Pressure Bleeding (General Procedures).
	• Brake Booster. • Brake master cylinder.	• GO to Pinpoint Test E.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• The brake pedal is low or feels spongy.	• Brake pads or brake shoes.	• INSPECT the brake pads and brake shoes. INSTALL new brake pads or brake shoes as necessary. REFER to: Brake Pads (206-03 Front Disc Brake, Removal and Installation), Brake Pads (206-04 Rear Disc Brake, Removal and Installation), Brake Shoes (206-02 Drum Brake, Removal and Installation).
	• Brake system.	• GO to Pinpoint Test F.
• Brake lockup during light brake pedal force.	• Brake pads or brake shoes. • Brake calipers. • Brake load sensor proportioning valve.	• GO to Pinpoint Test G.
• Excessive/erratic brake pedal travel	• Brake pads or brake shoes.	• INSPECT the brake pads and brake shoes. REPAIR or INSTALL new brake pads or brake shoes as necessary. REFER to: Brake Pads (206-03 Front Disc Brake, Removal and Installation), Brake Pads (206-04 Rear Disc Brake, Removal and Installation), Brake Shoes (206-02 Drum Brake, Removal and Installation).
	• Air in the brake system.	• Bleed the brake. REFER to:(206-00 Brake System - General Information) Brake System Bleeding (General Procedures), Brake System Pressure Bleeding (General Procedures).
• Brakes drag	• Brake booster. • Seized brake caliper/wheel cylinder. • Parking brake control applied/inoperative/over adjusted. • Seized parking brake cables. • Seized brake caliper slide pins.	• GO to Pinpoint Test H.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Excessive brake pedal effort	• Brake booster.	• CHECK the brake booster. Carry out the component test. REPAIR or INSTALL a new brake booster as necessary. REFER to:Brake Booster (206-07 Power Brake Actuation, Removal and Installation).
	• Brake pads or brake shoes.	• INSPECT the brake pads and brake shoes. REFER to: Specifications (206-03 Front Disc Brake, Specifications), Specifications (206-04 Rear Disc Brake, Specifications), Specifications (206-02 Drum Brake, Specifications).
	• Brake booster check valve.	• GO to Pinpoint Test I.
• Slow or incomplete brake pedal return	• Brake booster. • Brake master cylinder.	• GO to Pinpoint Test J.

Pinpoint Tests

PINPOINT TEST A : THE BRAKES PULL OR DRIFT.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: INSPECT THE BRAKE PADS OR BRAKE SHOES	
	1 Check the brake pads or brake shoes for grease or fluid on the linings and excessive wear. • Are the brake pad or brake shoe linings contaminated, or worn excessively? → **Yes** INSTALL new brake pads or brake shoes. REFER to: Brake Pads (206-03 Front Disc Brake, Removal and Installation), Brake Pads (206-04 Rear Disc Brake, Removal and Installation), Brake Shoes (206-02 Drum Brake, Removal and Installation). → **No** GO to A2.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A2: INSPECT THE BRAKE CALIPERS	
	1 Check the brake caliper components for binding, leaking or sticking. • Is there evidence of leaks, or do the pistons and pins bind or stick? → **Yes** INSTALL new pistons or pins as necessary. REFER to: Brake Caliper (206-03 Front Disc Brake, Removal and Installation), Brake Caliper (206-04 Rear Disc Brake, Removal and Installation). TEST the system for normal operation. → **No** GO to A3.
A3: INSPECT THE BRAKE DISCS	
	1 Check the brake discs for damage. • Are the brake discs damaged? → **Yes** INSTALL new brake discs. REFER to: Brake Disc - RWD (206-03 Front Disc Brake, Removal and Installation), Brake Disc - FWD (206-03 Front Disc Brake, Removal and Installation), Brake Disc - FWD (206-04 Rear Disc Brake, Removal and Installation), Brake Disc - RWD (206-04 Rear Disc Brake, Removal and Installation). → **No** GO to A4.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A4: CHECK THE VEHICLE WHEEL ALIGNMENT	
	1 Check the vehicle wheel alignment. • Is the wheel alignment within specification? → **Yes** Vehicle is OK. VERIFY the customer concern. → **No** ADJUST the wheel alignment as necessary. REFER to:(204-00 Suspension System - General Information) Specifications (Specifications), Front Toe Adjustment (General Procedures). TEST the system for normal operation.

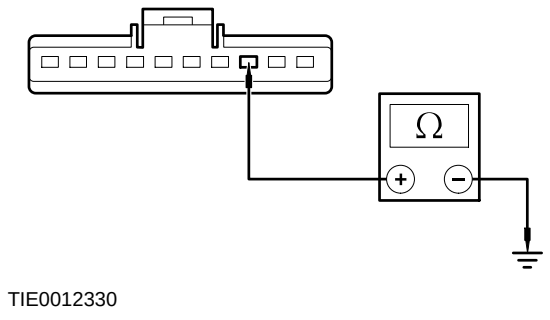
PINPOINT TEST B : THE RED BRAKE WARNING INDICATOR IS ALWAYS ON

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK THE RED BRAKE WARNING INDICATOR	
	1 Ignition switch in position II. • Is the red brake warning indicator on? → **Yes** GO to B2. → **No** Vehicle is OK. VERIFY the customer concern.
B2: CHECK THE AMBER ABS WARNING INDICATOR	
	1 Ignition switch in position II. • Is the amber ABS warning indicator on? → **Yes** REFER to WDS. → **No** GO to B3.
B3: CHECK THE PARKING BRAKE	
	1 Check the parking brake is fully released. • Does the red brake warning indicator go out? → **Yes** Vehicle is OK. TEST the system for normal operation. → **No** GO to B4.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B4: CHECK THE PARKING BRAKE SWITCH FOR SHORT TO GROUND	
	1 Disconnect Parking Brake Warning Indicator Switch. • Does the red brake warning indicator go out? → **Yes** INSTALL a new parking brake warning indicator switch. TEST the system for normal operation. → **No** GO to B5.
B5: CHECK THE BRAKE FLUID LEVEL	
	1 Check the brake fluid level in the brake fluid reservoir. • Is the brake fluid level within specification? → **Yes** GO to B6. → **No** FILL the brake fluid reservoir to the MAX mark.
B6: CHECK THE BRAKE FLUID LEVEL SWITCH FOR SHORT TO GROUND	
	1 Disconnect Brake Fluid Level Switch. • Does the red brake warning indicator go out? → **Yes** INSTALL a new brake fluid level switch. TEST the system for normal operation. → **No** GO to B7.
B7: CHECK CIRCUIT 31S-GC6/31S-GC7 (BK/BU) FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Instrument Cluster (C220b).

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0012330	3 Measure the resistance between the instrument cluster C220b pin 3, circuit 31S-GC6/31S-GC7 (BK/BU) and ground. • Is the resistance greater than 10,000 ohms? → **Yes** INSTALL a new instrument cluster. REFER to:Instrument Cluster (413-01 Instrument Cluster, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit 31S-GC6/31S-GC7 (BK/BU). TEST the system for normal operation.

PINPOINT TEST C : VIBRATION WHEN BRAKES ARE APPLIED

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: ROAD TEST THE VEHICLE	
	1 Road test the vehicle between 40-80 km/h (25-50 mph) without depressing the brakes. • Is a vibration present? → **Yes** TEST for noise, vibration and harshness. REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing). REPEAT the road test if necessary. → **No** GO to C2.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C2: CHECK FOR REAR BRAKE VIBRATION	
	1 Road test the vehicle between 40-80 km/h (25-50 mph) with medium application on the parking brake control only. • Is a vibration present? → **Yes** CHECK the brake drums and brake shoes for excessive wear. REFER to: Specifications (206-03 Front Disc Brake, Specifications), Specifications (206-04 Rear Disc Brake, Specifications), Specifications (206-02 Drum Brake, Specifications). INSTALL new brake drums or brake shoes as necessary. REFER to: Brake Pads (206-03 Front Disc Brake, Removal and Installation), Brake Pads (206-04 Rear Disc Brake, Removal and Installation), Brake Shoes (206-02 Drum Brake, Removal and Installation). TEST the system for normal operation. → **No** GO to C3.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C3: CHECK FOR FRONT BRAKE VIBRATION	
	1 Road test the vehicle between 40-80 km/h (25-50 mph) with light and medium application on the brake pedal. • Is a vibration present? → **Yes** CHECK the brake discs and brake pads for excessive wear. REFER to: Specifications (206-03 Front Disc Brake, Specifications), Specifications (206-04 Rear Disc Brake, Specifications), Specifications (206-02 Drum Brake, Specifications). INSTALL new brake discs or brake pads as necessary. REFER to: Brake Pads (206-03 Front Disc Brake, Removal and Installation), Brake Pads (206-04 Rear Disc Brake, Removal and Installation), Brake Shoes (206-02 Drum Brake, Removal and Installation). TEST the system for normal operation. → **No** Vehicle is OK. VERIFY the customer concern.

PINPOINT TEST D : THE PEDAL GOES DOWN FAST

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: CHECK THE BRAKE PEDAL EFFORT	
	1 Road test the vehicle and depress the brake pedal. • Is the brake pedal effort OK? → **Yes** Vehicle is OK. VERIFY the customer concern. → **No** GO to D2.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D2: CHECK THE BRAKE FLUID LEVEL	
	1 Check the brake fluid level in the brake fluid reservoir. • Is the brake fluid level between the MAX and MIN mark? → **Yes** GO to D3. → **No** INSPECT the brake fluid reservoir sealing points. For additional information, refer to the procedure Brake Master Cylinder component test in this procedure. ADD brake fluid and BLEED the brake system. REFER to:(206-00 Brake System - General Information) Brake System Bleeding (General Procedures), Brake System Pressure Bleeding (General Procedures). INSPECT the brake system for further leaks. TEST the system for normal operation
D3: CHECK THE BRAKE PEDAL HEIGHT - PRESSURIZE THE SYSTEM	
	1 Pump the brake pedal rapidly five times and hold in the depressed position. • Does the brake pedal height build up and then hold? → **Yes** BLEED the brake system. REFER to:(206-00 Brake System - General Information) Brake System Bleeding (General Procedures), Brake System Pressure Bleeding (General Procedures). TEST the system for normal operation. ROAD TEST as necessary. → **No** GO to D4.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D4: CHECK THE BRAKE SYSTEM FOR LEAKS	
	1 Inspect for external brake system leaks. For additional information, refer to the procedure Brake Master Cylinder component test in this section. • Are leaks found? → **Yes** REPAIR as necessary. ADD brake fluid and BLEED the brake system. REFER to:(206-00 Brake System - General Information) Brake System Bleeding (General Procedures), Brake System Pressure Bleeding (General Procedures). TEST the system for normal operation. → **No** GO to D5.
D5: CHECK BRAKE MASTER THE CYLINDER BYPASS CONDITION	
	1 Test for brake master cylinder bypass condition. For additional information, refer to the procedure Brake Master Cylinder component test in this section. • Are any concerns found? → **Yes** INSTALL a new brake master cylinder. REFER to:Brake Master Cylinder (206-06 Hydraulic Brake Actuation, Removal and Installation). → **No** System is OK.

PINPOINT TEST E : THE PEDAL EASES DOWN SLOWLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: CHECK THE BRAKE BOOSTER	
	1 With the engine running, apply and release the brake pedal three times. Slowly apply the brake pedal. • Does the brake pedal continue to gradually apply before holding? → **Yes** System is OK. This is a characteristic of a tandem type brake booster. → **No** GO to E2.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E2: CHECK THE BRAKE PEDAL OPERATION	
	1 Check if the condition occurs during actual stopping application by depressing the brake pedal while the vehicle is moving. • Does the condition occur when the vehicle is moving? → **Yes** GO to E3. → **No** GO to E4.
E3: CHECK THE BRAKE SYSTEM FOR LEAKS	
	1 Check for external brake system leaks. For additional information, REFER to the procedure Brake Master Cylinder component test in this section. • Are leaks found? → **Yes** REPAIR as necessary. ADD brake fluid and BLEED the brake system. REFER to:(206-00 Brake System - General Information) Brake System Bleeding (General Procedures), Brake System Pressure Bleeding (General Procedures). TEST the system for normal operation. → **No** GO to E4.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E4: CHECK THE BRAKE MASTER CYLINDER BYPASS CONDITION	
	1 Test the brake master cylinder bypass condition. For additional information, REFER to the procedure Brake Master Cylinder component test in this section. • Are any concerns found? → **Yes** INSTALL a new brake master cylinder. REFER to:Brake Master Cylinder (206-06 Hydraulic Brake Actuation, Removal and Installation). TEST the system for normal operation. → **No** System is OK.

PINPOINT TEST F : THE PEDAL IS LOW OR FEELS SPONGY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F1: CHECK FOR SPONGY BRAKE PEDAL FEEL	
	1 Road test the vehicle and depress the brake pedal. • Is the brake pedal effort normal? → **Yes** Vehicle is OK. VERIFY the customer concern. → **No** GO to F2.
F2: CHECK BRAKE PEDAL RESERVE	
NOTE: The increased resistance may feel like the brake pedal has bottomed out.	
	1 Ignition switch in position III.
	2 Engine at idle.
	3 Pump the brake pedal lightly three or four times.
	4 Wait 15 seconds for the vacuum to replenish.
	5 Depress the brake pedal until it stops moving downwards or an increased resistance to the brake pedal travel occurs.
	6 Hold the brake pedal in the depressed position while increasing the engine speed to 2000 rpm.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	7 Release the accelerator pedal. • Does the brake pedal move downwards as the engine speed returns to idle? → **Yes** GO to F3. → **No** CHECK the vacuum to the brake booster. For additional information, REFER to the procedure Brake Booster component test in this procedure.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F3: CHECK THE BRAKE FLUID LEVEL	
	1 Check the brake fluid reservoir fluid level. • Is the brake fluid level between the MAX and MIN mark? → **Yes** BLEED the brake system. REFER to:(206-00 Brake System - General Information) Brake System Bleeding (General Procedures), Brake System Pressure Bleeding (General Procedures). TEST the system for normal operation. → **No** CHECK the brake fluid reservoir sealing points. For additional information, REFER to the procedure Brake Master Cylinder component test in this procedure. ADD fluid and BLEED the brake system. REFER to:(206-00 Brake System - General Information) Brake System Bleeding (General Procedures), Brake System Pressure Bleeding (General Procedures). TEST the system for normal operation. ROAD TEST as necessary. REFER to:Road/Roller Testing (100-00 General Information, Description and Operation).

PINPOINT TEST G : BRAKE LOCKUP DURING LIGHT BRAKE PEDAL FORCE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G1: TEST BRAKE LOCKUP	
	1 Road test the vehicle and depress the brake pedal lightly. • Do the rear brakes lockup? → **Yes** GO to G2. → **No** Vehicle is OK. VERIFY the customer concern.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G2: INSPECT THE BRAKE PADS OR BRAKE SHOES	
	1 Inspect the brake pads and brake shoes for grease or fluid on the linings and wear concerns, correct installation, damage, correct size and type. • Are any concerns found? → **Yes** INSTALL new brake shoes. REFER to: Brake Pads (206-03 Front Disc Brake, Removal and Installation), Brake Pads (206-04 Rear Disc Brake, Removal and Installation), Brake Shoes (206-02 Drum Brake, Removal and Installation). TEST the system for normal operation. ROAD TEST as necessary. → **No** GO to G3.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G3: CHECK THE BRAKE LOAD SENSOR PROPORTIONING VALVE	
	1 Check the brake load sensor proportioning valve for correct installation and adjustment. REFER to:Brake Load Sensor Proportioning Valve Adjustment (206-00 Brake System - General Information, General Procedures). • Is the brake load sensor proportioning valve correctly adjusted? → **Yes** INSTALL a new brake load sensor proportioning valve. TEST the system for normal operation. → **No** ADJUST the brake load sensor proportioning valve. REFER to:Brake Load Sensor Proportioning Valve Adjustment (206-00 Brake System - General Information, General Procedures).

PINPOINT TEST H : BRAKE DRAG

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
H1: ROAD TEST THE VEHICLE	
	1 Road test the vehicle and apply the brakes. • Are the brakes functioning correctly? → **Yes** Vehicle is OK. VERIFY the customer condition. → **No** INSPECT individual wheel cylinders or brake calipers and INSTALL new wheel cylinders or brake calipers as necessary. REFER to: Brake Caliper (206-03 Front Disc Brake, Removal and Installation), Brake Caliper (206-04 Rear Disc Brake, Removal and Installation), Wheel Cylinder (206-02 Drum Brake, Removal and Installation). GO to H2.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
H2: CHECK THE BRAKE BOOSTER	
	1 Check the brake booster actuating rod alignment and travel. • Is the actuating rod OK? → **Yes** Vehicle is OK. VERIFY the customer condition. → **No** INSTALL a new brake booster. REFER to:Brake Booster (206-07 Power Brake Actuation, Removal and Installation). TEST the system for normal operation.

PINPOINT TEST I : EXCESSIVE BRAKE PEDAL EFFORT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I1: CHECK THE VACUUM	
	1 Disconnect the vacuum hose from the brake booster.
	2 Connect the vacuum/pressure tester to the vacuum hose.
	3 Ignition switch in position III.
	4 Run the engine at normal operating temperature.
	5 Record the vacuum reading. • Is the vacuum reading 40.5kPa (12in-Hg)? → **Yes** GO to I2. → **No** LOCATE and REPAIR the source of low vacuum. TEST the system for normal operation.
I2: INSPECT THE VACUUM SYSTEM	
	1 Ignition switch in position 0.
	2 Reconnect the vacuum hose.
	3 Inspect the brake booster, rubber grommet, and all vacuum hoses for cracks, holes, bad connections, or missing clamps.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Pump the brake pedal five times to exhaust the vacuum and hold in the depressed position. • Does the brake pedal move down when the engine is started? → **Yes** Vacuum system is OK. → **No** GO to I3.
I3: CHECK THE BRAKE BOOSTER CHECK VALVE	
	1 Check the brake booster check valve. For additional information, REFER to the procedure Brake Booster component test in this section. • Is the brake booster check valve OK? → **Yes** CHECK the brake booster. For additional information, REFER to the procedure Brake Booster component Test in this section. INSTALL a new brake booster as necessary. REFER to:Brake Booster (206-07 Power Brake Actuation, Removal and Installation). TEST the system for normal operation. → **No** INSTALL a new brake booster check valve. TEST the system for normal operation.

PINPOINT TEST J : SLOW OR INCOMPLETE BRAKE PEDAL RETURN

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
J1: CHECK THE BRAKE PEDAL RETURN	
	1 Ignition switch in position III.
	2 Run the engine at fast idle while making several brake applications.
	3 Pull the brake pedal rearward with approximately 44.5 N (10lb) of force.
	4 Release the brake pedal and measure the pedal travel. From the floor pan to the pedal rubber.
	5 Make a hard brake application.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	6 Release the brake pedal and measure the brake pedal travel. The brake pedal should return to its original position. • Does the brake pedal return to its original position? → **Yes** Vehicle is OK. VERIFY the customer concern. → **No** GO to J2.
J2: CHECK FOR BRAKE PEDAL BINDING	
	1 Check the brake pedal to make sure it is operating freely. • Is the brake pedal operating freely? → **Yes** INSTALL a new brake booster. REFER to:Brake Booster (206-07 Power Brake Actuation, Removal and Installation). TEST the system for normal operation. → **No** REPAIR or INSTALL new brake pedal bushings. REFER to:Brake Pedal and Bracket (206-06 Hydraulic Brake Actuation, Removal and Installation). TEST the system for normal operation.

Component Tests

Brake Booster

1. Inspect all hoses and connections. All unused vacuum connectors should be capped. Hoses and their connections should be correctly secured and in good condition with no holes and no collapsed areas. Inspect the brake booster check valve for damage.
2. Check the hydraulic brake system for leaks or low fluid.
3. With the transmission in PARK (automatic transmission), stop the engine and operate the parking brake. Operate the brake pedal several times to exhaust all vacuum in the system.
4. With the engine turned OFF and all vacuum in the system exhausted, operate the brake pedal and hold it down. Start the engine. If the vacuum system is operating, the brake pedal will tend to move downward under constant foot pressure. If no motion is felt, the vacuum booster system is not functioning.
5. Remove the vacuum hose from the brake booster. Manifold vacuum should be available at the brake booster end of the hose with the engine at idle speed and the transmission in PARK or NEUTRAL. Make sure that all unused vacuum outlets are correctly capped, hose connectors are correctly secured and vacuum hoses are in good condition. When it is established that manifold vacuum is available to the brake booster, connect the vacuum hose to the brake booster and repeat Step 3. If no downward movement of the brake pedal is felt, the vacuum booster system is not functioning.
6. Run the engine for a minimum of 10 seconds at fast idle. Stop the engine and let the vehicle stand for 10 minutes. Then, operate the brake pedal with approximately 89N (20 lb) of force. The pedal feel (brake applications) should be

DIAGNOSIS AND TESTING

the same as noted with the engine running. If the brake pedal feels hard (no power assist), install a new check valve and then repeat the testing. If the brake pedal stills feels hard, install a new brake booster. If the brake pedal movement feels spongy, bleed the brake system. REFER to:(206-00 Brake System - General Information)

Brake System Bleeding (General Procedures), Brake System Pressure Bleeding (General Procedures).

Brake Master Cylinder

NOTE: Before carrying out any diagnosis, make sure the brake system warning indicator is functional.

Usually, the first and strongest indicator of anything wrong in the brake system is a feeling through the brake pedal. In diagnosing the condition of the brake master cylinder, check brake pedal feel as evidence of a brake concern.

Check for brake warning indicator illumination and the brake fluid level in the brake fluid reservoir.

Normal Conditions

The following conditions are considered normal and are not indications that the brake master cylinder is in need of repair.

1. New brake systems are not designed to produce as hard a pedal effort as in the past. Complaints of light pedal efforts should be compared to pedal efforts of another vehicle, same model and year.
2. During normal operation of the brake master cylinder, the brake fluid level in the reservoir will rise during brake application and fall during release. The net brake fluid level (after brake application and release) will remain unchanged.
3. A trace of brake fluid exists on the brake booster shell below the master cylinder mounting flange. This results from the normal lubricating action of the master cylinder bore end seal.
4. Brake fluid level will fall with brake pad and brake shoe wear.

Abnormal Conditions

Changes in brake pedal feel or travel are indicators that something could be wrong in the brake system. The diagnostic procedure and techniques are brake pedal feel, brake warning indicator illumination and low brake fluid level as indicators in diagnosing brake system concerns. The following conditions are considered abnormal and indicate that the brake master cylinder is in need of repair.

5. Brake pedal goes down fast. This could be caused by an external or internal leak.
6. Brake pedal eases down slowly. This could be caused by an external or internal leak.
7. Brake pedal is low or feels spongy. This condition may be caused by no fluid in the brake master cylinder reservoir, brake fluid reservoir cap vent holes blocked or air in the hydraulic system.
8. Brake pedal effort is excessive. This may be caused by a bind or obstruction in pedal or linkage, blocked fluid control valve or insufficient brake booster vacuum.
9. Rear brakes lock up during light pedal force. This may be caused by grease or fluid on brake shoes, damaged brake shoes and linings, incorrectly adjusted parking brakes, damaged, contaminated brake pressure control valve.
10. Brake pedal effort is erratic. This condition could be caused by the brake booster being in operative, extreme brake caliper piston knock back or incorrectly installed brake shoes.
11. Brake warning indicator is always ON. This may be caused by low fluid level, ignition wire routing too close to the fluid level indicator, or float assembly damage.

Bypass Condition Test

12. Check the brake fluid level in the brake fluid reservoir. Fill the brake fluid reservoir to the MAX mark if low or empty.
13. Observe the brake fluid level in the brake fluid reservoir. If after several brake applications, the brake fluid level remains the same, measure the wheel turning torque required to rotate the wheels with rearward with brakes applied as follows:
    1. Place the transmission in NEUTRAL and raise and support the vehicle.

       REFER to:Lifting (100-02 Jacking and Lifting, Description and Operation).
    2. Operate the brakes with a minimum of 445 N (100 lb) and hold for approximately 15 seconds. With the brakes still applied, exert torque on the front wheels to 102 Nm (75 lb-ft). If either wheel rotates, install a new brake master cylinder.

DIAGNOSIS AND TESTING

Non-Pressure Leaks

Any empty brake fluid reservoir condition may be the result of two types of non-pressure external leaks.

- Type 1: An external leak may occur at the brake fluid reservoir cap because of incorrect positioning of the gasket and cap. Reposition the gasket and cap.
- Type 2: An external leak may occur at the brake fluid reservoir mounting seals, install new seals

GENERAL PROCEDURES

Brake System Leak Check

Check

1. NOTE:Brake fluid is water soluble and it is possible that all evidence of fluid leakage has been washed off if the vehicle has been operated in rain or snow.

   Check the brake fluid level. Add brake fluid as necessary.

2. Apply the brakes several times and make sure the pedal feel is not spongy. If necessary, bleed the brake system.

   For additional information, refer to**Brake System Bleeding**in this section.

3. Check the brake fluid level and verify that the fluid level is actually dropping.

4. NOTE:If the brake fluid level drops and no external leak is evident, check for a brake master cylinder bore end seal leak.

   Locate and correct the external leak.

GENERAL PROCEDURES

Brake Load Sensor Proportioning Valve Adjustment (12 136 0)

Materials	
Name	**Specification**
Adhesive - Loctite 243	WSK-M2G349-A7

Adjustment

1. **Raise and support the vehicle.**

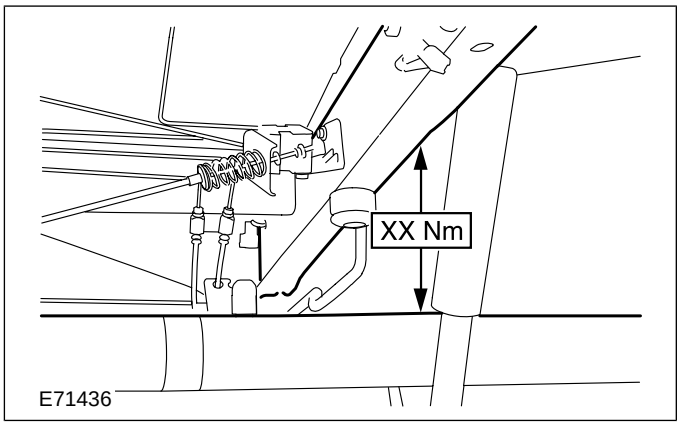
   For additional information, refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

2. **NOTE:Make sure the rear axle is raised evenly on each end of the rear axle tubes.**

   Using a suitable trolley jack, raise the rear axle evenly until the appropriate unladen ride height is obtained on both sides.

   For additional information, refer to:Specifications (206-00 Brake System - General Information, Specifications).

   - XX = Unladen ride height.



3. **WARNINGS:**

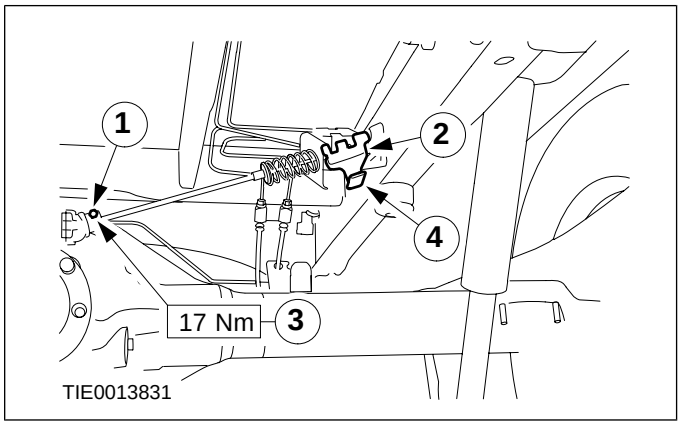
   Incorrect adjustment of the brake load sensor proportioning valve will result in inefficient braking. Only use the adjustment spacer supplied with the vehicle to adjust the brake load sensor proportioning valve. Failure to follow this instruction may result in personal injury.

   Incorrect tightening of the brake load sensor proportioning valve setting screw will result in inefficient braking. Make sure the setting screw is clean and free from foreign material before tightening. Failure to follow this instruction may result in personal injury.

NOTE: The adjustment spacer sets the brake load sensor proportioning valve linkage to the correct measurement with the vehicle in an unladen ride height condition.

Adjust the brake load sensor proportioning valve.

1. Remove and clean the setting screw.
   - Remove all traces of used adhesive.
2. Install the spacer.
3. Install the setting screw.
   - Apply adhesive to the screw thread.
4. Remove the spacer.

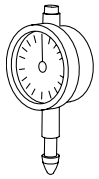
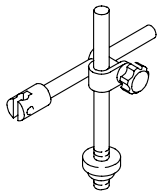
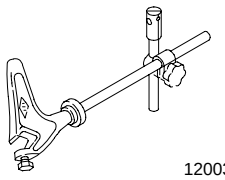


4. **Lower the vehicle.**

GENERAL PROCEDURES

Brake Disc Runout Check (12 221 0)

Special Tool(s)

 15046	Dial Indicator Gauge (Metric) 205-069 (15-046)
 15022A	Holding Fixture, Dial Indicator Gauge 205-070 (15-022A)
 12003	Holding Fixture, Dial Indicator Gauge (Disc Brake) 206-003 (12-003)

General Equipment

Micrometer 0-125 mm

Check

1. **Remove the wheel and tire.**

   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

2. **Remove the brake pads. For additional information, refer to:**

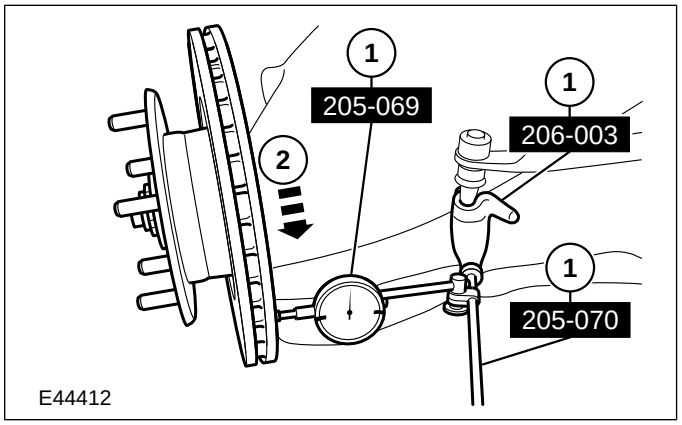
   Brake Pads (206-03 Front Disc Brake, Removal and Installation),
   Brake Pads (206-04 Rear Disc Brake, Removal and Installation).

3. **NOTE:The total dial indicator gauge reading should not exceed specification. For additional information, refer to:**

   Specifications (206-03 Front Disc Brake, Specifications),
   Specifications (206-04 Rear Disc Brake, Specifications).

Using the special tools, measure the brake disc runout on the inner face of the brake disc.

1. Position the dial indicator gauge so that it contacts the brake disc approximately 10 mm from the outer edge.
2. Slowly rotate the brake disc and note the readings.

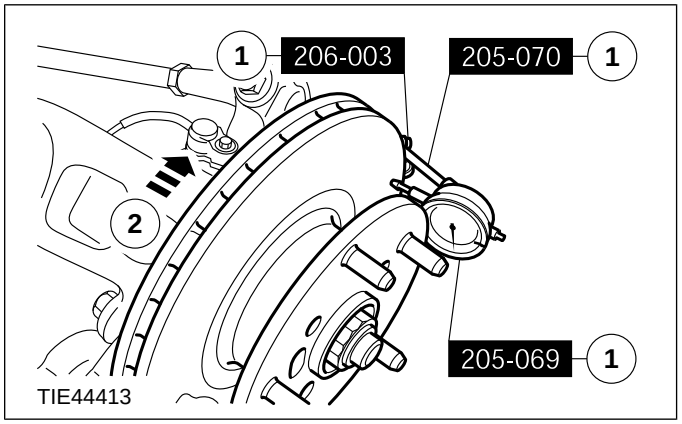


4. **NOTE:The total dial indicator gauge reading should not exceed specification. For additional information, refer to:**

   Specifications (206-03 Front Disc Brake, Specifications),
   Specifications (206-04 Rear Disc Brake, Specifications).

Using the special tools, measure the brake disc runout on the inner and outer faces of the brake disc (outer face measurement shown).

1. Position the dial indicator gauge so that it contacts the brake disc approximately 10 mm from the outer edge.
2. Slowly rotate the brake disc and note the readings.



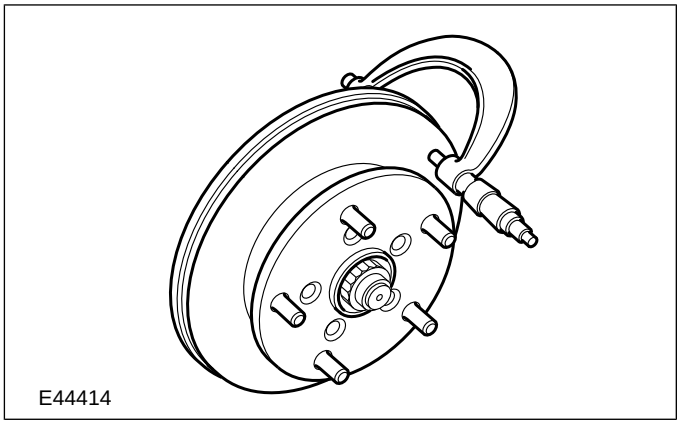
GENERAL PROCEDURES

5. **NOTE:If any of the measurements exceed the run out specification of 0.10 mm or the brake disc thickness variation is more than 0.02 mm, a new brake disc must be installed and the brake disc runout re-checked.**

   Check the brake disc thickness variation. For additional information, refer to:

   Specifications (206-03 Front Disc Brake, Specifications),
   Specifications (206-04 Rear Disc Brake, Specifications).

   - Using a suitable micrometer, measure the brake disc thickness at eight positions, 45 degrees apart and approximately 15 mm from the outer edge of the brake disc.



6. **If all the brake disc runout measurements and the thickness variation are within the specifications, check the wheel balance.**

GENERAL PROCEDURES

Brake System Bleeding (12 141 0)

General Equipment

Worldwide Diagnostic System (WDS)

Bleeding

All Vehicles

WARNING:Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

CAUTION:If brake fluid is spilt on the paintwork, the affected area must be immediately washed down with cold water.

NOTE: Make sure that the vehicle is standing on a level surface.

NOTE: The system consists of separate circuits for each front and diagonally opposite rear wheel. Each circuit can be bled independently.

1. **CAUTION:The brake fluid reservoir must remain full with new, clean brake fluid at all times during bleeding.**

   Install the bleed tube to the bleed nipple.
2. **Immerse the end of the bleed tube in a bleed jar containing a small quantity of approved brake fluid.**
3. **Position the bleed jar base at least 300 mm above the bleed nipple to maintain fluid pressure and prevent air leaking past the threads of the bleed nipple.**
4. **Loosen the rear left bleed nipple by one-half turn.**
5. **Operate the brake pedal fully (pumping brake fluid and air into the bleed jar) and allow the brake pedal to return to the rest position.**
6. **NOTE:Rear brakes only.**

   Rapidly operate the parking brake control several times.
7. **Fill the brake fluid reservoir to the MAX mark.**
8. **Continue operating the brake pedal until air-free fluid is being pumped into the bleed jar.**
9. **With the brake pedal fully depressed tighten the bleed nipple.**
10. **CAUTION:Make sure that the bleed nipple cap is installed after bleeding the brake line(s). This will prevent corrosion to the bleed nipple. Failure to follow this instruction may result in the bleed nipple becoming seized.**

    Repeat the procedure for the remaining brake lines in the following order:

    1. Front left.
    2. Front right.
    3. Rear right.

Vehicles with anti-lock brakes

11. **NOTE:This step is only necessary when changing the brake fluid to remove the used brake fluid from the hydraulic control unit (HCU).**

    Using WDS, bleed the brake system.

GENERAL PROCEDURES

Brake System Pressure Bleeding (12 141 0)

General Equipment

Worldwide Diagnostic System (WDS)
Brake/clutch system pressure bleeder/filler

Bleeding

All vehicles

WARNING:Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

CAUTION:If brake fluid is spilt on the paintwork, the affected area must be immediately washed down with cold water.

NOTE: Make sure that the vehicle is standing on a level surface.

NOTE: The system consists of separate circuits for each front and diagonally opposite rear wheel. Each circuit can be bled independently.

1. **Fill the brake fluid reservoir to the MAX mark.**
2. **CAUTIONS:**

   Make sure that the pressure within the brake system does not exceed 1 bar.

   Make sure that the pressure bleeding equipment is filled with new brake fluid to the correct specification.

   Using the brake/clutch system pressure bleeder/filler, pressure bleed the system in accordance with the manufacturer's instructions in the following order:

   1. Rear left.
      - Rapidly operate the parking brake control several times.
   2. Front left.
   3. Front right.
   4. Rear right.
      - Rapidly operate the parking brake control several times.

CAUTION:Make sure that the bleed nipple cap is installed after bleeding the brake line(s). This will prevent corrosion to the bleed nipple. Failure to follow this instruction may result in the bleed nipple becoming seized.

3. **Fill the brake fluid reservoir to the MAX mark as necessary.**

Vehicles with anti-lock brakes

4. **NOTE:This step is only necessary when changing the brake fluid to remove the used brake fluid from the hydraulic control unit (HCU).**

   Using WDS, bleed the brake system.

SECTION 206-03 Front Disc Brake

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 206-03-2

DESCRIPTION AND OPERATION

Front Disc Brake 206-03-3

DIAGNOSIS AND TESTING

Front Disc Brake 206-03-4

REMOVAL AND INSTALLATION

Brake Pads ..... (12 234 0) 206-03-5
Brake Caliper ..... (12 243 0) 206-03-6
Brake Caliper Anchor Plate 206-03-7
Brake Disc — RWD ..... (12 223 0) 206-03-8

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Super DOT 4 brake fluid	ESD-M6C57-A
High temperature grease	ESE-M12A4-A

Front Disc Brake Specification

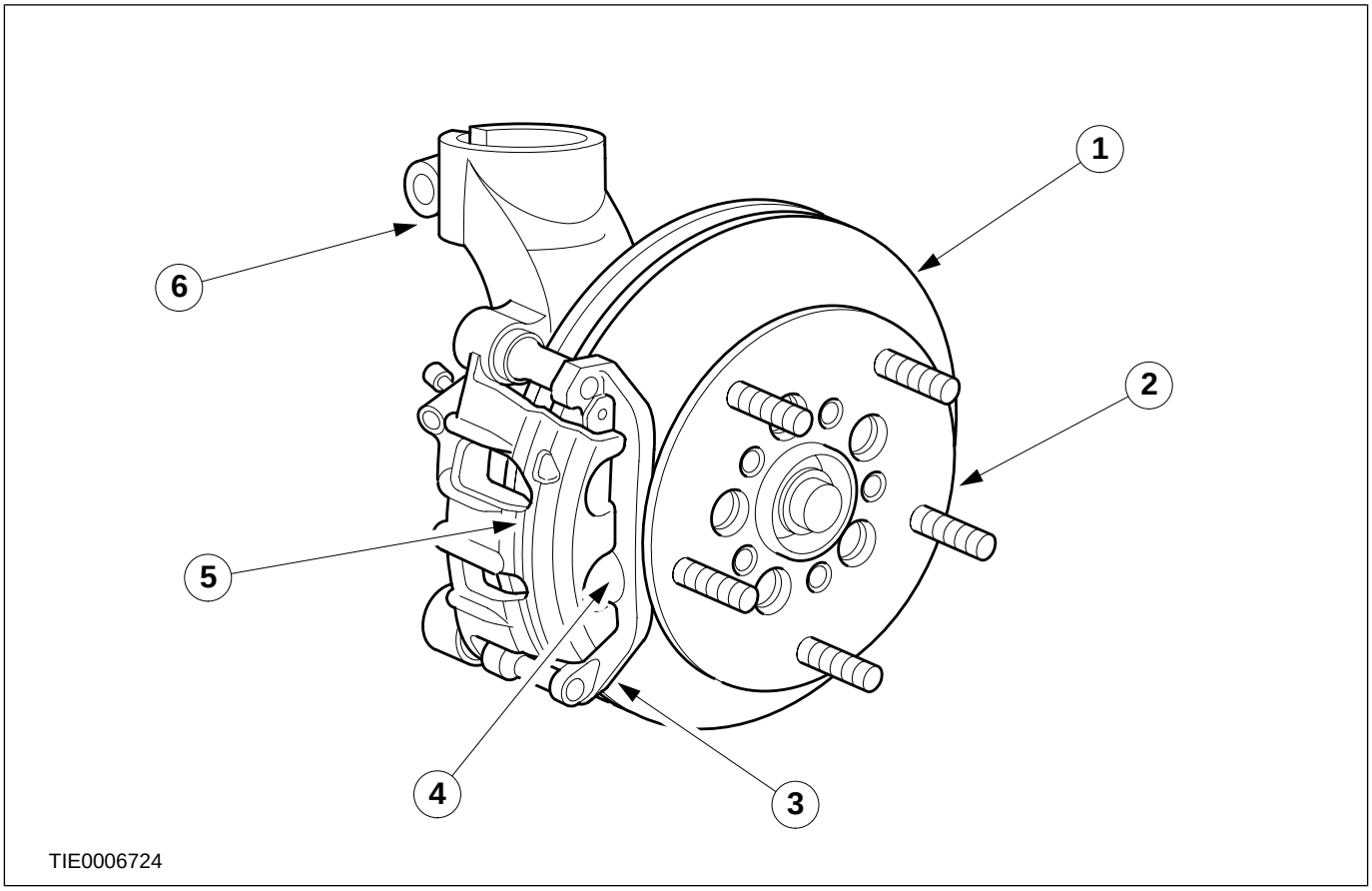
Brake disc diameter - 1 Tonne vehicles	280 mm
Brake disc diameter - 2 Tonne vehicles with FWD	300 mm
Brake disc diameter - RWD vehicles	300 mm
Brake disc diameter - AWD vehicles	300 mm
New brake disc nominal thickness	28 mm
Worn brake disc discard thickness *	25 mm
Maximum brake disc thickness variation	0.020 mm
Worn brake pad discard thickness *	1.5 mm
Maximum brake disc runout (installed)	0.1 mm
*When the discard thickness has been reached, install a new brake disc/brake pads.	

Torque Specifications

Description	Nm	lb-ft	lb-in
Brake caliper anchor plate bolts	175	129	-
Brake hose to brake caliper union	17	13	-
Brake caliper housing bolts	60	44	-
Brake disc retaining bolts	80	59	-
Wheel hub and brake disc assembly bolts	53	39	-
Halfshaft retaining nut - FWD	420	310	-
Wheel spindle retaining nut - RWD	420	310	-
Wheel spindle retaining nut - AWD	420	310	-

DESCRIPTION AND OPERATION

Front Disc Brake



Item	Description
1	Brake disc
2	Wheel hub
3	Brake caliper anchor plate
4	Brake pad
5	Brake caliper
6	Wheel knuckle

DIAGNOSIS AND TESTING

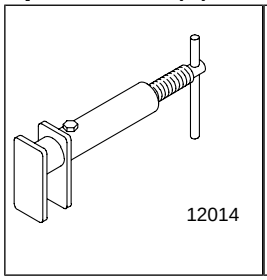
Front Disc Brake

REFER to Section 206-00 [Brake System - General Information].

REMOVAL AND INSTALLATION

Brake Pads (12 234 0)

Special Tool(s)

 12014	Retractor, Caliper Piston 206-005 (12-014)

Materials	
Name	**Specification**
Super DOT 4 brake fluid	ESD-M6C57-A

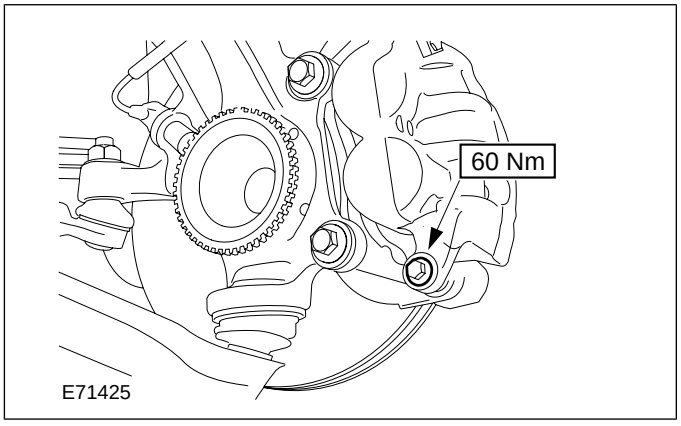
Removal

CAUTION:If brake fluid is spilt on the paintwork, the affected area must be immediately washed down with cold water.

1. **Remove the wheel and tire.**

   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

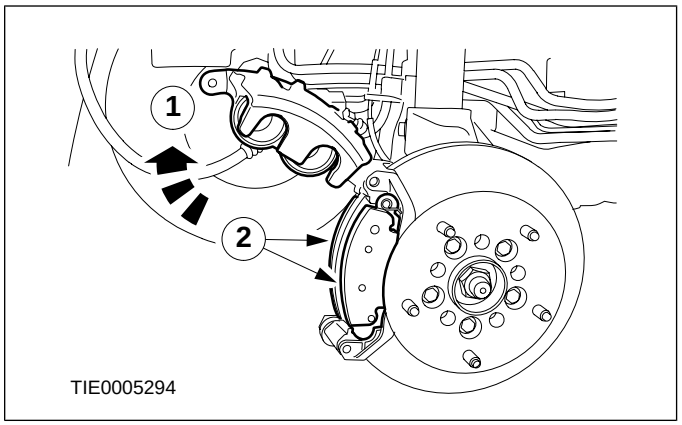
2. **Remove the brake caliper lower bolt.**
   - Discard the brake caliper lower bolt.



3. **NOTE:A brake wear indicator is fitted to the inner brake pad.**

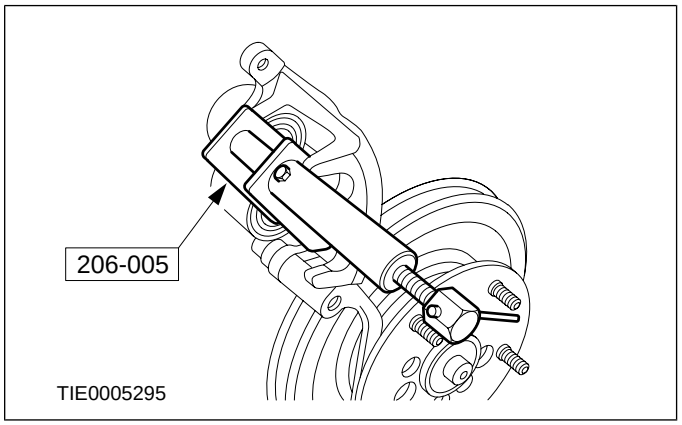
   Remove the brake pads.

   1. Rotate the brake caliper upwards.
   2. Remove the brake pads.



4. **CAUTION:When the brake caliper pistons are retracted into the piston housing, brake fluid will be displaced into the brake fluid reservoir.**

   Using the special tool, fully retract the brake caliper pistons.



Installation

1. **NOTE:Install a new brake caliper lower bolt.**

   To install, reverse the removal procedure.

2. **Install the wheel and tire.**

   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

3. **Depress the brake pedal, check the fluid level in the brake fluid reservoir and top up if necessary with brake fluid.**

REMOVAL AND INSTALLATION

Brake Caliper (12 243 0)

General Equipment

Brake hose clamp

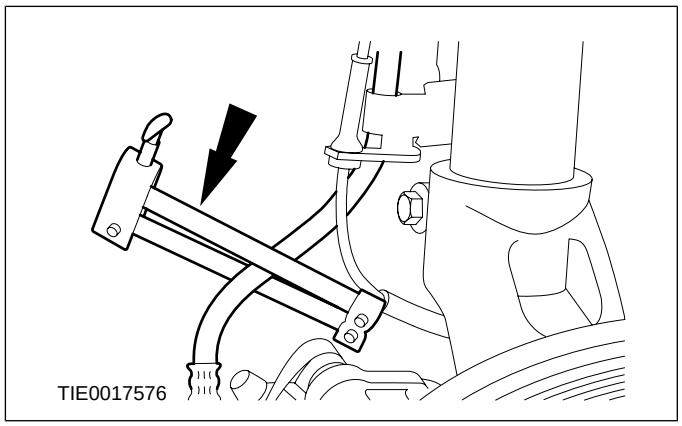
Removal

CAUTION:If brake fluid is spilt on the paintwork, the affected area must be immediately washed down with cold water.

1. **Remove the brake pads.**

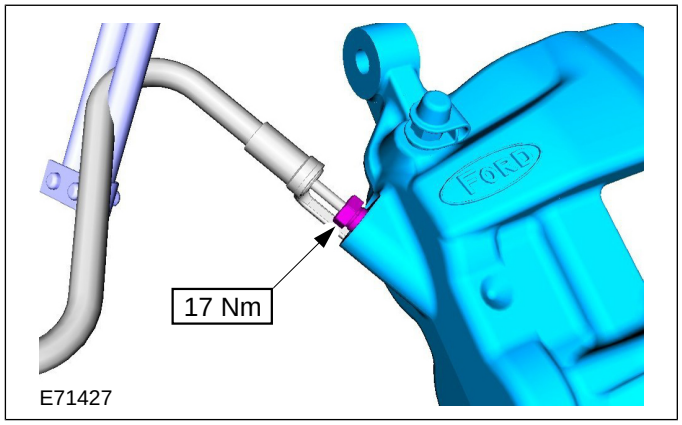
   For additional information, refer to:Brake Pads (206-03 Front Disc Brake, Removal and Installation).

2. **Using a suitable brake hose clamp, clamp the brake hose.**

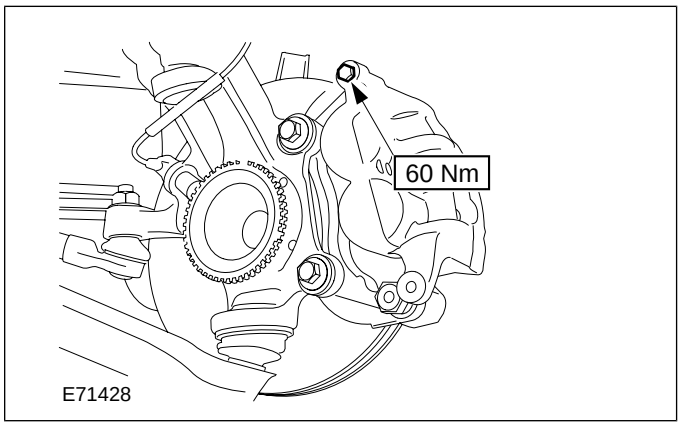


3. **CAUTION:Cap the brake hose to prevent fluid loss or dirt ingress.**

   Disconnect the brake hose from the brake caliper.



4. **Remove the brake caliper.**



Installation

1. **To install, reverse the removal procedure.**
2. **Bleed the brake system.**

   For additional information, refer to:Brake System Bleeding (206-00, General Procedures).

REMOVAL AND INSTALLATION

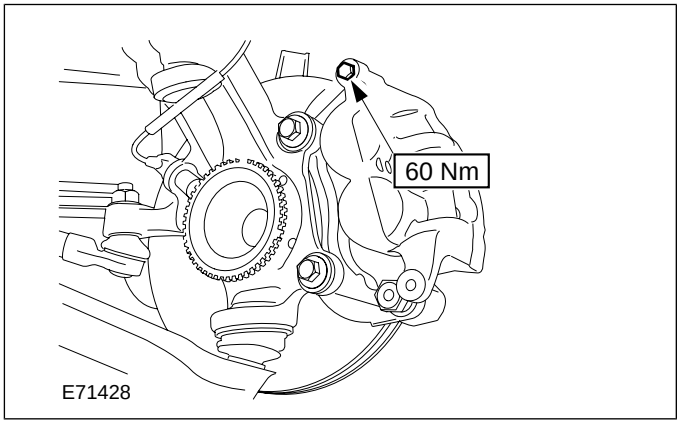
Brake Caliper Anchor Plate

Removal

1. **Remove the brake pads.**

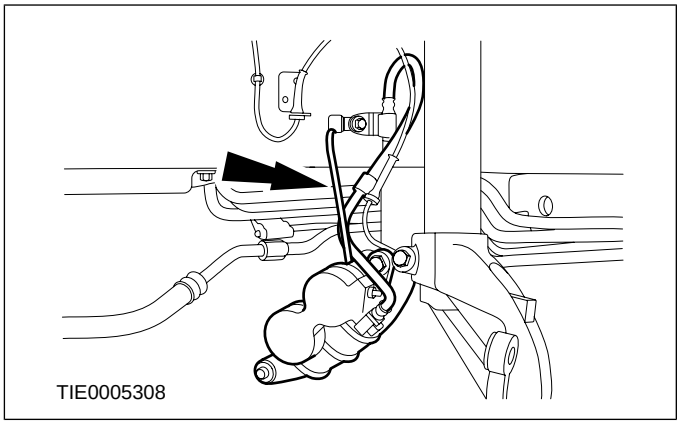
   For additional information, refer to:Brake Pads (206-03 Front Disc Brake, Removal and Installation).

2. **Detach the brake caliper from the brake caliper anchor plate.**

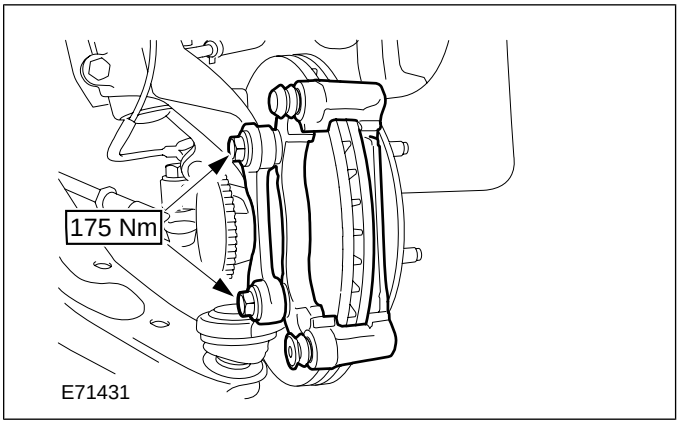


3. **CAUTION:Suspend the brake caliper to prevent load being placed on the brake hose.**

   Suspend the brake caliper.



4. **Remove the brake caliper anchor plate.**



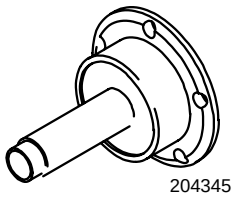
Installation

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

Brake Disc — RWD (12 223 0)

Special Tool(s)

 204345	Remover, Wheel Bearing 204-345A

General Equipment

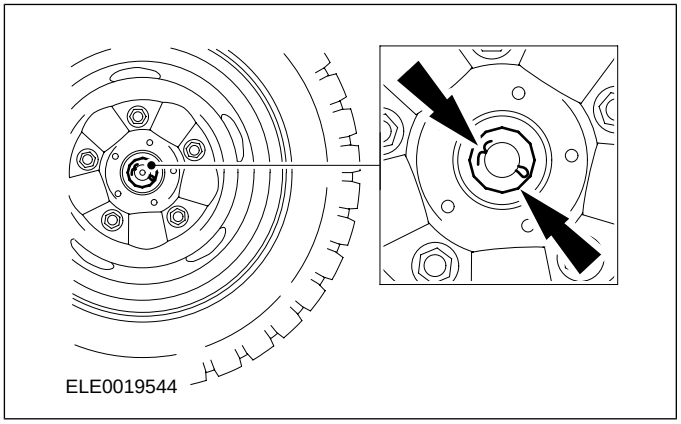
Press

Materials

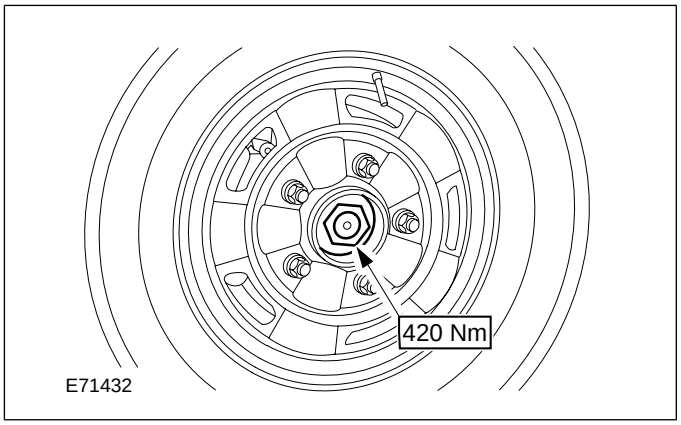
Name	Specification
High temperature grease	ESE-M12A4-A

Removal

1. **Remove the wheel spindle retaining nut locking ring.**
   - Discard the cotter pin.



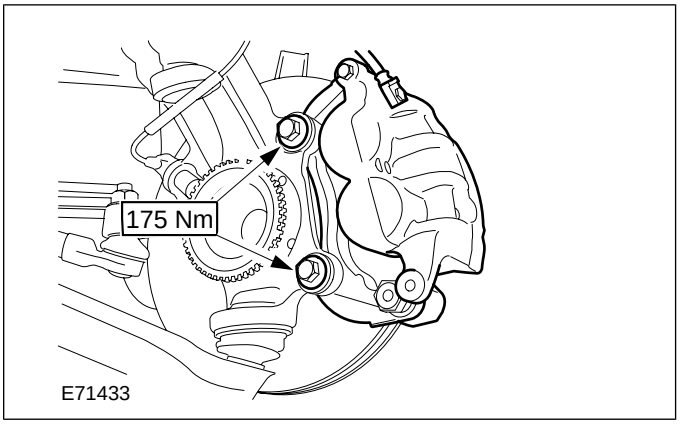
2. **Loosen the wheel spindle retaining nut.**



3. **Remove the wheel and tire.**

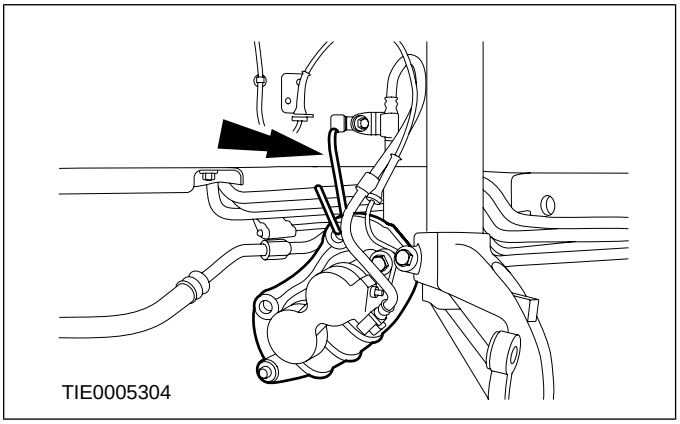
   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

4. **Detach the brake caliper and anchor plate from the wheel knuckle.**



5. **⚠CAUTION:Suspend the brake caliper and anchor plate to prevent load being placed on the brake hose.**

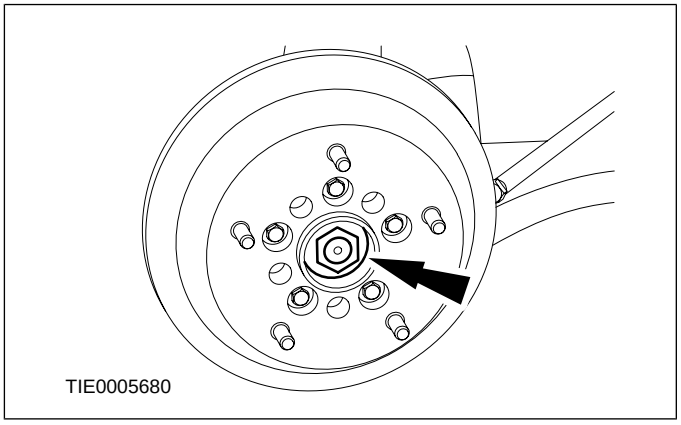
   Suspend the brake caliper and anchor plate.



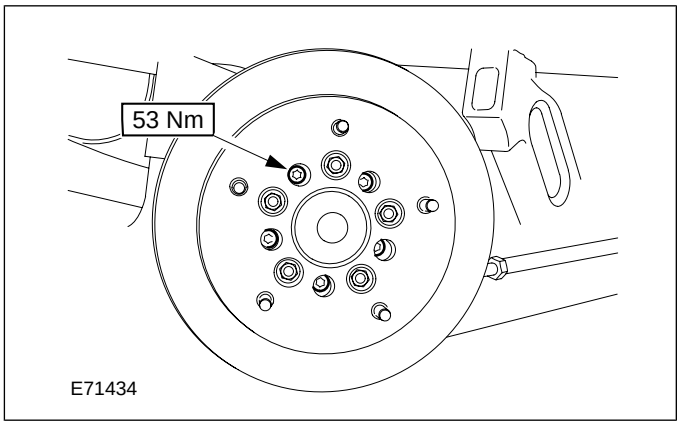
6. **Remove the wheel spindle.**

REMOVAL AND INSTALLATION

- Remove the wheel spindle retaining nut and washer.

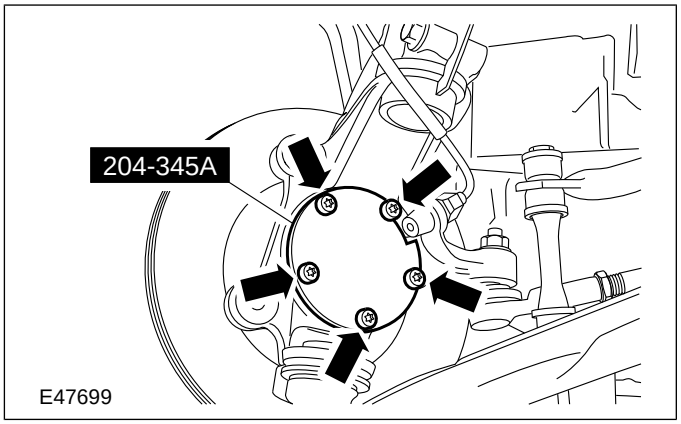


7. **Remove the wheel hub and brake disc assembly retaining bolts.**



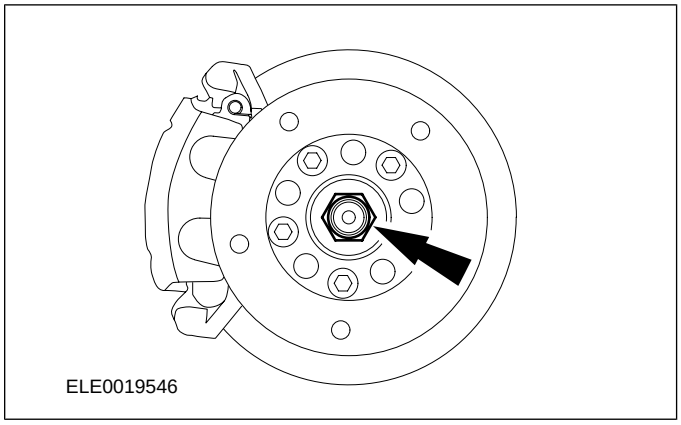
8. **CAUTION:Make sure that the special tool cut out is aligned with the wheel speed sensor.**

   Using the wheel hub retaining bolts, install the special tool.

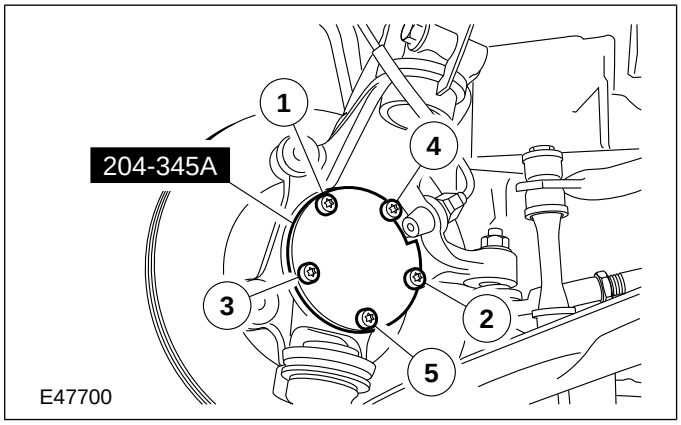


9. **WARNING:Install the wheel spindle retaining nut to the special tool. Failure to follow this instruction may result in personal injury.**

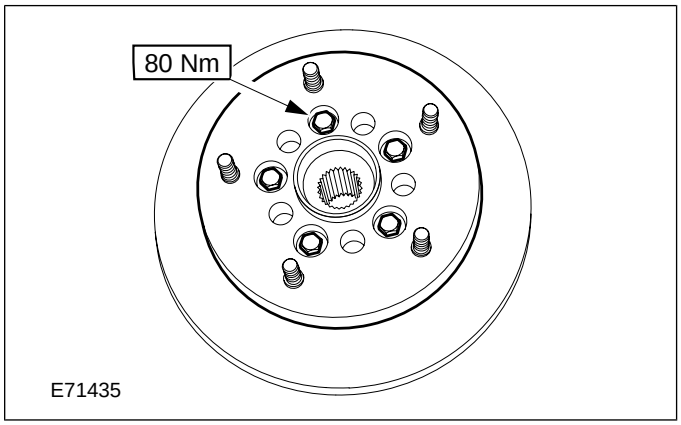
   Attach the wheel spindle retaining nut to the special tool.



10. **Tighten the retaining bolts in the sequence shown.**

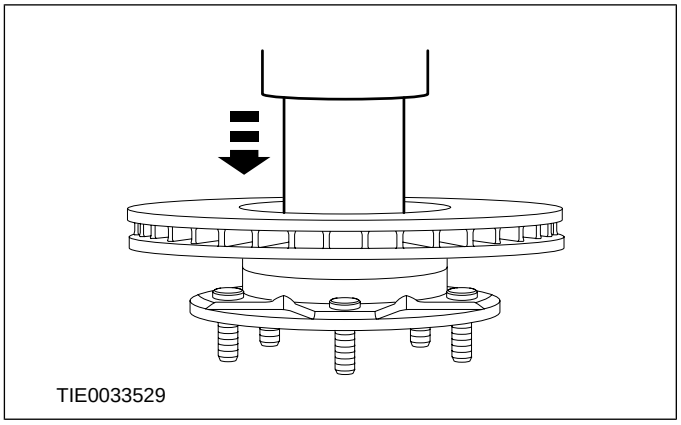


11. **Remove the special tool.**
12. **Remove the brake disc retaining bolts.**



REMOVAL AND INSTALLATION

13. **Using a suitable press and drift, remove the brake disc.**



Installation

1. **NOTE:Apply high temperature grease to the mating surfaces of the wheel bearing housing and the wheel knuckle.**

NOTE: Install a new cotter pin.

To install, reverse the removal procedure.

SECTION 206-04 Rear Disc Brake

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 206-04-2

DESCRIPTION AND OPERATION

Rear Disc Brake..... 206-04-3

DIAGNOSIS AND TESTING

Rear Disc Brake..... 206-04-5

REMOVAL AND INSTALLATION

Brake Pads..... (12 238 0) 206-04-6
Brake Caliper..... 206-04-8
Brake Disc — RWD..... 206-04-10

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Super DOT 4 Brake Fluid	ESD-M6C57-A

Rear Disc Brake Specification

Description	
Brake disc diameter	280 mm
New brake disc nominal thickness	16 mm
Worn brake disc discard thickness*	13 mm
Maximum brake disc thickness variation	0.020 mm
Worn brake pad discard thickness*	1.5 mm
Maximum brake disc runout (installed)	0.1 mm

* When the discard thickness has been reached, install a new brake disc/brake pads.

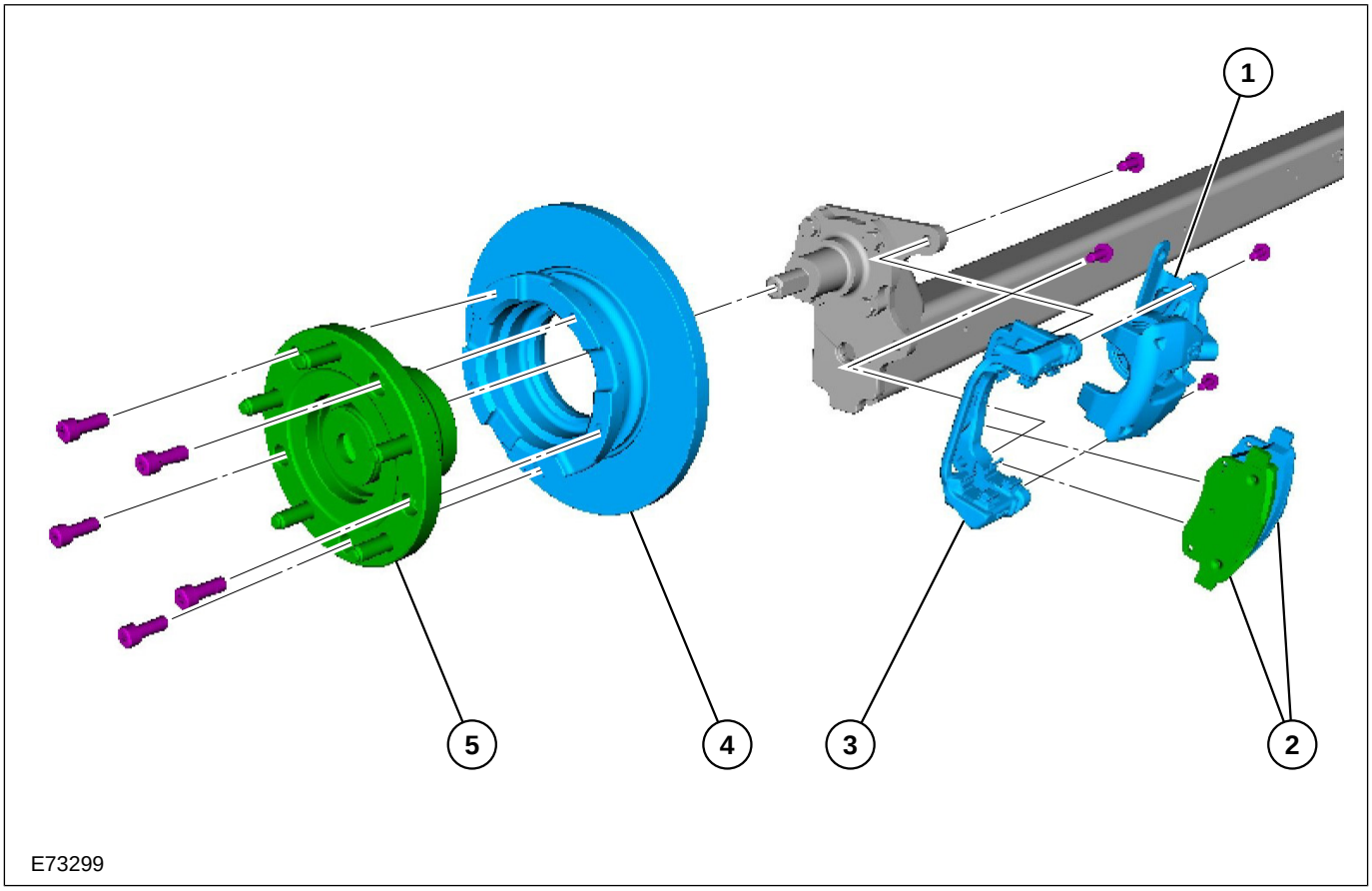
Torque Specifications

Description	Nm	lb-ft	lb-in
Brake caliper anchor plate bolts	115	85	–
Brake caliper bolts	31	23	–
Brake hose to brake caliper union	18	13	-
Wheel hub nut - with a flange diameter of 51 mm - FWD	450	332	-
Wheel hub nut - with a flange diameter of 44 mm - FWD	300	221	-
Axle shaft bolts - RWD	134	99	-
Axle shaft bolts - AWD	134	99	-
Wheel hub and brake disc assembly bolts	70	52	-

DESCRIPTION AND OPERATION

Rear Disc Brake

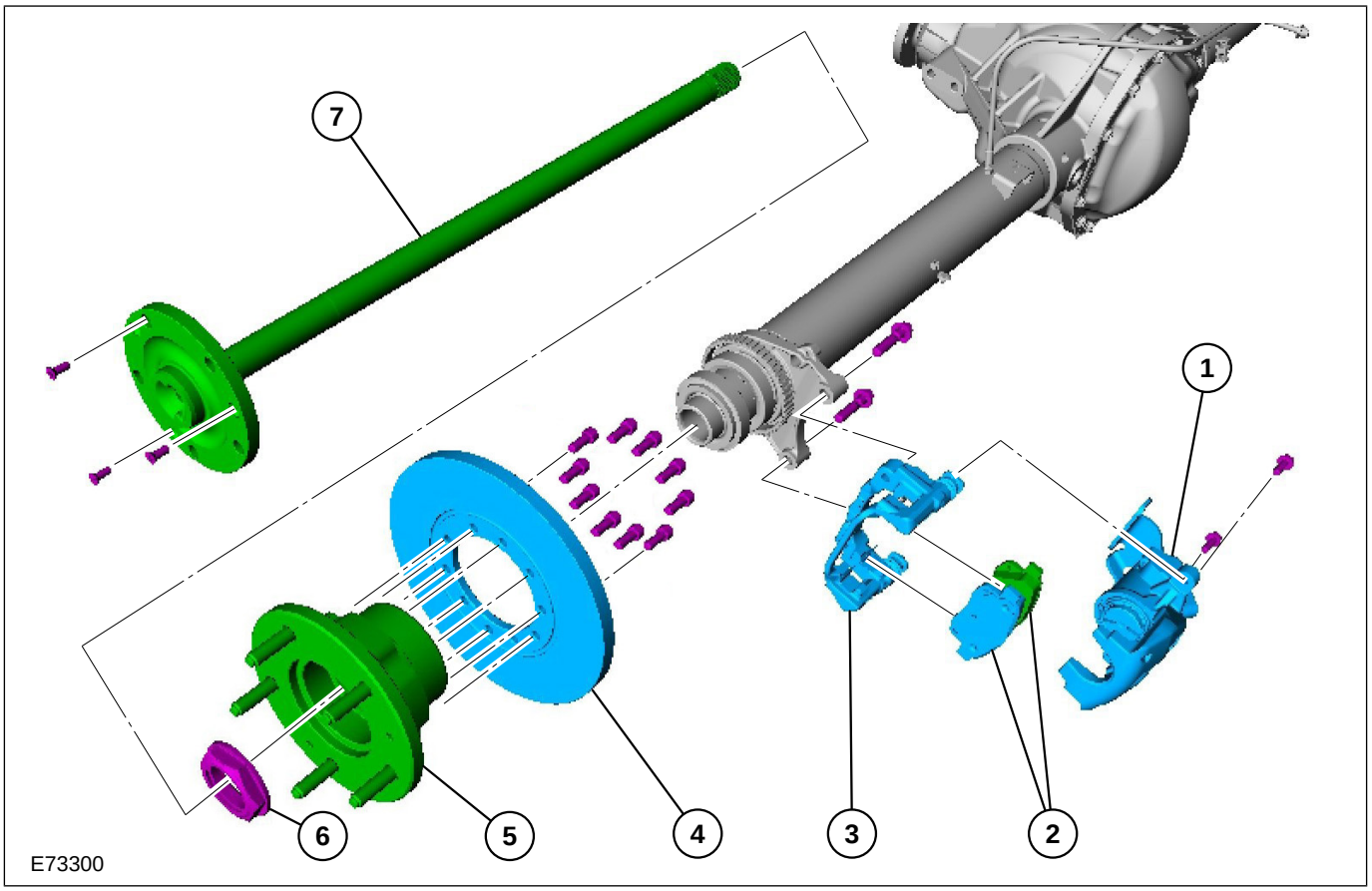
Front Wheel Drive Vehicles



Item	Part Number	Description
1		Brake caliper
2		Brake pads
3		Brake caliper anchor plate
4		Brake disc
5		Wheel hub

Rear Wheel Drive Vehicles

DESCRIPTION AND OPERATION



Item	Part Number	Description
1		Brake caliper
2		Brake pads
3		Brake caliper anchor plate
4		Brake disc
5		Wheel hub
6		Wheel hub nut
7		Driveshaft

DIAGNOSIS AND TESTING

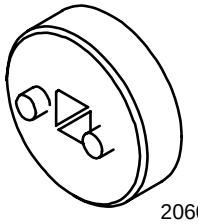
Rear Disc Brake

REFER to: Brake System - Vehicles Built Up To: 04/2006 (206-00 Brake System - General Information, Diagnosis and Testing).

REMOVAL AND INSTALLATION

Brake Pads (12 238 0)

Special Tool(s)

 206085	Retractor, Rear Brake Caliper Piston 206-085

Materials	
Name	**Specification**
Brake Fluid - Super DOT4	ESD-M6C57-A

Removal

CAUTION:If brake fluid is spilt on the paintwork, the affected area must be immediately washed down with cold water.

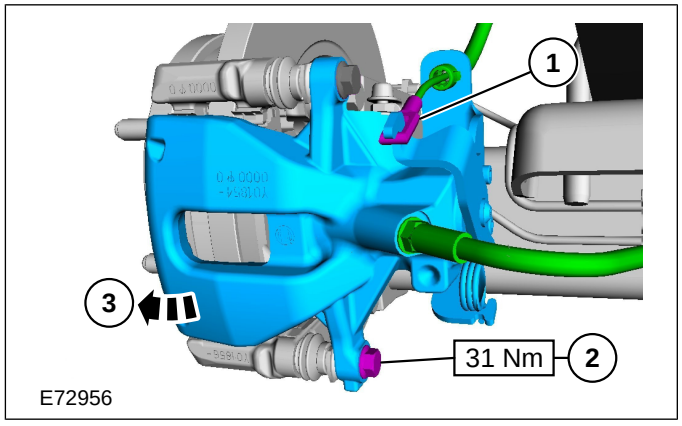
1. **Remove the wheel and tire.**

   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

2. **Release the parking brake cable.**

3. **Detach the brake caliper from the brake caliper anchor plate lower post.**

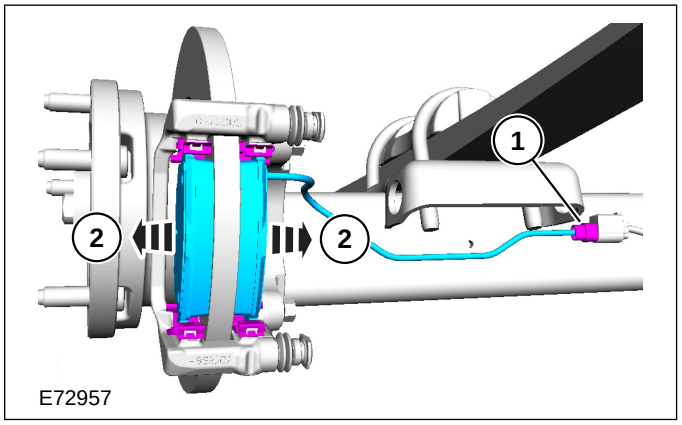
   1. Detach the parking brake cable from the brake caliper.
   2. Remove and discard the brake caliper upper bolt.
   3. Rotate the brake caliper downwards.



4. **NOTE:Note the position of the brake pads to aid installation.**

   Remove the brake pads (brake caliper shown removed for clarity).

   1. Disconnect the pad wear indicator.
   2. Release the brake pads from the clips.



Installation

1. **CAUTIONS:**

   When the brake caliper pistons are retracted to the piston housing, brake fluid will be displaced into the brake fluid reservoir.

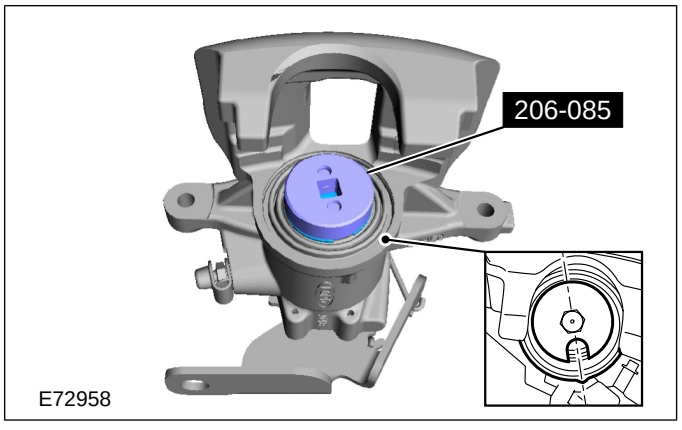
   Support the brake caliper against the brake pad and disc assembly during brake caliper piston retraction.

NOTE: To retract the left-hand side brake caliper piston, apply pressure to, and rotate the brake caliper piston clockwise.

NOTE: To retract the right-hand side brake caliper piston, apply pressure to, and rotate the brake caliper piston counterclockwise.

Using the special tool, retract the brake caliper piston.

- Centralize the brake caliper piston.

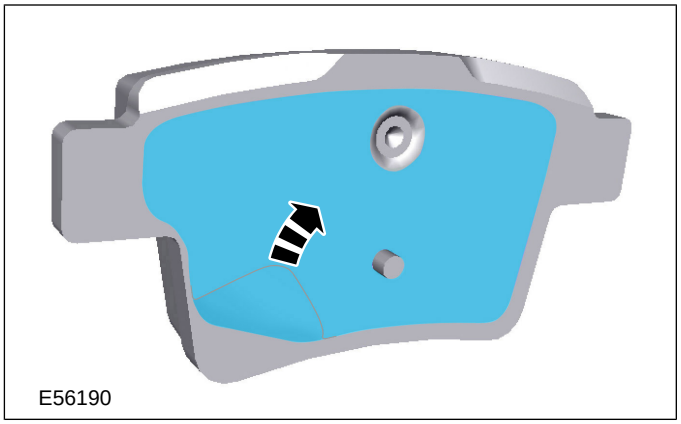


2. **NOTE:Make sure that the brake pad contact points are clean and free of foreign material.**

REMOVAL AND INSTALLATION

NOTE: Install a new brake caliper upper bolt.

To install, reverse the removal procedure.


E56190

3. **Depress and release the brake pedal 3 times, check the brake fluid level in the brake fluid reservoir and top up as necessary with brake fluid.**

REMOVAL AND INSTALLATION

Brake Caliper

Materials	
Name	Specification
Brake Fluid - Super DOT4	ESD-M6C57-A

General Equipment

Brake hose clamp(s)

Removal

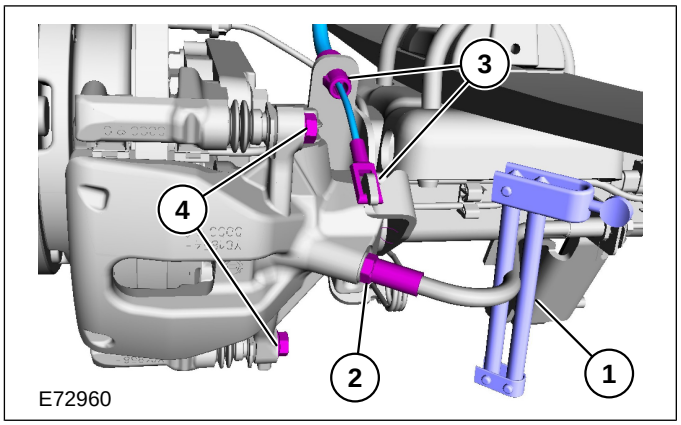
CAUTION:

Refer to:Brake System Health and Safety Precautions (100-00 General Information, Description and Operation).

NOTE: Removal steps in this procedure may contain installation details.

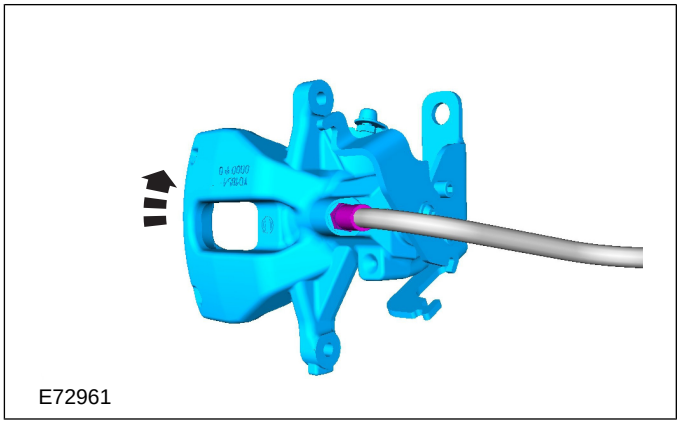
1. Release the parking brake.
2. Remove the wheel and tire.

   Refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).
3. 1. General Equipment: Brake hose clamp(s)
   2. Torque: 18 Nm
   4. Torque: 31 Nm

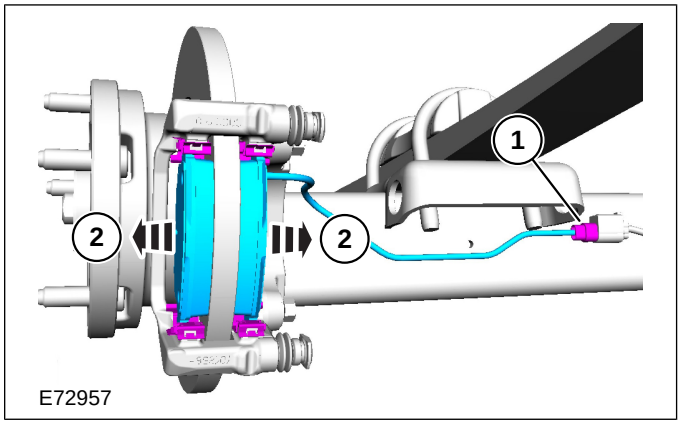


E72960

4. **CAUTION:Make sure that all openings are sealed.**

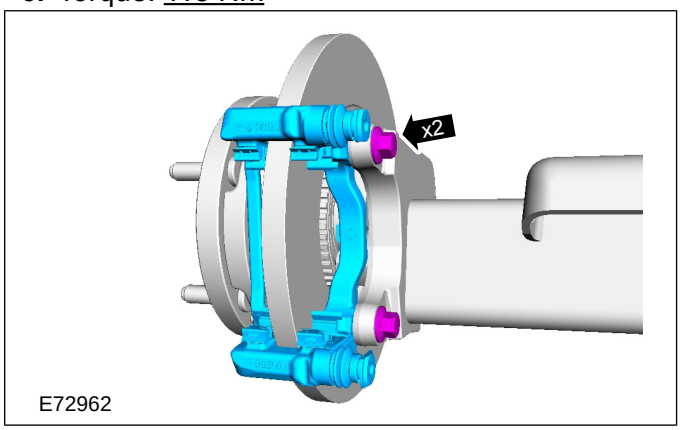

E72961

5. **NOTE:**Note the position of the brake pads to aid installation.



E72957

6. Torque: 115 Nm



E72962

Installation

1. **NOTE:**Make sure that the brake pad contact points are clean and free of foreign material.

   To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

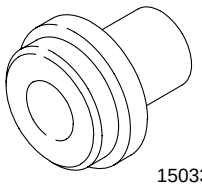
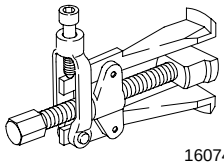
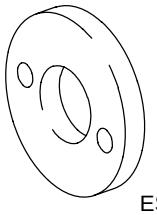
2. Bleed the brake system.

Refer to: Brake System Bleeding (206-00 Brake System - General Information, General Procedures).
Refer to: Brake System Pressure Bleeding (206-00 Brake System - General Information, General Procedures).
Material: Brake Fluid - Super DOT4

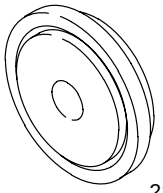
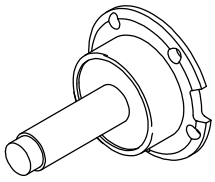
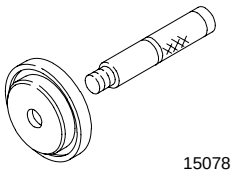
REMOVAL AND INSTALLATION

Brake Disc — RWD

Special Tool(s)

 1503301	Adapter for 205-066 205-066-01
 16074	Remover, Halfshaft Seal 308-208
 ES21208	Installer, Crankshaft Rear Seal 303-505

Special Tool(s)

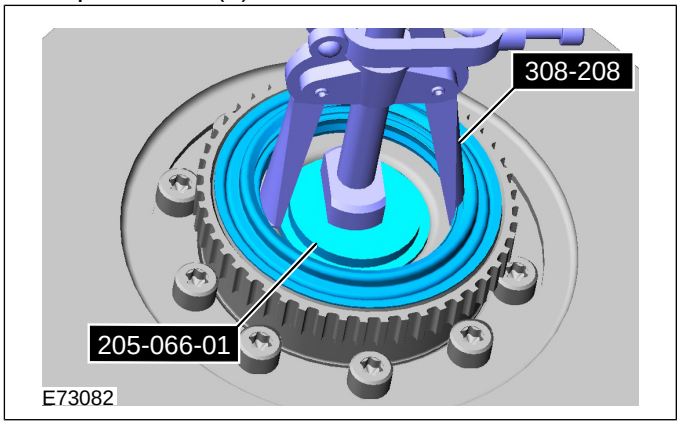
 2110201	Adapter for 303-172 303-172-01
 14067	Remover Wheel Bearing 204-345A
 15078	Installer, Rear Wheel Hub Seal 205-215

Removal

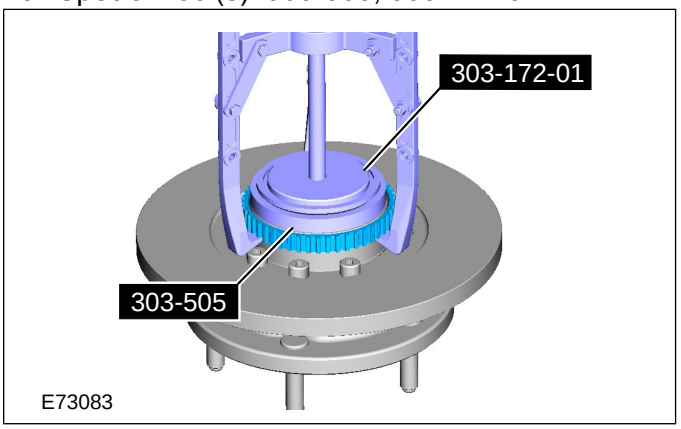
1. Remove the wheel hub.

   Refer to:Wheel Hub (205-02 Wheel Hubs and Bearings - Full Floating Axle, Removal and Installation).

2. Special Tool(s): 205-066-01, 308-208

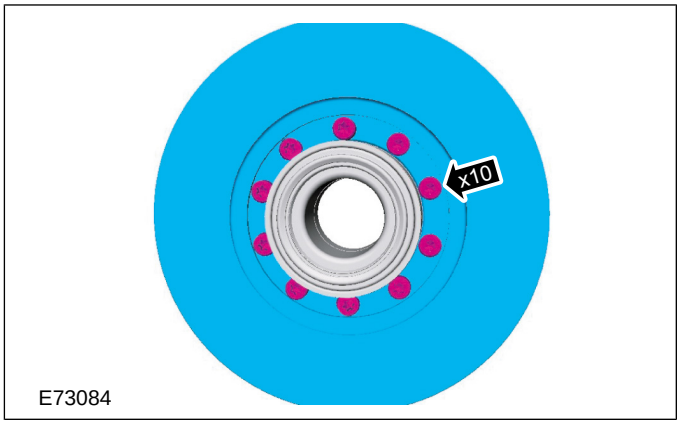


3. Special Tool(s): 303-505, 303-172-01



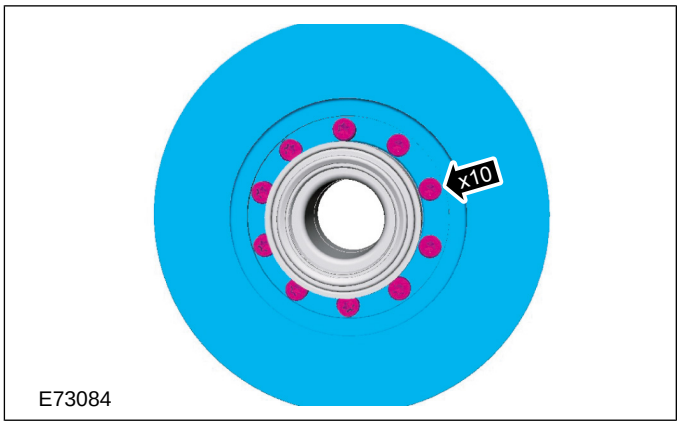
REMOVAL AND INSTALLATION

4. • Remove and discard the brake disc bolts.

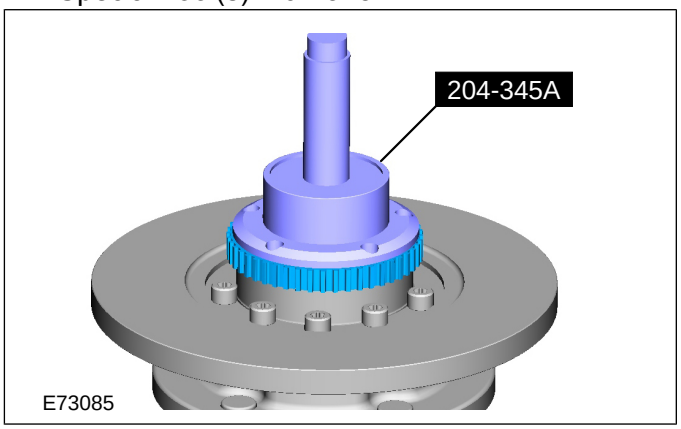


Installation

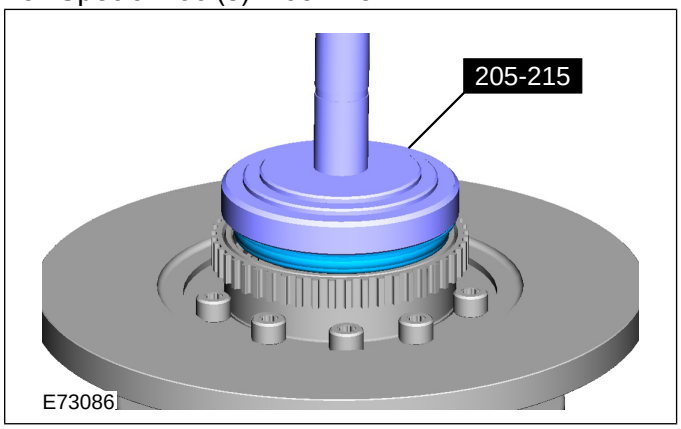
1. • Install new brake disc bolts.
Torque: 70 Nm



2. Special Tool(s): 204-345A



3. Special Tool(s): 205-215



4. Install the wheel hub.

Refer to:Wheel Hub (205-02 Wheel Hubs and Bearings - Full Floating Axle, Removal and Installation).

SECTION 206-05A Parking Brake and Actuation

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 206-05A-2

DESCRIPTION AND OPERATION

Parking Brake 206-05A-3

DIAGNOSIS AND TESTING

Parking Brake 206-05A-4
Inspection and Verification 206-05A-4
Symptom Chart 206-05A-4
Pinpoint Tests 206-05A-4

GENERAL PROCEDURES

Parking Brake Cable Adjustment — Vehicles With: Rear Disc Brakes ..... (12 662 0) 206-05A-8

REMOVAL AND INSTALLATION

Parking Brake Control ..... (12 664 0) 206-05A-9
Parking Brake Front Cable 206-05A-11
Parking Brake Intermediate Cable 206-05A-13
Parking Brake Rear Cables 206-05A-14

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

	Specifications
Molybdenum disulphide grease	WSD-M1C 230-A

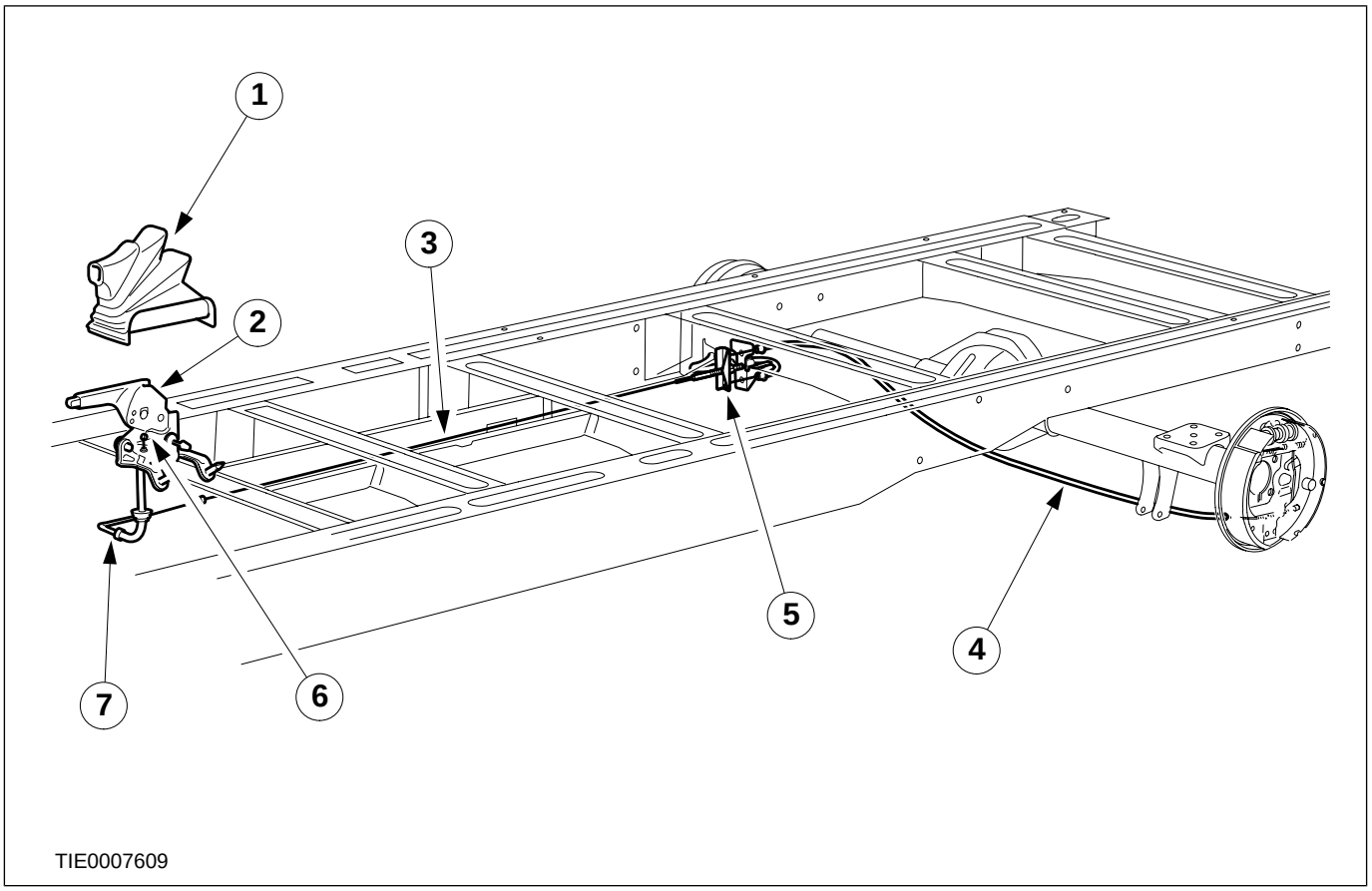
Torque Specifications

Description	Nm	lb-ft	lb-in
Parking brake control bolts	22	16	-
Rear parking brake cable support bolt	22	16	-

DESCRIPTION AND OPERATION

Parking Brake

NOTE: Vehicles with Rear Drum Brake Shown



TIE0007609

Item	Part Number	Description
1	-	Parking brake control boot
2	-	Parking brake control
3	-	Parking brake intermediate cable - Vehicles with rear drum brakes
3	-	Parking brake intermediate rod - Vehicles with rear disc brakes
4	-	Parking brake rear cable
5	-	Equalizer
6		Parking brake warning indicator switch
7	-	Parking brake front cable

DIAGNOSIS AND TESTING

Parking Brake

Inspection and Verification

1. Verify the customer concern by operating the parking brake system.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Parking brake control REFER to: Parking Brake Control (206-05, Removal and Installation). – Cable and conduit REFER to: Parking Brake Cable (206-05, Removal and Installation).	– Parking brake warning circuit. REFER to: Instrument Cluster (413-01, Diagnosis and Testing).

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the concern is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom Chart

Symptom	Possible Sources	Action
• The parking brake will not apply	• Parking brake control. • Cable and conduit.	• GO to Pinpoint Test A.
• The parking brake will not release	• Parking brake control. • Cable and conduit.	• GO to Pinpoint Test B.

Pinpoint Tests

PINPOINT TEST A : THE PARKING BRAKE WILL NOT APPLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK FOR MISADJUSTED REAR PARKING BRAKE CABLE	
	1 Operate the parking brake control several times to adjust the cable. • Does the parking brake now engage correctly? → **Yes** Vehicle OK → **No** GO to A2.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A2: CHECK FOR WORN BRAKE SHOES OR PADS	
	1 Inspect the brake shoes or pads for excessive wear. REFER to: Specifications (206-00, Specifications) / Brake Shoes (206-02 Drum Brake, Removal and Installation) / Brake Pads (206-04, Removal and Installation). • Are the brake shoe linings or brake pads OK? → **Yes** GO to A3. → **No** INSTALL new brake shoes or pads. REFER to: Brake Shoes (206-02 Drum Brake, Removal and Installation) / Brake Pads (206-04, Removal and Installation). TEST the system for normal operation.
A3: CHECK FOR DAMAGED PARKING BRAKE CABLES	
	1 Inspect the parking brake cables and conduits for damage, rust or fraying. • Are the parking brake cables and conduits OK? → **Yes** CHECK for other causes such as loose parking brake control or conventional brake system components. → **No** REPAIR or INSTALL cables and conduit as necessary. TEST the system for normal operation.

DIAGNOSIS AND TESTING

PINPOINT TEST B : THE PARKING BRAKE WILL NOT RELEASE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK PARKING BRAKE CONTROL	
	1 Raise and support the vehicle on a lift with the parking brake fully applied. REFER to: Lifting (100-02, Description and Operation). – With the aid of another technician, release the parking brake and check the operation of the brake cables and levers. • Did the parking brake release? → **Yes** CHECK the other causes such as conventional brake system components. REPAIR or INSTALL new components as necessary. → **No** GO to B2.
B2: CHECK PARKING BRAKE CABLES	
	1 Loosen the parking brake cable tension. – Rotate the rear wheels by hand. • Did the rear wheels turn freely? → **Yes** INSTALL a new parking brake control. REFER to: Parking Brake Control (206-05, Removal and Installation). TEST the system for normal operation. → **No** GO to B3.
B3: CHECK FRONT PARKING BRAKE CABLE	
	1 Disconnect the parking brake front cable and conduit from the rear brake cable and conduit at the equalizer. – Rotate the rear wheels by hand. • Did the rear wheels turn freely? → **Yes** INSTALL a new front parking brake cable and conduit. REFER to:Parking Brake Cable (206-05, Removal and Installation). TEST the system for normal operation. → **No** GO to B4.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B4: CHECK REAR PARKING BRAKE CABLES	
	1 Disconnect the parking brake at the rear brakes, one at a time. – Rotate the wheel affected by the disconnected parking brake. • Did the wheel turn freely? → **Yes** INSTALL a new parking brake control lever on the rear drum brakes or caliper assembly on rear disc brakes. REFER to: Brake Shoes (206-02 Drum Brake, Removal and Installation) / Brake Caliper (206-04, Removal and Installation). TEST the system for normal operation. → **No** REFER to: Brake System (206-00, Diagnosis and Testing).

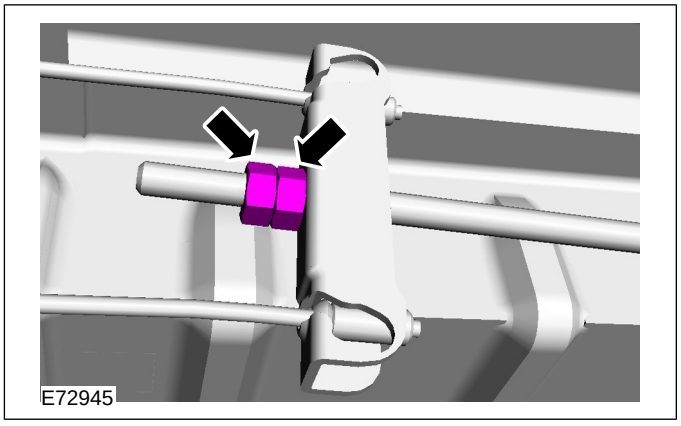
GENERAL PROCEDURES

Parking Brake Cable Adjustment — Vehicles With: Rear Disc Brakes (12 662 0)

Adjustment

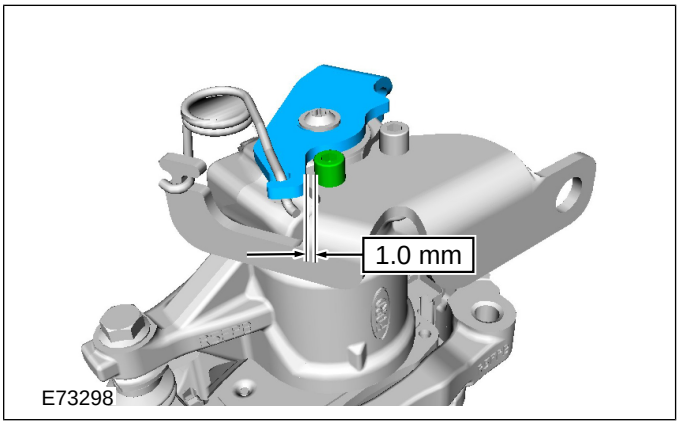
1. **Depress and release the brake pedal 10 times.**
2. **Release the parking brake.**
3. **Raise and support the vehicle.**

   For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).
4. **Settle the parking brake cable in five stages.**
   - Stage 1: Remove the parking brake cable adjustment nut lock nut.
   - Stage 2: Tighten the parking brake cable adjustment nut to 8 Nm.
   - Stage 3: Loosen the parking brake cable adjustment nut to the end of the thread.
   - Stage 4: Carry out stages 2 and 3 a further three times.
   - Stage 5: Raise the parking brake control to its highest position.



5. **Release the parking brake.**
6. **Loosen the parking brake cable adjustment nut until the brake caliper levers contact the brake caliper abutment on both sides.**
7. **NOTE:Make sure the parking brake control is fully released.**

   Adjust the parking brake cable in five stages.
   - Stage 1: Insert a 1.0 mm spacer between the parking brake lever and the brake caliper abutment on both sides.
   - Stage 2: With the aid of another technician, tighten the parking brake cable adjustment nut until movement is observed on one of parking brake levers.
   - Stage 3: Remove the spacers.
   - Stage 4: Tighten the parking brake cable adjustment nut two complete turns.
   - Stage 5: Install the parking brake cable adjustment nut lock nut.



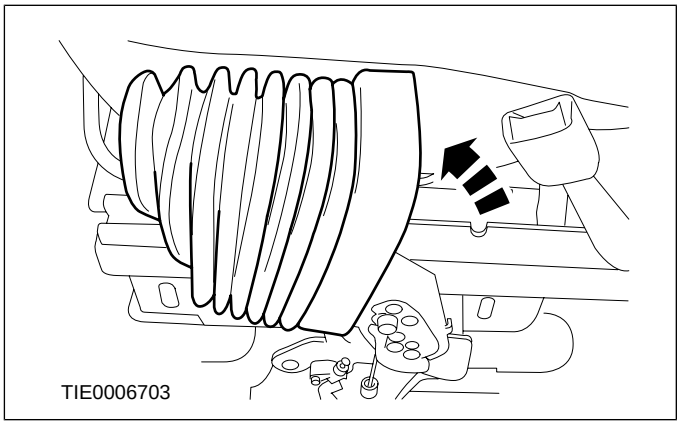
8. **Lower the vehicle.**

REMOVAL AND INSTALLATION

Parking Brake Control (12 664 0)

Removal

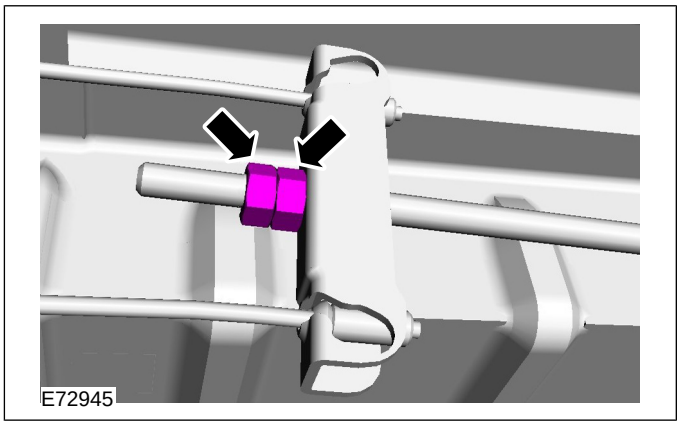
1. Release the parking brake.
2. Remove the parking brake control boot.



3. Raise and support the vehicle.

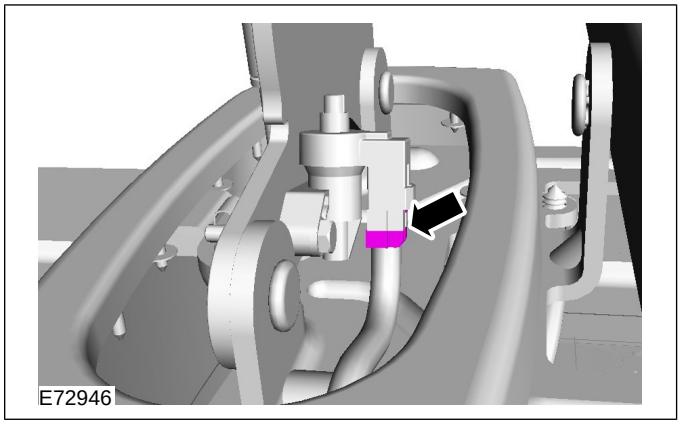
   For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

4. Loosen the parking brake cable adjustment nut.

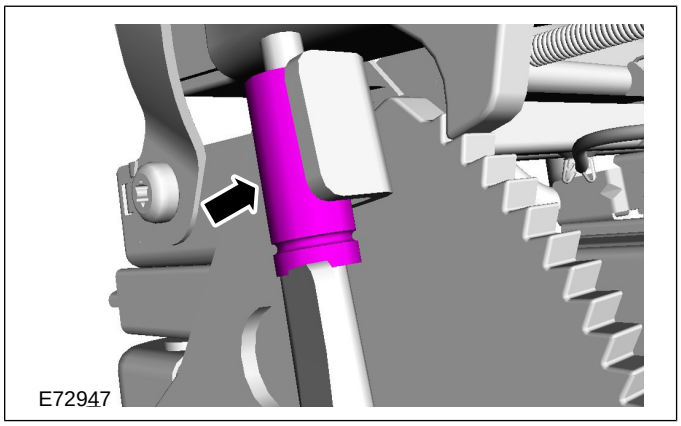


5. Lower the vehicle.

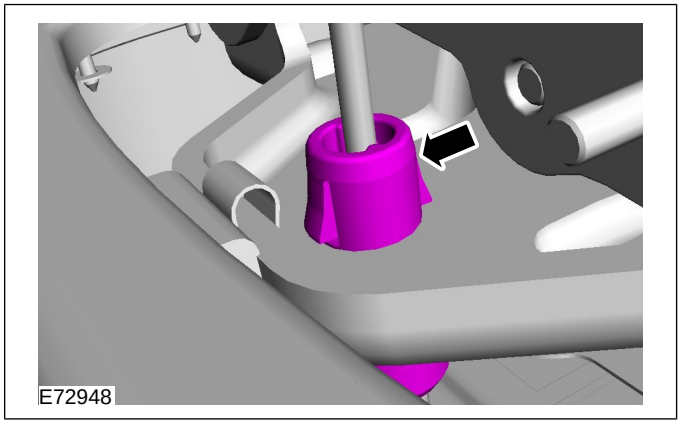
6. Disconnect the parking brake warning indicator switch electrical connector (if equipped).



7. Detach the front parking brake cable from the parking brake control.



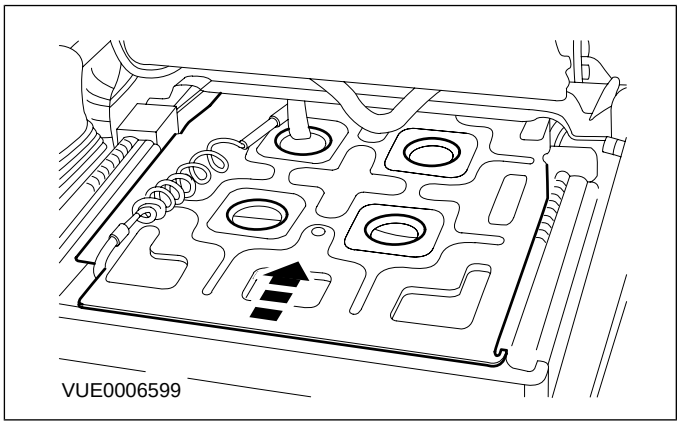
8. Detach the front parking brake cable from the parking brake control bracket.



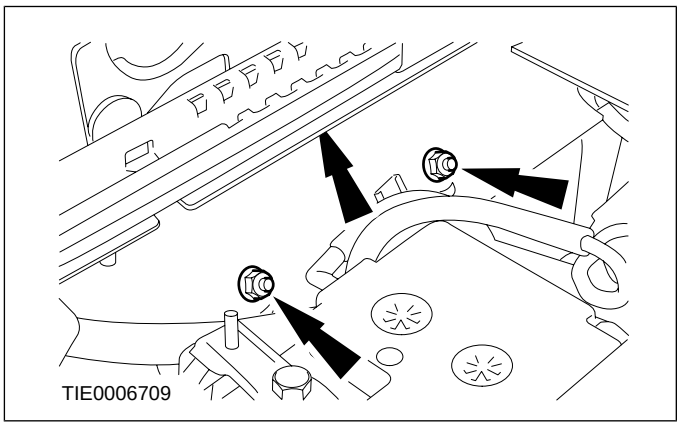
9. Slide the driver seat forwards.

REMOVAL AND INSTALLATION

10. Slide the battery cover forwards.

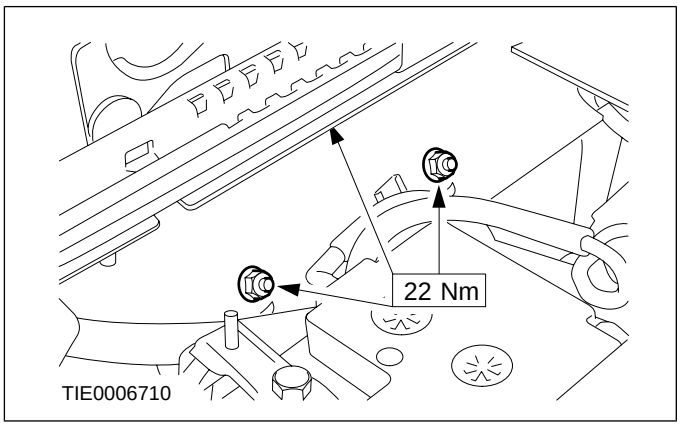


11. Remove the parking brake control.



Installation

1. To install, reverse the removal procedure.



2. Adjust the parking brake. For additional information, refer to: (206-05 Parking Brake and Actuation)

Parking Brake Cable Adjustment - Vehicles With: Rear Drum Brakes (General Procedures),
Parking Brake Cable Adjustment - Vehicles With: Rear Disc Brakes (General Procedures).

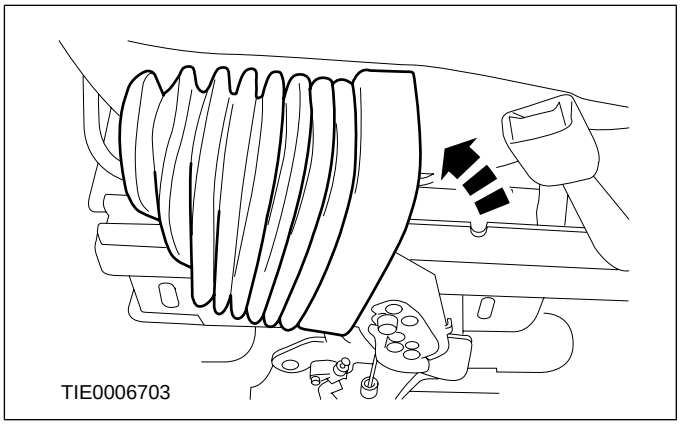
REMOVAL AND INSTALLATION

Parking Brake Front Cable

Removal

All vehicles

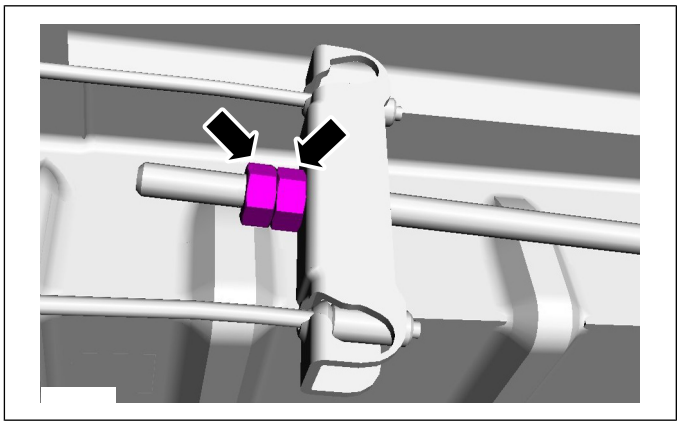
1. Release the parking brake.
2. Remove the parking brake control boot.



3. Raise and support the vehicle.

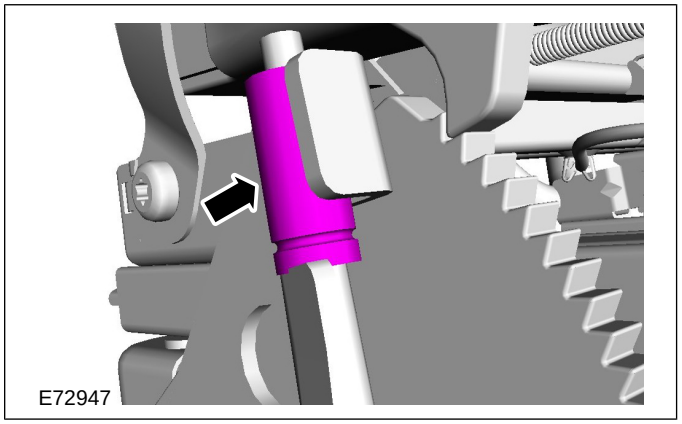
   For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

4. Loosen the parking brake cable adjustment nut.

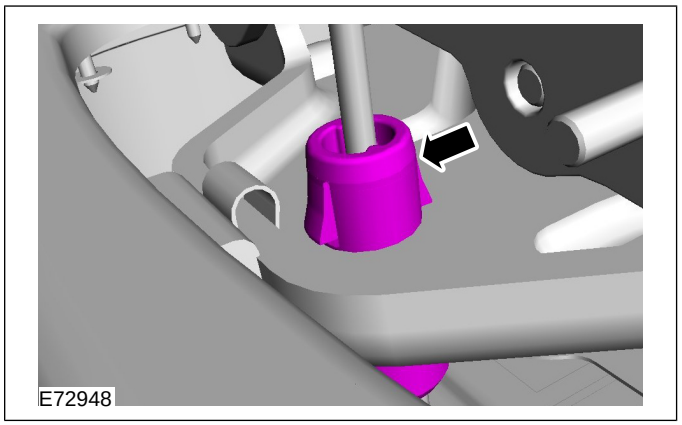


5. Lower the vehicle.

6. Detach the front parking brake cable from the parking brake control.



7. Detach the front parking brake cable from the parking brake control bracket.



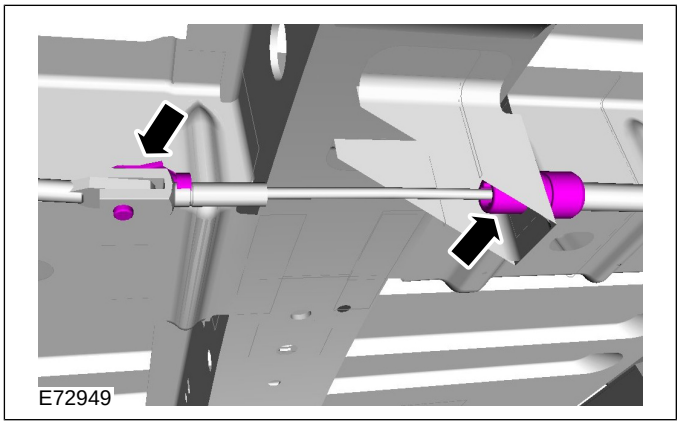
8. Raise and support the vehicle.

   For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

REMOVAL AND INSTALLATION

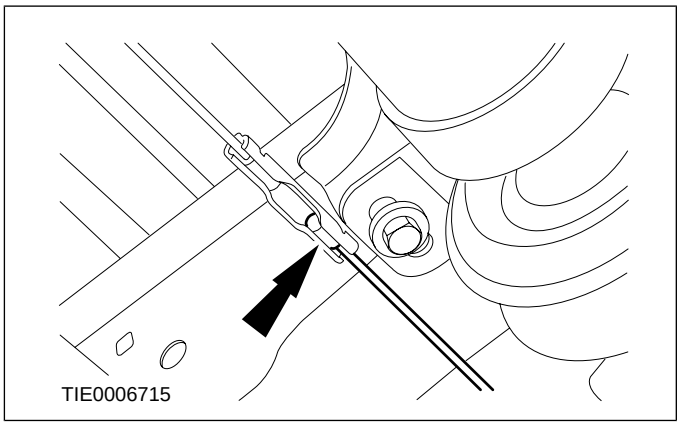
Vehicles with rear disc brakes

9. Detach the front parking brake cable from the parking brake intermediate rod.

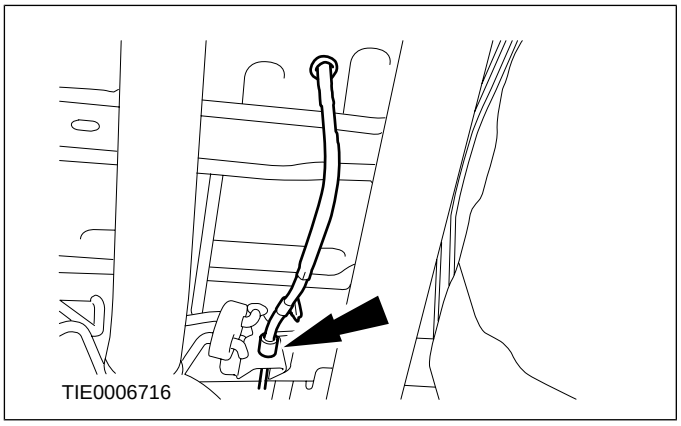


Vehicles with rear drum brakes

10. Detach the intermediate parking brake cable from the retainer.

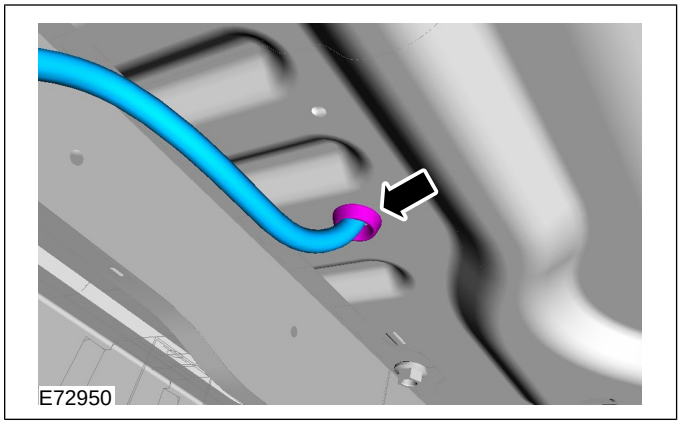


11. Detach the front parking brake cable from the retaining bracket.



All vehicles

12. Remove the front parking brake cable.



Installation

1. To install, reverse the removal procedure.
2. Adjust the parking brake. For additional information, refer to: (206-05 Parking Brake and Actuation)

   Parking Brake Cable Adjustment - Vehicles With: Rear Drum Brakes (General Procedures),
   Parking Brake Cable Adjustment - Vehicles With: Rear Disc Brakes (General Procedures).

REMOVAL AND INSTALLATION

Parking Brake Intermediate Cable

Removal

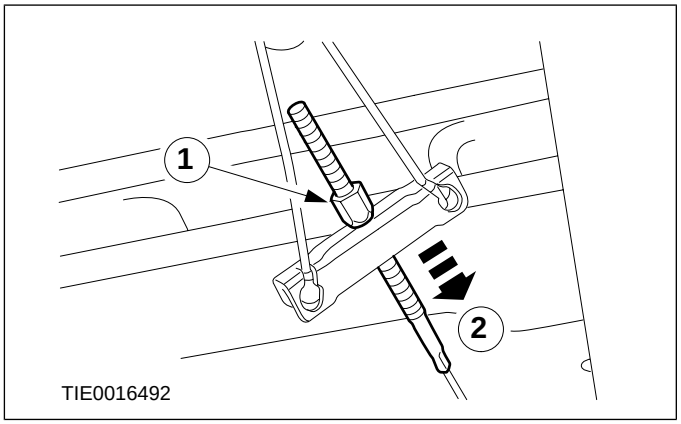
All vehicles

1. Release the parking brake.

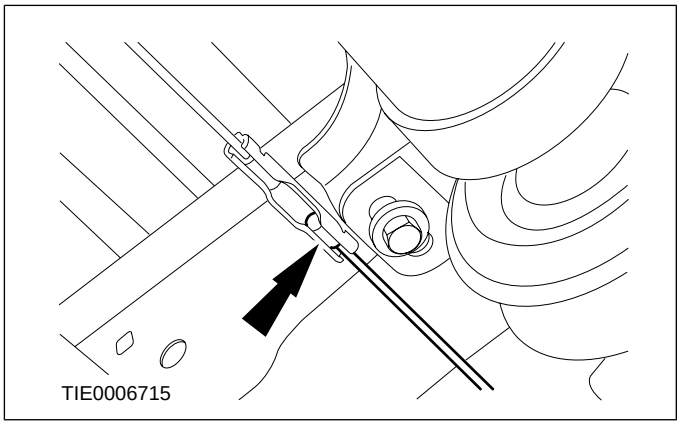
Vehicles with rear drum brakes

2. Detach the parking brake intermediate cable from the equalizer.

1. Remove the adjustment nut.
2. Detach the cable.



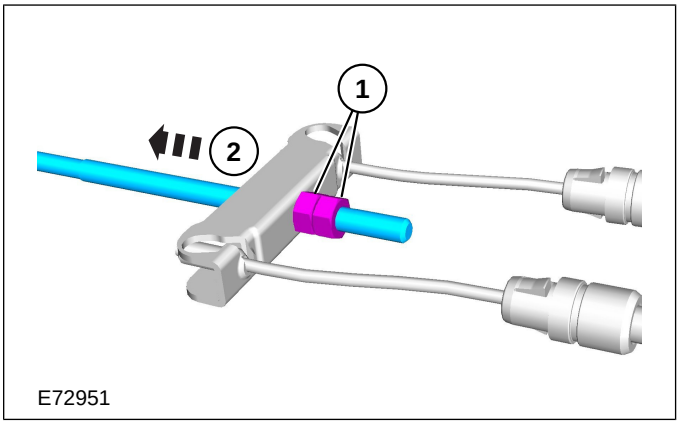
3. Remove the parking brake intermediate cable.



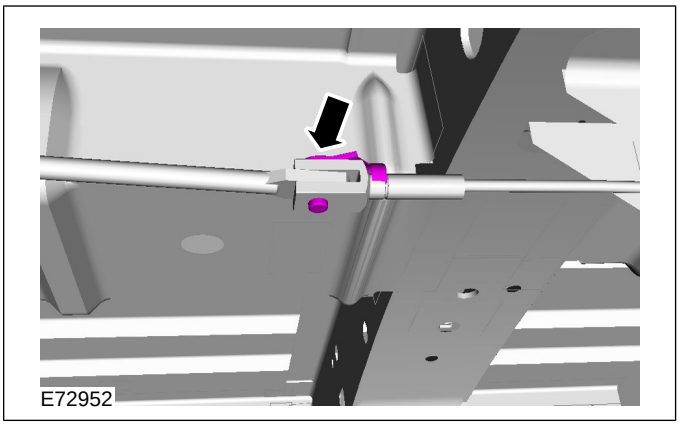
Vehicles with rear disc brakes

4. Detach the parking brake intermediate rod from the equalizer.

1. Remove the adjustment nuts.
2. Detach the rod.



5. Remove the parking brake intermediate rod.



Installation

1. To install, reverse the removal procedure.

2. Adjust the parking brake. For additional information, refer to: (206-05 Parking Brake and Actuation)

Parking Brake Cable Adjustment - Vehicles With: Rear Drum Brakes (General Procedures),
Parking Brake Cable Adjustment - Vehicles With: Rear Disc Brakes (General Procedures).

REMOVAL AND INSTALLATION

Parking Brake Rear Cables

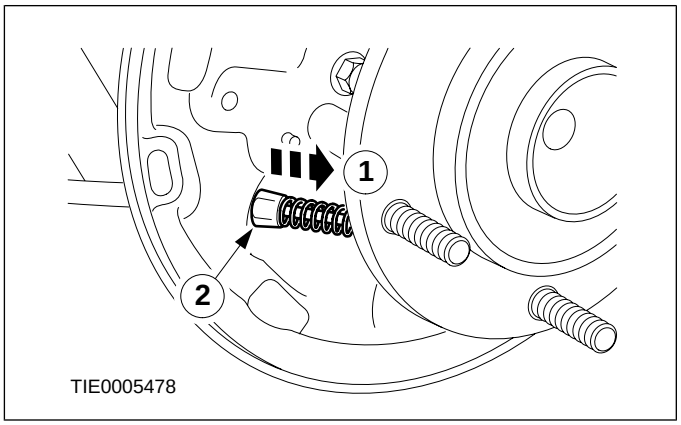
Removal

Vehicles with rear drum brakes

1. **Remove the brake shoes.**

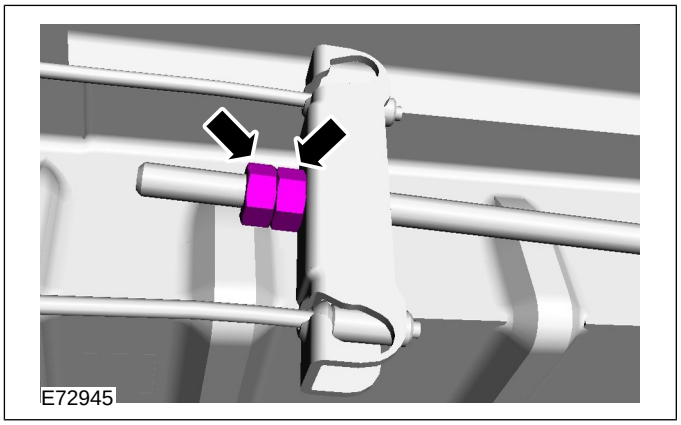
   For additional information, refer to: Brake Shoes (206-02 Drum Brake, Removal and Installation).

2. **Detach the parking brake rear cables from the brake backing plates.**
   1. Pull back the spring.
   2. Detach the clip.

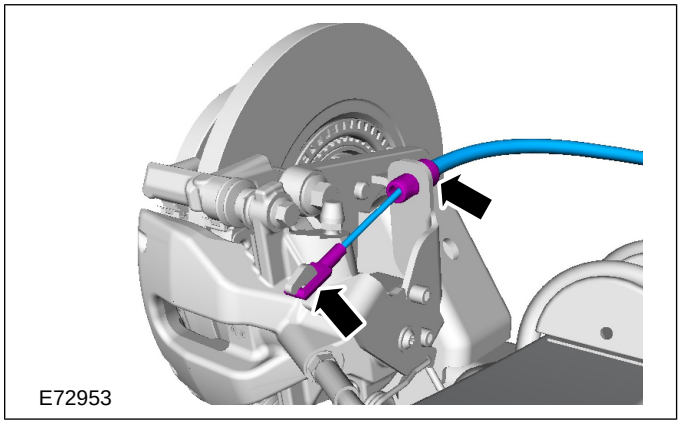


Vehicles with rear disc brakes

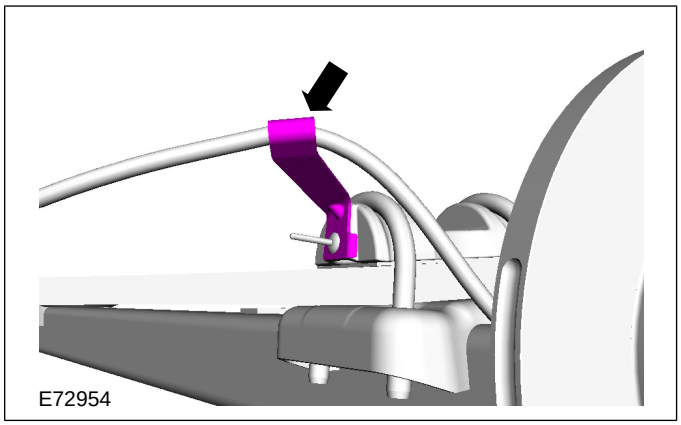
3. **Loosen the parking brake cable adjustment nut.**



4. **Detach the parking brake cable from the brake calliper on both sides.**

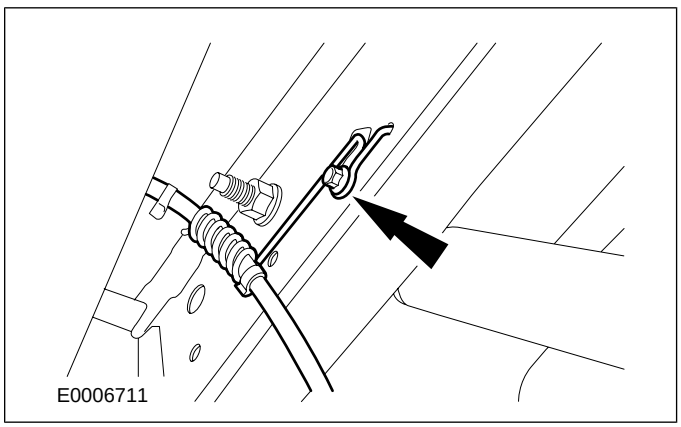


5. **Detach the parking brake cable from the support bracket on both sides.**



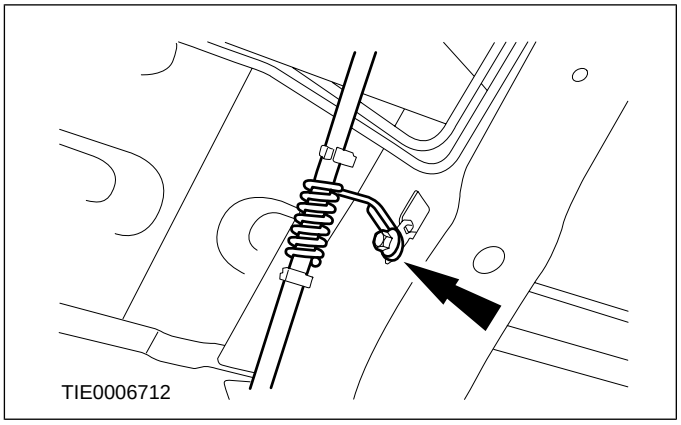
All vehicles

6. **Detach the parking brake right-hand rear cable from the chassis.**

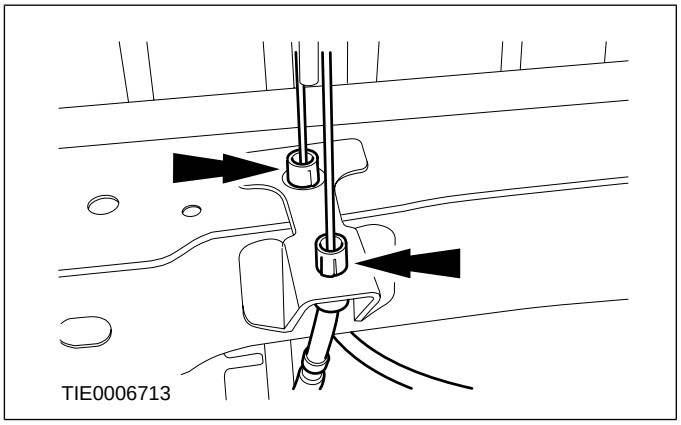


REMOVAL AND INSTALLATION

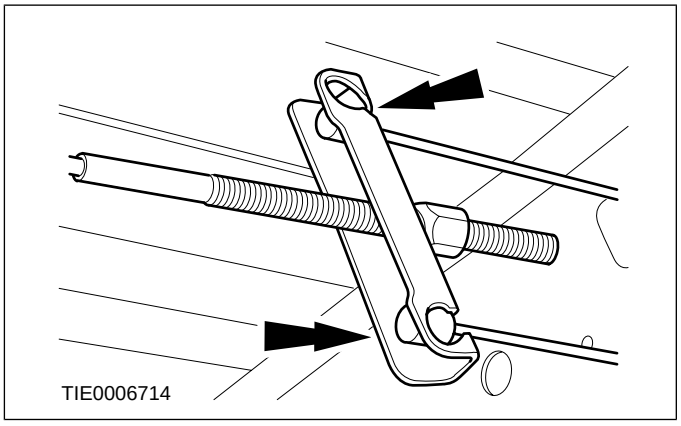
7. Detach the parking brake left-hand rear cable from the chassis.



8. Detach the parking brake rear cables from the retaining bracket.

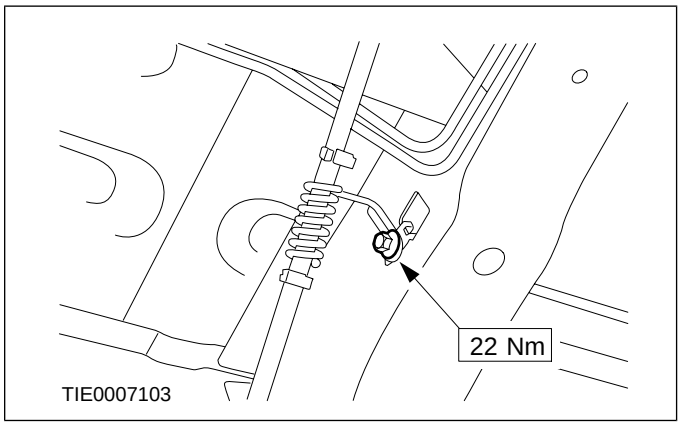


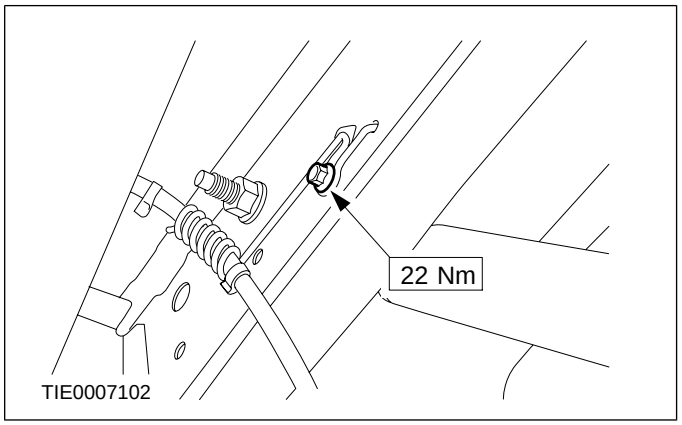
9. Remove the parking brake rear cables.



Installation

1. To install, reverse the removal procedure.





2. Adjust the parking brake. For additional information, refer to: (206-05 Parking Brake and Actuation)

   Parking Brake Cable Adjustment - Vehicles With: Rear Drum Brakes (General Procedures),
   Parking Brake Cable Adjustment - Vehicles With: Rear Disc Brakes (General Procedures).

SECTION 206-05B Parking Brake and Actuation — Vehicles With: Parking Brake Assist

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 206-05B-2

DESCRIPTION AND OPERATION

Parking Brake 206-05B-3

DIAGNOSIS AND TESTING

Parking Brake 206-05B-5
Inspection and Verification 206-05B-5
Symptom Chart 206-05B-7
Pinpoint Tests 206-05B-8

GENERAL PROCEDURES

Parking Brake Cable Adjustment ..... (12 662 0) 206-05B-28

REMOVAL AND INSTALLATION

Parking Brake Control ..... (12 664 0) 206-05B-31
Parking Brake Front Cable 206-05B-34
Parking Brake Intermediate Cable 206-05B-37
Parking Brake Rear Cables 206-05B-38
Parking Brake Module 206-05B-40
Parking Brake Wheel Speed Sensor 206-05B-41
Parking Brake Actuator 206-05B-42

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

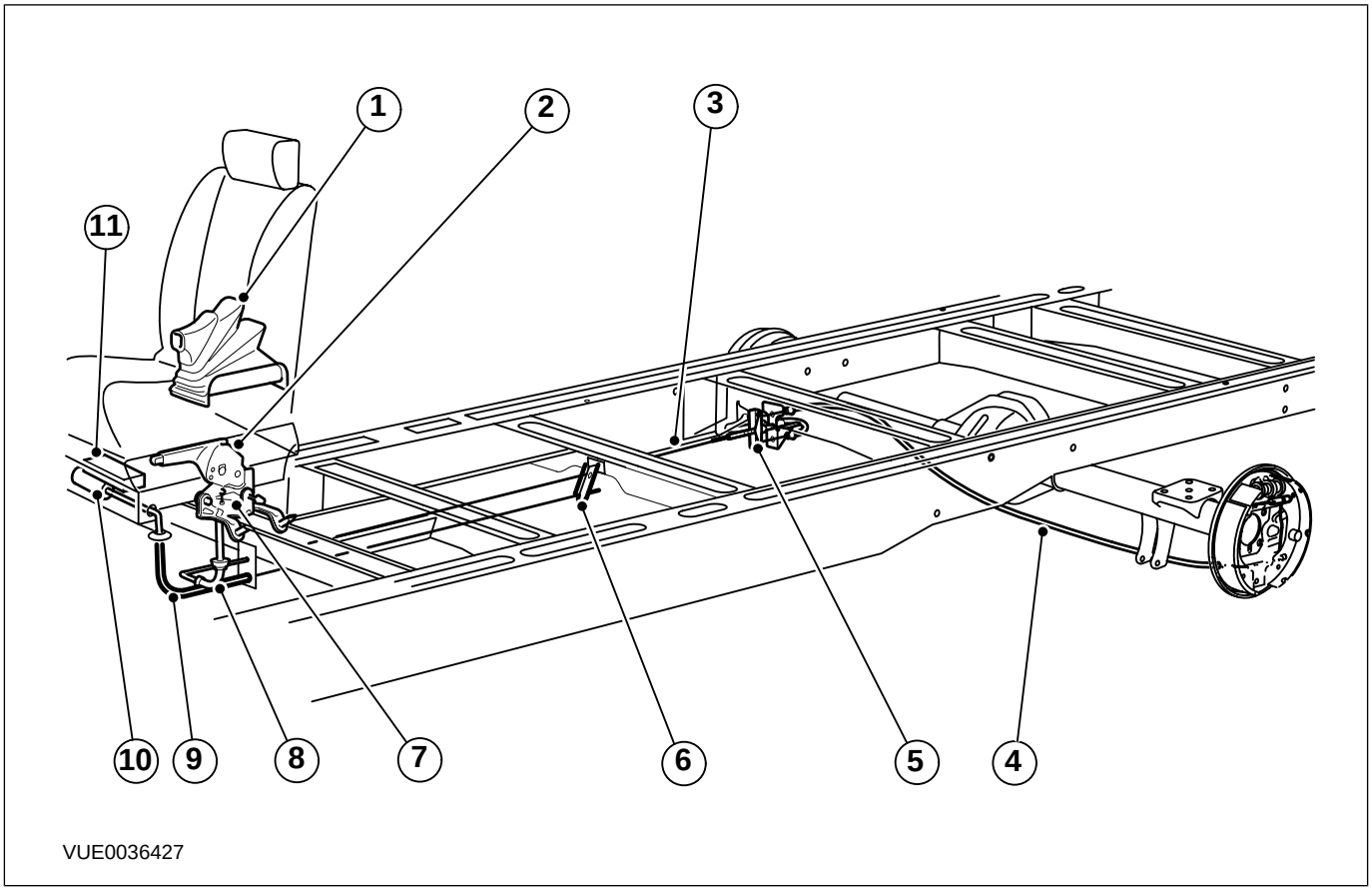
	Specifications
Molybdenum disulphide grease	WSD-M1C 230-A

Torque Specifications

Description	Nm	lb-ft	lb-in
Parking brake control retaining bolts	22	16	-
Rear parking brake cable support retaining bolt	22	16	-
Parking brake cable adjustment nut	7	-	62
Parking brake actuator retaining bolts	20	15	-
Parking brake actuator support bracket retaining bolts	20	15	-
Parking brake wheel speed sensor retaining bolt	9	-	80
Parking brake module retaining bolts	8	-	71
Parking brake assist equalizer retaining nut	20	15	-

DESCRIPTION AND OPERATION

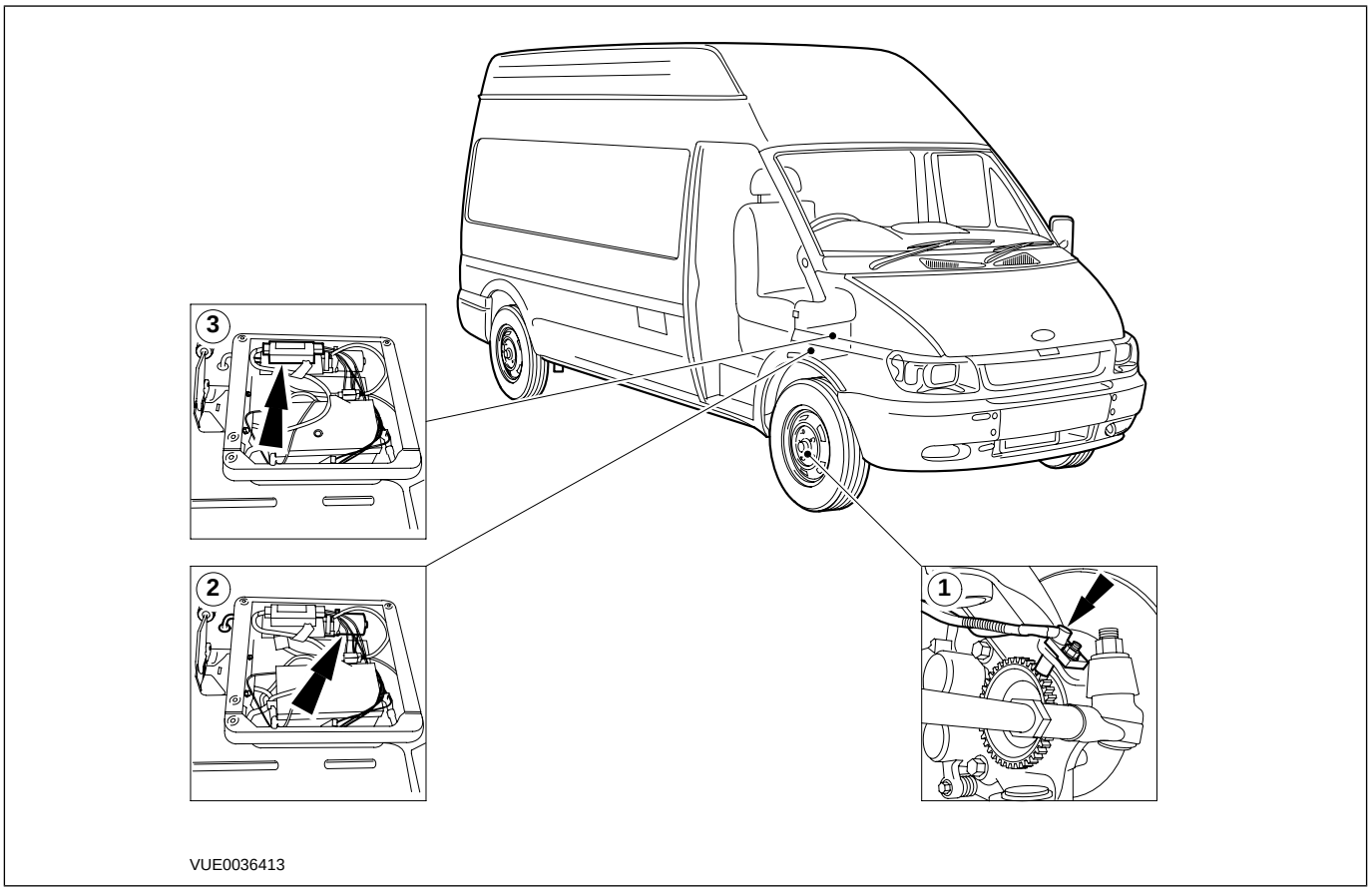
Parking Brake



Item	Part Number	Description
1	-	Parking brake control boot
2	-	Parking brake control
3	-	Parking brake intermediate cable
4	-	Parking brake rear cable
5	-	Equalizer

Item	Part Number	Description
6	-	Parking brake assist equalizer
7		Parking brake warning indicator switch
8		Parking brake front cable
9		Parking brake assist cable
10	-	Parking brake actuator
11	-	Parking brake module

DESCRIPTION AND OPERATION



Item	Description
1	Parking brake wheel speed sensor
2	Parking brake actuator
3	Parking brake module

DIAGNOSIS AND TESTING

Parking Brake

Refer to Wiring Diagrams Section206-05,for schematic and connector information.

General Equipment

73III Automotive Meter (105-R0057) or equivalent
Worldwide Diagnostic System (WDS) (418-F224)

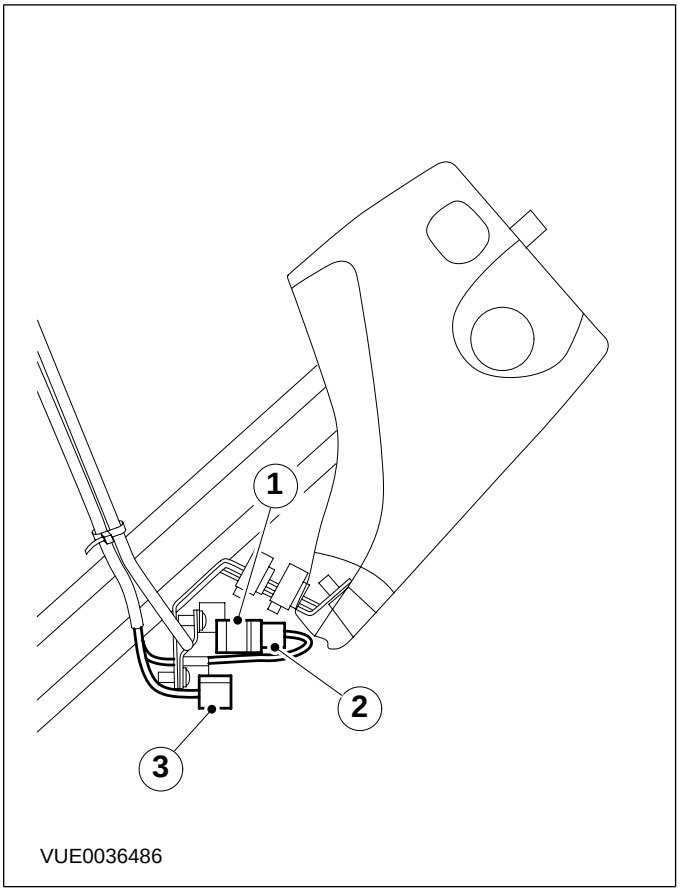
Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Parking brake control – Parking brake cable(s) – Parking brake actuator – Brake linings	– Fuse(s) – 25A fuse - situated in SVO fusebox – Bulb – Electrical connector(s) – Wiring harness – Wheel speed sensor – Parking brake switch – Parking brake actuator – Parking brake module – Instrument cluster

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.



VUE0036486

4. **NOTE:The Parking brake assist data link connector (DLC) wiring harness (orange connector) must be connected into the vehicle data link connector before entering any menus on the diagnostic tool. The diagnostic tool connector must be connected to the parking brake assist DLC.**

   Connect the diagnostic tool to the parking brake assist DLC (as shown in the detail above).
   1. Vehicle DLC
   2. Parking brake assist wiring harness link
   3. Parking brake assist DLC
5. If the cause is not visually evident, select the vehicle to be tested from the diagnostic tool menu.
6. If the DTCs retrieved are related to the concern, go to Parking Brake Assist Diagnostic Trouble Code (DTC) Index.
7. If no DTCs related to the concern are retrieved, proceed to the Symptom Chart.

DIAGNOSIS AND TESTING

Parking Brake Assist Diagnostic Trouble Code (DTC) Index

DTC	Description	Source	Action
C1308	Parking brake wheel speed sensor wire(s) short to ground	Parking brake module	GO to Pinpoint Test E.
C1309	Parking brake wheel speed sensor wire(s) shorted together	Parking brake module	GO to Pinpoint Test F.
C1518	Red fault warning lamp indicator short to battery	Parking brake module	REFER to WDS.
C1519	Red fault warning lamp indicator circuit failure	Parking brake module	GO to Pinpoint Test D.
C1784	Parking brake actuator output short to ground	Parking brake module	REFER to WDS.
C1785	Parking brake actuator output open circuit	Parking brake module	REFER to WDS.
C1786	Parking brake actuator output battery short to ground	Parking brake module	REFER to WDS.
C1799	Hall effect circuit failure	Parking brake module	REFER to WDS.
C1801	Parking brake engage current reached before full apply travel distance	Parking brake module	REFER to WDS.
C1802	Parking brake engage current not reached or traveled too far upon apply	Parking brake module	REFER to WDS.
C1803	Parking brake disengage full travel distance not reached upon release	Parking brake module	REFER to WDS.
B1317	Battery voltage high	Parking brake module	REFER to WDS.
B1318	Battery voltage low	Parking brake module	REFER to WDS.
B1342	Parking brake module is defective	Parking brake module	INSTALL a new parking brake module. REFER toParking Brake Module - in this section. TEST the system for normal operation.

DIAGNOSIS AND TESTING

DTC	Description	Source	Action
$A477	Module configuration failure	Parking brake module	REFER to WDS.
U1262	Communication bus failure	Parking brake module	REFER to WDS.

Symptom Chart

Symptom Chart

Symptom	Possible Sources	Action
• No communication with the parking brake module	• Parking brake assist DLC wiring harness.	• Make sure the parking brake assist DLC wiring harness (orange connector) is connected into the vehicle data link connector. The diagnostic tool connector must be connected to the parking brake assist DLC.
	• Circuit(s). • Parking brake module.	• GO to Pinpoint Test A.
• The parking brake will not apply	• Parking brake control. • Parking brake cable(s). • Circuit(s). • Parking brake module. • Parking brake actuator.	• GO to Pinpoint Test B.
• The parking brake will not release	• Parking brake cable(s) adjustment.	• REFER toParking Brake Cable Adjustment - in this section.
	• Parking brake control. • Parking brake cable(s). • Circuit(s). • Parking brake module. • Parking brake actuator.	• GO to Pinpoint Test C.
• The parking brake assist warning lamp is inoperative	• Circuit(s). • Parking brake switch. • Instrument cluster. • Parking brake module.	• GO to Pinpoint Test D.
• The parking brake warning lamp is flashing fast	• DTC(s) present.	• Go to Parking Brake Assist Diagnostic Trouble Code (DTC) Index.
• The parking brake warning lamp is flashing slowly	• Parking brake calibration. • Parking brake module.	• REFER toParking Brake Cable Adjustment - in this section.
• The parking brake warning lamp is continuously on	• Parking brake control applied.	• Release the parking brake control.
	• Fluid level.	• FILL the system to specification. CHECK for leaks.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Circuit(s). • Parking brake module.	• Go to Parking Brake Assist Diagnostic Trouble Code (DTC) Index.

Pinpoint Tests

NOTE: Use a digital multimeter for all electrical measurements.

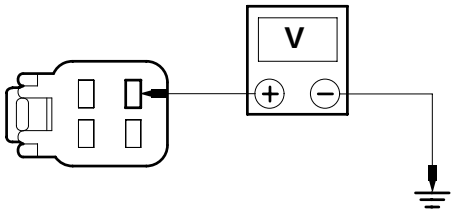
NOTE: Make sure that the parking brake assist is calibrated each time the battery or module is disconnected.

REFER toParking Brake Cable Adjustment - in this section.

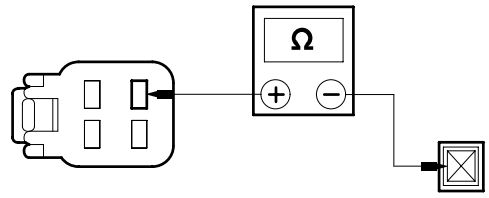
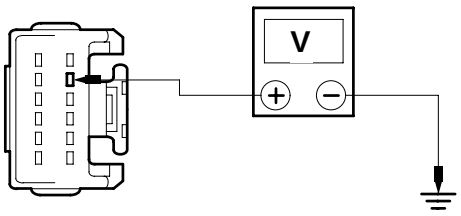
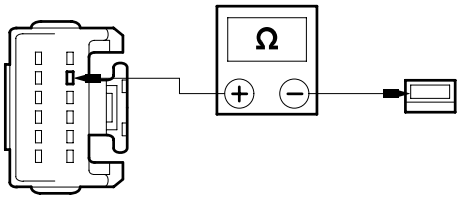
NOTE: When carrying out any measurements on the parking brake module make sure connector C7051b is disconnected before C7051a. Failure to follow this instruction will result in DTC(s) being stored. This could also cause the parking brake assist system to not operate correctly.

NOTE: All measurements on parking brake module connector C7051a must be done before the parking brake module enters the sleep mode, approximately five minutes after the ignition switch is turned to 0 position or the parking brake module is disconnected.

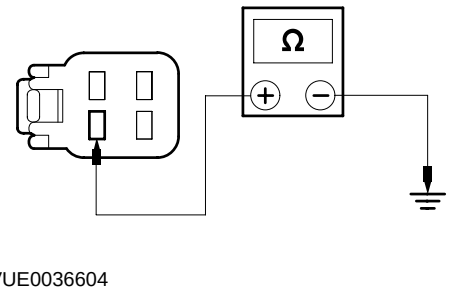
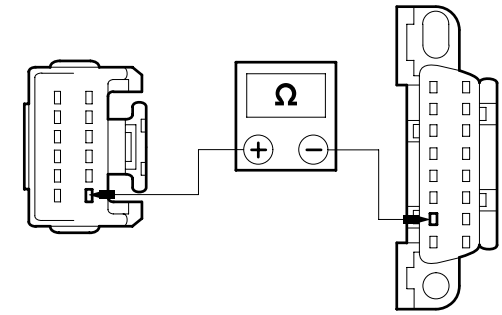
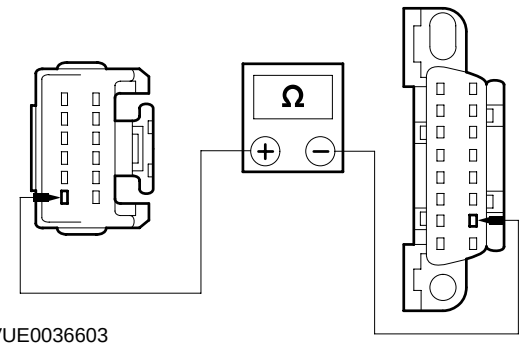
PINPOINT TEST A : NO COMMUNICATION WITH THE PARKING BRAKE MODULE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK THE PARKING BRAKE MODULE FOR VOLTAGE	
	1 Ignition switch in position 0.
	2 DisconnectParking Brake Module C7051b.
 VUE0036597	3 Measure the voltage between the parking brake module C7051b pin 1, circuit 29-XL1 (OG/BU), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A3. → **No** GO to A2.
A2: CHECK CIRCUIT 29-XL1 (OG/BU) FOR OPEN	
	1 DisconnectSVO fusebox C7052.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VUE0036598	2 Measure the resistance between the parking brake module C7051b pin 1, circuit 29-XL1 (OG/BU), harness side and SVO fusebox C7052 pin 1, circuit 29-DG8 (OG/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to A3. → **No** REPAIR the circuit. TEST the system for normal operation.
A3: CHECK THE PARKING BRAKE MODULE FOR SWITCHED VOLTAGE	
	1 DisconnectParking Brake Module C7051a.
	2 Ignition switch in position II.
 VUE0036599	3 Measure the voltage between the parking brake module C7051a pin 5, circuit 14-XL2 (VT/BU), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A5. → **No** GO to A4.
A4: CHECK CIRCUIT 14-XL2 (VT/BU) FOR OPEN	
	1 DisconnectIn-Line Fuse Holder C7055.
 VUE0036600	2 Measure the resistance between the parking brake module C7051a pin 5, circuit 14-XL2 (VT/BU), harness side and In-Line fuse holder C7055, circuit 15-FA5E (GN/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to A5. → **No** Repair the circuit. TEST the system for normal operation.

DIAGNOSIS AND TESTING

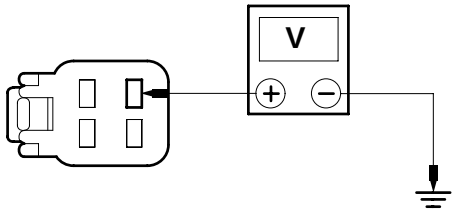
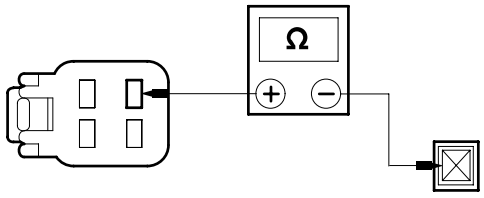
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A5: CHECK THE PARKING BRAKE MODULE FOR GROUND	
 VUE0036604	1 Measure the resistance between the parking brake module C7051b pin 4, circuit 31-XL1 (BK), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** GO to A6. → **No** REPAIR circuit 31-XL1 (BK). TEST the system for normal operation.
A6: CHECK CIRCUIT 4-EG7 (GY/RD) FOR OPEN	
	1 DisconnectDLC C251.
 VUE0036602	2 Measure the resistance between the parking brake module C7051a pin 1, circuit 4-EG7 (GY/RD), harness side and the DLC C251 pin 2, circuit 4-EG7A (BU/RD), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to A7. → **No** REPAIR the circuit(s) as necessary. TEST the system for normal operation.
A7: CHECK CIRCUIT 5-EG7 (BU/RD) FOR OPEN	
 VUE0036603	1 Measure the resistance between the parking brake module C7051a pin 7, circuit 5-EG7 (BU/RD), harness side and the DLC C251 pin 10, circuit 5-EG7A (BU/RD), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new parking brake module. REFER toParking Brake Module - in this section. TEST the system for normal operation. → **No** REPAIR the circuit(s) as necessary. TEST the system for normal operation.

DIAGNOSIS AND TESTING

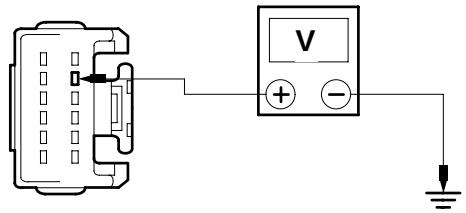
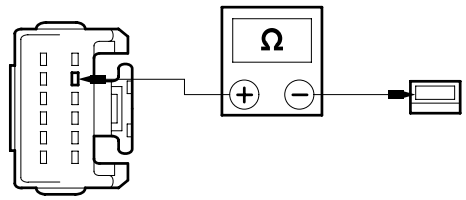
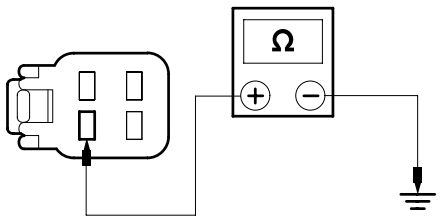
PINPOINT TEST B : THE PARKING BRAKE WILL NOT APPLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK ADJUSTMENT OF THE REAR PARKING BRAKE CABLE	
	1 Operate the parking brake control several times to adjust the cable. • Does the parking brake now engage correctly? → **Yes** Parking brake is OK. TEST the system for normal operation. → **No** GO to B2.
B2: CHECK THE BRAKE SHOES AND BRAKE DRUMS	
	1 Check the brake shoes and drums for grease or fluid on the linings and excessive wear. • Are any concerns present? → **Yes** CLEAN or INSTALL new brake shoes or brake drums as necessary. REFER to Section 206-02 [Drum Brake]. → **No** GO to B3.
B3: CHECK FOR DAMAGED PARKING BRAKE CABLE(S)	
	1 Inspect the parking brake cable(s) for damage, rust or fraying. • Are the parking brake cable(s) OK? → **Yes** GO to B4. → **No** REPAIR or INSTALL parking brake cable(s) as necessary. TEST the system for normal operation.
B4: CHECK OPERATION OF THE PARKING BRAKE ASSIST	
NOTE: The vehicle must be moved up to a maximum of two meters before the parking brake assist system operates.	
	1 Apply the park brake control until the first audible click is heard.

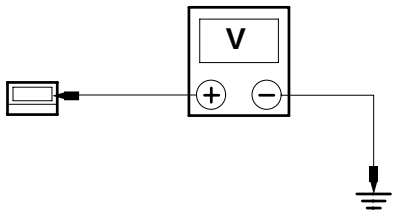
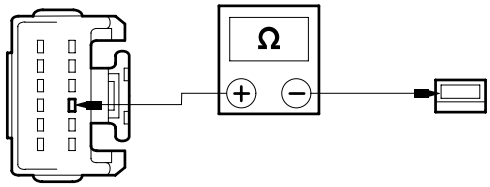
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Move the vehicle in either direction with the parking brake control still applied until the parking brake assist activates. • Does the parking brake assist operate? → **Yes** TEST the system for normal operation. → **No** GO to B5.
B5: CHECK THE PARKING BRAKE MODULE FOR VOLTAGE	
	1 Ignition switch in position 0.
	2 DisconnectParking Brake Module C7051b.
 VUE0036597	3 Measure the voltage between the parking brake module C7051b pin 1, circuit 29-XL1 (OG/BU), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to B7. → **No** GO to B6.
B6: CHECK CIRCUIT 29-XL1 (OG/BU) FOR OPEN	
	1 DisconnectSVO fusebox C7052.
 VUE0036598	2 Measure the resistance between the parking brake module C7051b pin 1, circuit 29-XL1 (OG/BU), harness side and SVO fusebox C7052 pin 1, circuit 29-DG8 (OG/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B7. → **No** REPAIR the circuit. TEST the system for normal operation.
B7: CHECK THE PARKING BRAKE MODULE FOR SWITCHED VOLTAGE	
	1 DisconnectParking Brake Module C7051a.
	2 Ignition switch in position II.

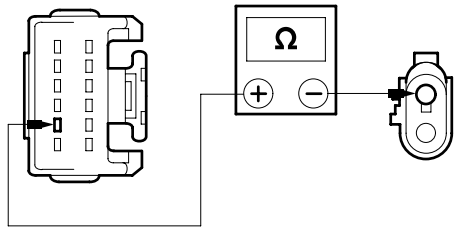
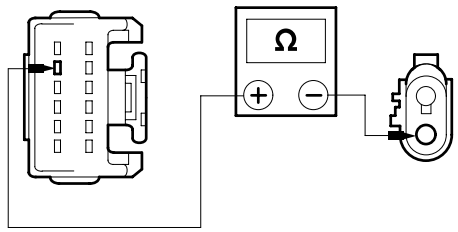
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VUE0036599	3 Measure the voltage between the parking brake module C7051a pin 5, circuit 14-XL2 (VT/BU), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to B9. → **No** GO to B8.
B8: CHECK CIRCUIT 14-XL2 (VT/BU) FOR OPEN	
	1 DisconnectIn-Line Fuse Holder C7055.
 VUE0036600	2 Measure the resistance between the parking brake module C7051a pin 5, circuit 14-XL2 (VT/BU), harness side and In-Line fuse holder C7055, circuit 15-FA5E (GN/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B9. → **No** REPAIR the circuit. TEST the system for normal operation.
B9: CHECK THE PARKING BRAKE MODULE FOR GROUND	
	1 ConnectParking Brake Module C7051a. 2 DisconnectParking Brake Module C7051b.
 VUE0036604	3 Measure the resistance between the parking brake module C7051b pin 4, circuit 31-XL1 (BK), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** GO to B10. → **No** REPAIR circuit 31-XL1 (BK). TEST the system for normal operation.
B10: CHECK PARK BRAKE SWITCH	
	1 DisconnectPark Brake Switch C4066.

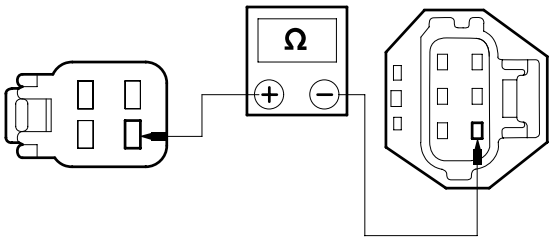
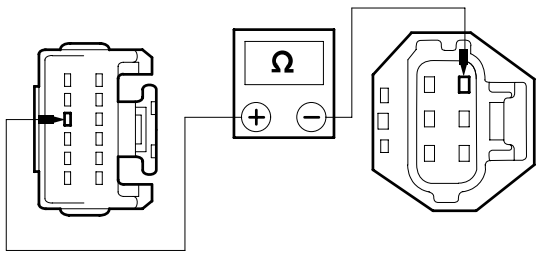
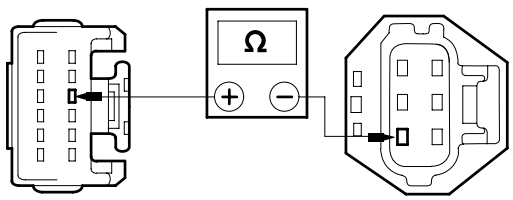
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Ignition switch in position II.
 VUE0036605	3 Measure the voltage between the park brake switch C4066 pin 1, circuit 31S-GE44 (BK-RD), component side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to B11. → **No** INSTALL a new park brake switch. TEST the system for normal operation.
B11: CHECK CIRCUIT 31S-GE44 (BK/RD) FOR OPEN	
	1 DisconnectParking Brake Module C7051a.
 VUE0036606	2 Measure the resistance between the parking brake module C7051a pin 3, circuit 31S-GE44C (BK/RD), harness side and the park brake switch C4066 pin 1, circuit 31S-GE44 (BK/RD), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B12. → **No** REPAIR the circuit. TEST the system for normal operation.
B12: CHECK THE PARKING BRAKE WHEEL SPEED SENSOR USING WDS OSCILLOSCOPE	
	1 ConnectParking Brake Module C7051a.
	2 DisconnectParking Brake Wheel Speed Sensor C7057.

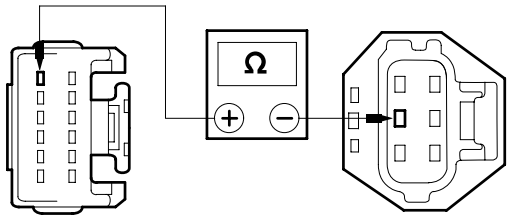
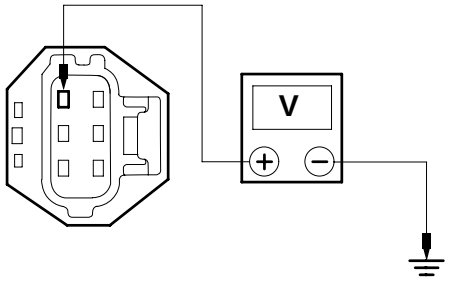
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Using WDS oscilloscope, measure the parking brake wheel speed sensor input signal frequency between the speed sensor connector pin 1 and pin 2, while rotating the front right-hand wheel. • Is the frequency pattern within working parameters? → **Yes** GO to B13. → **No** CHECK the wheel knuckle wheel speed sensor mounting is clean and free from foreign material. If the concern persists, INSTALL a new parking brake wheel speed sensor. REFER toParking Brake Wheel Speed Sensor - in this section. TEST the system for normal operation.
B13: CHECK CIRCUIT 8-XL6 (WH/BU) FOR OPEN	
	1 DisconnectParking Brake Module C7051a.
 VUE0036607	2 Measure the resistance between the parking brake wheel speed sensor C7057 pin 1, circuit 8-XL6 (WH/BU), harness side and the parking brake module C7051a, pin 8, circuit 8-XL6 (WH/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B14. → **No** REPAIR the circuit. TEST the system for normal operation.
B14: CHECK CIRCUIT 10-XL6 (GY/VT) FOR OPEN	
 VUE0036608	1 Measure the resistance between the parking brake wheel speed sensor C7057 pin 2, circuit 10-XL6 (GY/VT), harness side and the parking brake module C7051a, pin 11, circuit 10-XL6 (GY/VT), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B15. → **No** REPAIR the circuit. TEST the system for normal operation.

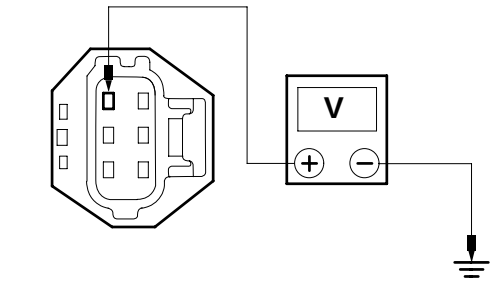
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B15: CHECK CIRCUIT 29S-XL2 (OG/BU) FOR OPEN	
	1 DisconnectParking Brake Actuator C7058.
	2 DisconnectParking Brake Module C7051b.
 VUE0036609	3 Measure the resistance between the parking brake actuator C7058 pin 1, circuit 29S-XL2 (OG/BU), harness side and the parking brake module C7051b pin 3, circuit 29S-XL2 (OG/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B16. → **No** REPAIR the circuit. TEST the system for normal operation.
B16: CHECK CIRCUIT 7-XL4 (YE/RD) FOR OPEN	
 VUE0036610	1 Measure the resistance between the parking brake actuator C7058 pin 3, circuit 7-XL4 (YE/RD), harness side and the parking brake module C7051a pin 10, circuit 7-XL4 (YE/RD), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B17. → **No** REPAIR the circuit. TEST the system for normal operation.
B17: CHECK CIRCUIT 8-XL4 (WH/RD) FOR OPEN	
 E0036611	1 Measure the resistance between the parking brake actuator C7058 pin 4, circuit 8-XL4 (WH/RD), harness side and the parking brake module C7051a pin 4, circuit 8-XL4 (WH/RD), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B18. → **No** REPAIR the circuit. TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B18: CHECK CIRCUIT 9-XL4 (BN/RD) FOR OPEN	
 VUE0036612	1 Measure the resistance between the parking brake actuator C7058 pin 5, circuit 9-XL4 (BN/RD), harness side and the parking brake module C7051a pin 12, circuit 9-XL4 (BN/RD), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B19. → **No** REPAIR the circuit. TEST the system for normal operation.
B19: CHECK FOR SUPPLY VOLTAGE TO THE PARKING BRAKE ACTUATOR	
	1 ConnectParking Brake Module C7051b.
 VUE0036613	2 Measure the voltage by backprobing between the parking brake actuator C7058 pin 6, circuit 31S-XL2 (BK/BU), harness side and ground. • Is any voltage present? → **Yes** GO to B20. → **No** INSTALL a new parking brake actuator. REFER toParking Brake Actuator - in this section. TEST the system for normal operation. If the concern persists, INSTALL a new parking brake module. REFER toParking Brake Module - in this section. TEST the system for normal operation.
B20: CHECK FOR SHORT TO BATTERY POSITIVE VOLTAGE	
	1 DisconnectParking Brake Module C7051b.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VUE0036613	2 Measure the voltage between the parking brake actuator C7058 pin 6, circuit 31S-XL2 (BK/BU), harness side and ground. • Is any voltage present? → **Yes** REPAIR the short to battery positive. TEST the system for normal operation. → **No** INSTALL a new parking brake module. REFER to Parking Brake Module - in this section. TEST the system for normal operation.

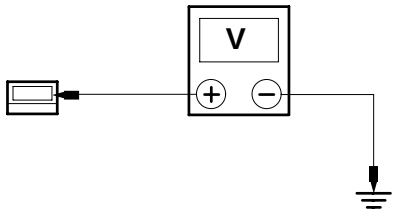
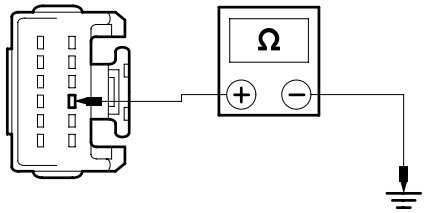
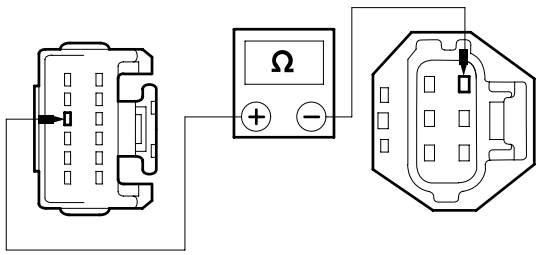
PINPOINT TEST C : THE PARKING BRAKE WILL NOT RELEASE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CHECK THE PARKING BRAKE CONTROL	
	1 Raise and support the vehicle on a wheel-free lift with the parking brake fully applied. REFER to Section 100-02 [Jacking and Lifting]. – Release the parking brake. • Did the parking brake release? → **Yes** INSPECT for other causes such as conventional brake system components. REPAIR or INSTALL new components as necessary. REFER to Section 206-00 [Brake System - General Information]. → **No** GO to C2.
C2: CHECK THE PARKING BRAKE CABLE	
	1 Loosen the parking brake cable tension at the parking brake cable equalizer. – Rotate the rear wheels by hand. • Did the rear wheels turn freely? → **Yes** INSTALL a new parking brake control. REFER to Parking Brake Control - in this section. TEST the system for normal operation. If the concern persists, GO to C5. → **No** GO to C3.

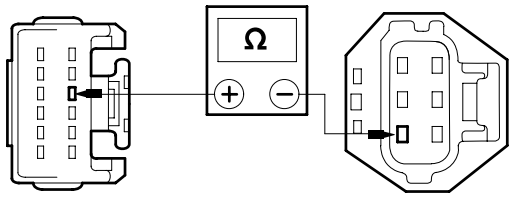
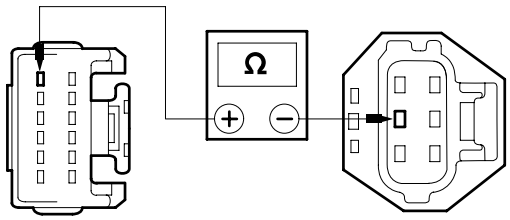
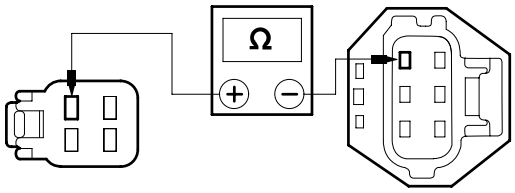
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C3: CHECK THE FRONT PARKING BRAKE CABLE	
	1 Disconnect the parking brake cable from the rear parking brake cable at the parking brake cable equalizer. – Rotate the rear wheels by hand. • Did the rear wheels turn freely? → **Yes** INSTALL a new front parking brake cable. REFER toParking Brake Front Cable - in this section. TEST the system for normal operation. → **No** GO to C4.
C4: CHECK THE REAR PARKING BRAKE CABLES	
	1 Disconnect the rear parking brake cable at the rear brakes, one at a time. REFER toParking Brake Cablein this section. – Rotate the wheel affected by the disconnected parking brake cable. • Did the wheel turn freely? → **Yes** INSTALL a new rear parking brake cable. REFER toParking Brake Rear Cables - in this section. TEST the system for normal operation. → **No** INSPECT for other causes such as conventional brake system components. REPAIR or INSTALL new components as necessary. REFER to Section 206-00 [Brake System - General Information].
C5: CHECK PARK BRAKE SWITCH	
	1 DisconnectPark Brake Switch C4066.
	2 Ignition switch in position II.

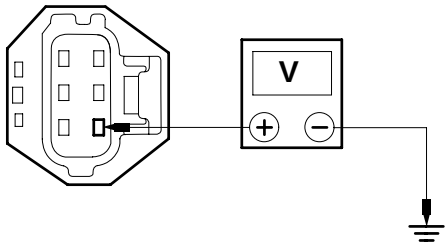
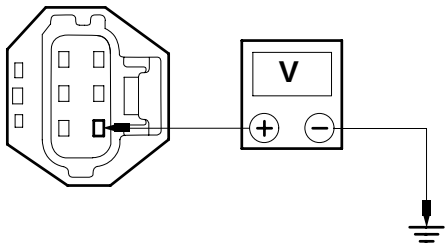
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VUE0036605	3 Measure the voltage between the park brake switch C4066 pin 1, circuit 31S-GE44 (BK-RD), component side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to C6. → **No** INSTALL a new park brake switch. TEST the system for normal operation.
C6: CHECK CIRCUIT 31S-GE44C (BK/RD) FOR SHORT TO GROUND	
	1 DisconnectParking Brake Module C7051a.
 VUE0036614	2 Measure the resistance between the parking brake module C7051a pin 3, circuit 31S-GE44C (BK/RD), harness side and ground. • Is the resistance greater than 10,000 ohms? → **Yes** GO to C7. → **No** REPAIR the short to ground. TEST the system for normal operation.
C7: CHECK CIRCUIT 7-XL4 (YE/RD) FOR OPEN	
	1 DisconnectParking Brake Actuator C7058.
 VUE0036610	2 Measure the resistance between the parking brake actuator C7058 pin 3, circuit 7-XL4 (YE/RD), harness side and the parking brake module C7051a pin 10, circuit 7-XL4 (YE/RD), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to C8. → **No** REPAIR the circuit. TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C8: CHECK CIRCUIT 8-XL4 (WH/RD) FOR OPEN	
 E0036611	1 Measure the resistance between the parking brake actuator C7058 pin 4, circuit 8-XL4 (WH/RD), harness side and the parking brake module C7051a pin 4, circuit 8-XL4 (WH/RD), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to C9. → **No** REPAIR the circuit. TEST the system for normal operation.
C9: CHECK CIRCUIT 9-XL4 (BN/RD) FOR OPEN	
 VUE0036612	1 Measure the resistance between the parking brake actuator C7058 pin 5, circuit 9-XL4 (BN/RD), harness side and the parking brake module C7051a pin 12, circuit 9-XL4 (BN/RD), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to C10. → **No** REPAIR the circuit. TEST the system for normal operation.
C10: CHECK CIRCUIT 31S-XL2 (BK/BU) FOR OPEN	
	1 DisconnectParking Brake Module C7051b.
 VUE0036615	2 Measure the resistance between the parking brake actuator C7058 pin 6, circuit 31S-XL2 (BK/BU), harness side and the parking brake module C7051b pin 2, circuit 31S-XL2 (BK/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to C11. → **No** REPAIR the circuit. TEST the system for normal operation.
C11: CHECK FOR SUPPLY VOLTAGE TO THE PARKING BRAKE ACTUATOR	
	1 ConnectParking Brake Module C7051b.

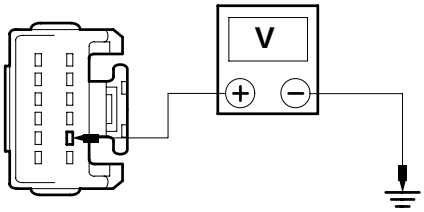
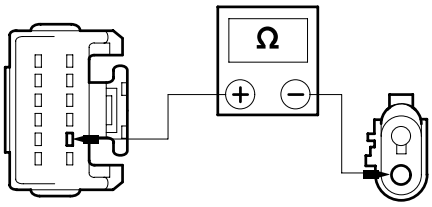
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VUE0036616	2 Measure the voltage by backprobing between the parking brake actuator C7058 pin 1, circuit 29S-XL2 (OG/BU), harness side and ground. • Is any voltage present? → **Yes** GO to C12. → **No** INSTALL a new parking brake actuator. REFER toParking Brake Actuator - in this section. TEST the system for normal operation. If the concern persists, INSTALL a new Parking brake module. REFER toParking Brake Module - in this section. TEST the system for normal operation.
C12: CHECK FOR SHORT TO BATTERY POSITIVE	
	1 DisconnectParking Brake Module C7051b.
 VUE0036616	2 Measure the voltage between the parking brake actuator C7058 pin 1, circuit 29S-XL2 (OG/BU), harness side and ground. • Is any voltage present? → **Yes** REPAIR the short to battery positive. TEST the system for normal operation. → **No** INSTALL a new parking brake module. REFER toParking Brake Module - in this section. TEST the system for normal operation.

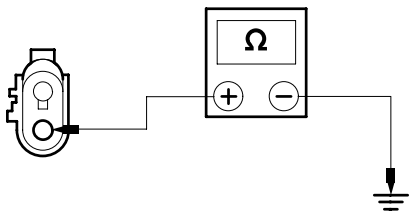
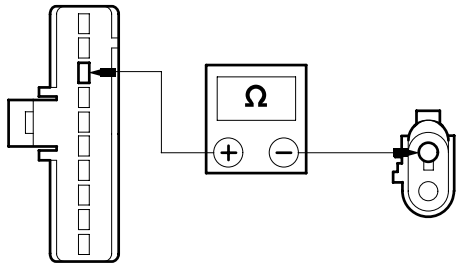
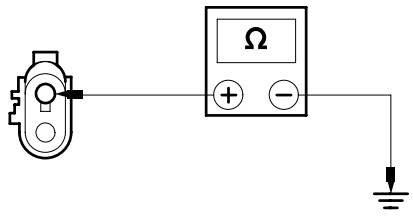
PINPOINT TEST D : THE PARKING BRAKE WARNING LAMP IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: CHECK PARKING BRAKE WARNING LAMP CIRCUIT FOR BATTERY POSITIVE	
	1 Ignition switch in position 0.
	2 DisconnectParking Brake Module C7051a.
	3 Ignition switch in position II.

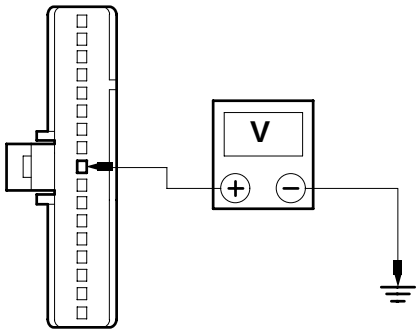
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VUE0036648	4 Measure the voltage between the parking brake module C7051a pin 2, circuit 31S-GE43 (BK/GN), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** INSTALL a new parking brake module. REFER toParking Brake Module - in this section. TEST the system for normal operation. → **No** GO to D2.
D2: CHECK PARK LAMP ENABLE DIODE	
	1 DisconnectPark Lamp Enable Diode C2054.
	2 Measure the resistance between the park lamp enable diode pin 1 and pin 2. • Is the resistance high one way and low when the multimeters test leads are reversed? → **Yes** GO to D3. → **No** INSTALL a new park lamp enable diode. TEST the system for normal operation.
D3: CHECK CIRCUIT 31S-GE44A (BK/RD) FOR OPEN	
 VUE0036649	1 Measure the resistance between the park lamp enable diode C2054 pin 2, circuit 31S-GE44A (BK/RD), harness side and parking brake module C7051a pin 2, circuit 31S-GE43 (BK/GN), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to D4. → **No** REPAIR the circuit. TEST the system for normal operation.

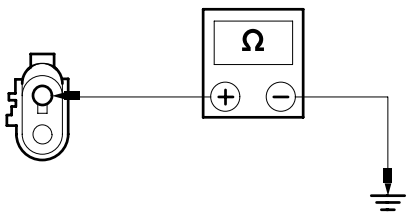
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D4: CHECK CIRCUIT 31S-GE44A (BK/RD) FOR SHORT TO GROUND	
 VUE0036650	1 Measure the resistance between the park lamp enable diode C2054 pin 2, circuit 31S-GE44A (BK/RD), harness side and ground. • Is the resistance greater than 10,000 ohms? → **Yes** GO to D5. → **No** REPAIR the short to ground. TEST the system for normal operation.
D5: CHECK CIRCUIT 31S-GC7 (BK/BU) FOR OPEN	
	1 DisconnectInstrument Cluster C220b.
 VUE0036651	2 Measure the resistance between the instrument cluster C220b pin 3, circuit 31S-GC7 (BK/BU), harness side and park lamp enable diode C2054 pin 1, circuit 31S-XL4 (BK/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to D6. → **No** REPAIR the circuit. TEST the system for normal operation.
D6: CHECK CIRCUIT 31S-GC7 (BK/BU) FOR SHORT TO GROUND	
	1 ConnectInstrument Cluster C220b.
 VUE0036652	2 Measure the resistance between the park lamp enable diode C2054 pin 1, circuit 31S-GC7 (BK/BU), harness side and ground. • Is the resistance greater than 10,000 ohms? → **Yes** GO to D7. → **No** REPAIR the short to ground. TEST the system for normal operation.
D7: CHECK THE INSTRUMENT CLUSTER FOR BATTERY POSITIVE	
	1 DisconnectInstrument Cluster C220a.
	2 Ignition switch in position II.

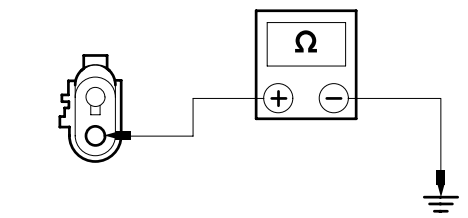
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VUE0036653	3 Measure the voltage between the instrument cluster C220a pin 9, circuit 15 LK29 (GN/BU), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** REPLACE the instrument cluster. REFER to Section 413-01 [Instrument Cluster]. TEST the system for normal operation. → **No** REPAIR circuit 15 LK29 (GN/BU). TEST the system for normal operation.

PINPOINT TEST E : PARKING BRAKE WHEEL SPEED SENSOR WIRE(S) SHORT TO GROUND

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: CHECK CIRCUIT 8-XL6 (WH/BU) FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 DisconnectParking Brake Module C7051a.
	3 DisconnectParking Brake Wheel Speed Sensor C7057.
 VUE0036654	4 Measure the resistance between the parking brake wheel speed sensor C7057 pin 1, circuit 8-XL6 (WH/BU), harness side and ground. • Is the resistance greater than 10,000 ohms? → **Yes** GO to E2. → **No** REPAIR the short to ground. TEST the system for normal operation.

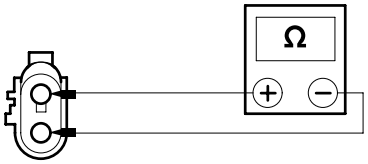
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E2: CHECK CIRCUIT 10-XL6 (GY/VT) FOR SHORT TO GROUND	
 VUE0036655	1 Measure the resistance between the parking brake wheel speed sensor C7057 pin 2, circuit 10-XL6 (GY/VT), harness side and ground. • Is the resistance greater than 10,000 ohms? → **Yes** INSTALL a new parking brake wheel speed sensor. REFER toParking Brake Wheel Speed Sensor - in this section. TEST the system for normal operation. If the concern persists INSTALL a new Parking brake module. REFER toParking Brake Module - in this section. TEST the system for normal operation. → **No** REPAIR the short to ground. TEST the system for normal operation.

PINPOINT TEST F : PARKING BRAKE WHEEL SPEED SENSOR WIRE(S) SHORTED TOGETHER

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F1: CHECK PARKING BRAKE WHEEL SPEED SENSOR CIRCUITS FOR SHORT	
	1 Ignition switch in position 0.
	2 DisconnectParking Brake Module C7051a.
	3 DisconnectParking Brake Wheel Speed Sensor C7057.

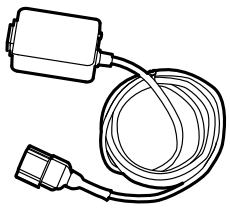
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VUE0036656	4 Measure the resistance between the parking brake wheel speed sensor C7057 pin 1, circuit 8-XL4 (WH/BU), harness side and pin 2, circuit 10-XL6 (GY/VT), harness side. • Is the resistance greater than 10,000 ohms? → **Yes** INSTALL a new parking brake wheel speed sensor. REFER toParking Brake Wheel Speed Sensor - in this section. TEST the system for normal operation. If the concern persists INSTALL a new parking brake module. REFER toParking Brake Module - in this section. TEST the system for normal operation. → **No** REPAIR the short circuit. TEST the system for normal operation.

GENERAL PROCEDURES

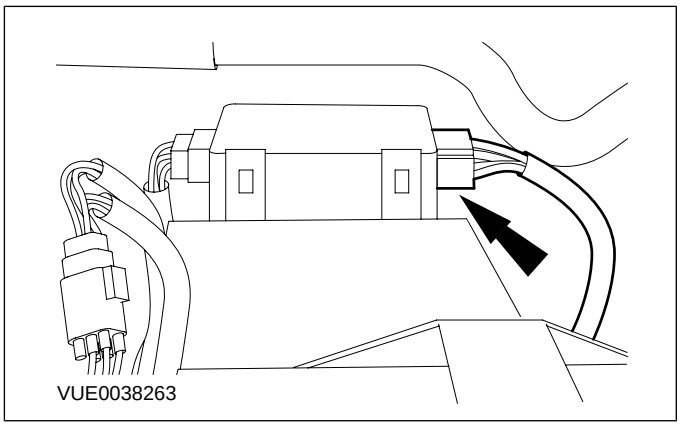
Parking Brake Cable Adjustment (12 662 0)

Special Tool(s)

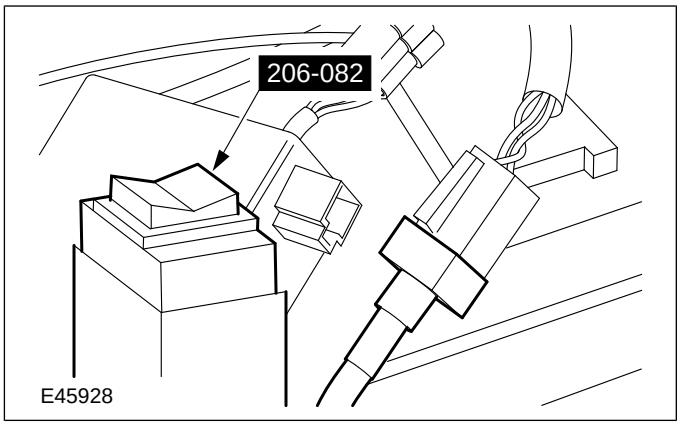
 206-082	Electric parking brake release tool 206-082

Adjustment

1. **Remove the plastic cover from under the driver seat.**
2. **Slide the driver seat fully forward.**
3. **Disconnect the parking brake assist control module electrical connector.**

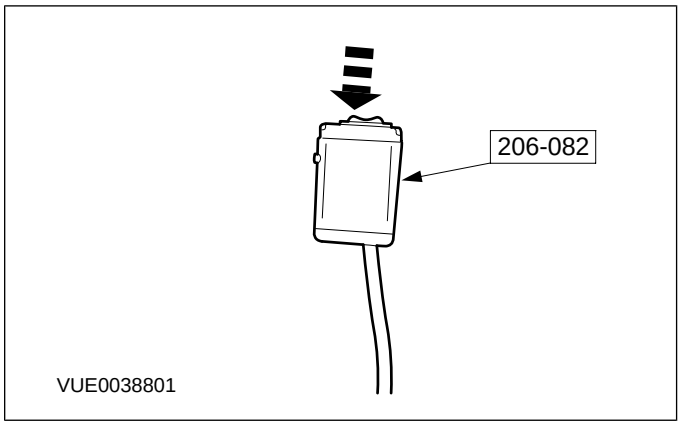


4. **Connect the special tool to the parking brake assist control module wiring harness electrical connector.**



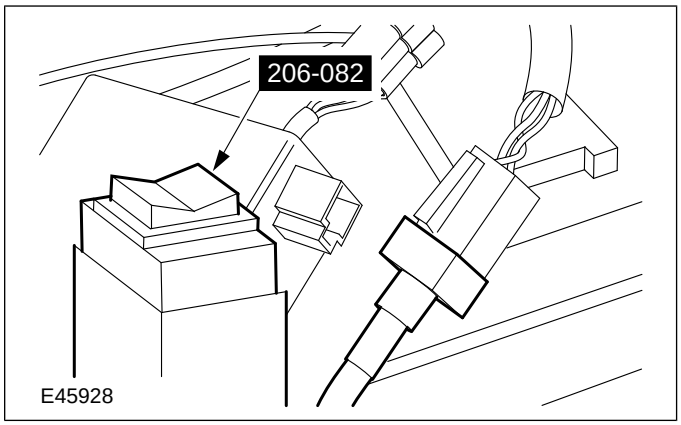
5. **⚠CAUTION:Make sure the special tool is used to release the parking brake assist actuator in this step. Observe the parking brake assist mechanism while operating the special tool and make sure the parking brake assist actuator is releasing. Failure to follow this instruction may result in damage to the parking brake assist system.**

   Push down and hold the special tool rocker switch to fully release the parking brake assist actuator, release the rocker switch when an audible clicking is heard.



6. **NOTE:Do not connect the parking brake assist control module electrical connector to the parking brake assist control module after disconnecting the special tool.**

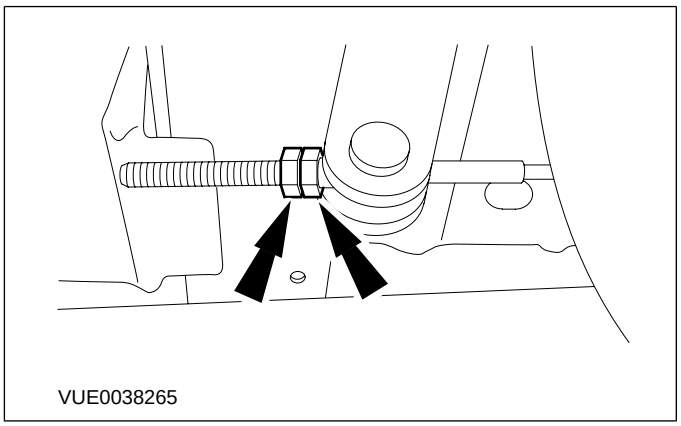
   Disconnect the special tool from the parking brake assist control module electrical connector.



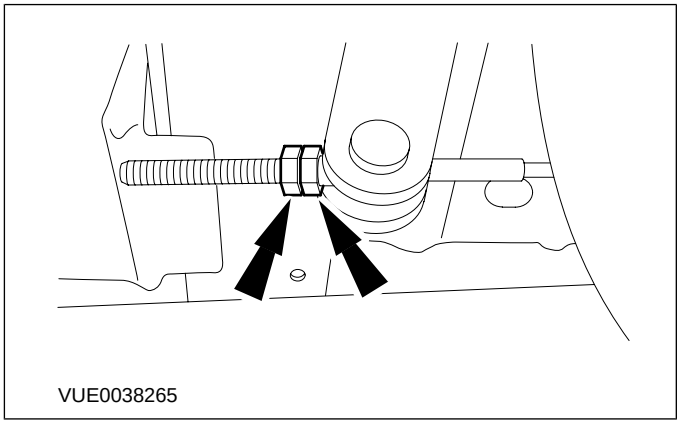
7. **Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].**
8. **Check the parking brake assist cable has fully released, the cable will appear longer than before and allow the relay lever to rotate more toward the rear of the vehicle.**

GENERAL PROCEDURES

9. Remove the parking brake assist cable locking nut and the parking brake assist cable adjustment nut from the parking brake assist cable.

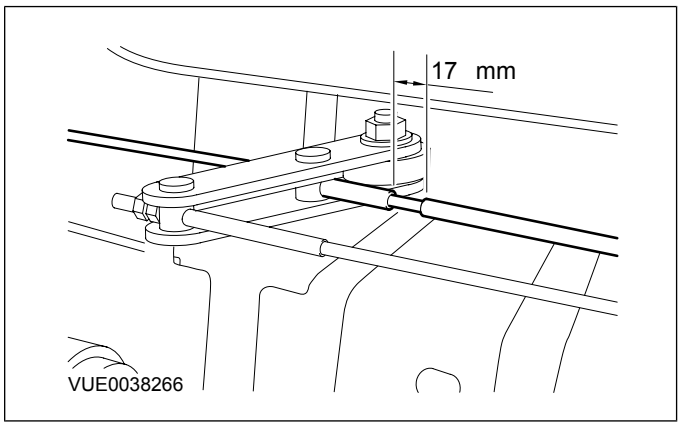


10. Adjust the standard parking brake cable. For additional information, refer to Section 206-05A [Parking Brake and Actuation] / 206-05B [Parking Brake and Actuation -- Vehicles With: Parking Brake Assist].
11. Apply the parking brake lever until one audible click is heard.
12. Install the parking brake assist cable adjustment nut and loosely install the parking brake assist cable locking nut to the parking brake assist cable.

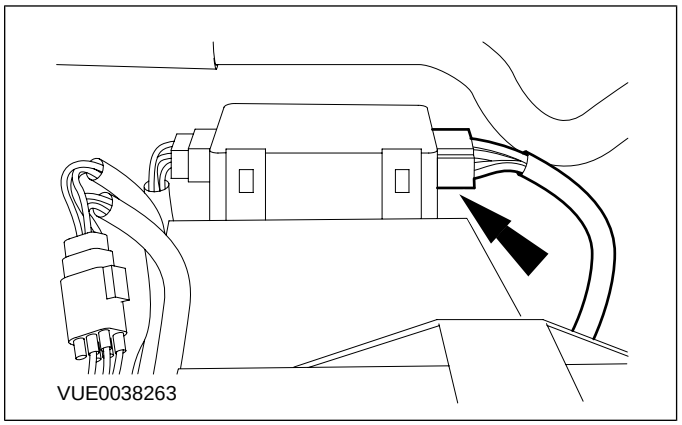


13. NOTE:Make sure the relay lever is rotated fully toward the rear of the vehicle. This will pre-tension the parking brake assist cable during adjustment.

Adjust the parking brake assist cable adjustment nut to give a distance of 17mm between the T connector and the connector between the front and intermediate cables.



14. Set the parking brake assist cable locking nut up against the parking brake assist cable adjustment nut.
15. Partially lower the vehicle.
16. Release the parking brake lever.
17. Connect the parking brake assist control module electrical connector.



18. Turn the ignition switch to position II.
19. NOTE:The parking brake assist warning light in the instrument cluster will begin to flash. Make sure the light flashes at a rate of 1 Hz during this test. If the light flashes at a rate of 5 Hz it will be accompanied by a warning chime and this indicates a failure within the parking brake assist system.

    Apply the parking brake lever until one audible click is heard and check the parking brake assist warning light begins to flash in the instrument cluster. This will calibrate the parking brake assist control module.
20. Release the parking brake lever.

GENERAL PROCEDURES

21. Rotate the rear wheels and check the parking brake assist has fully released.
22. Check the operation of the parking brake assist.

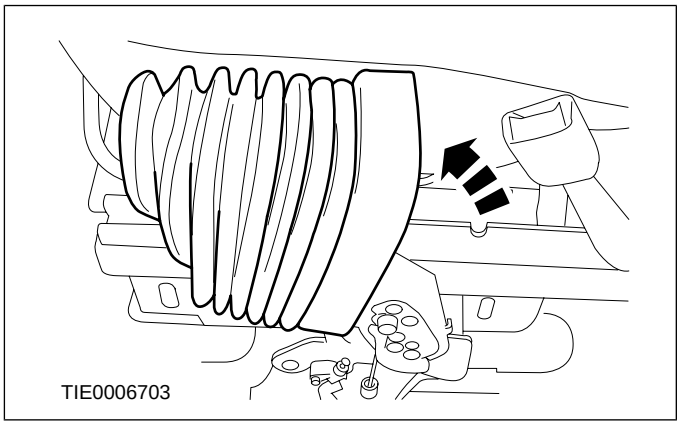
REMOVAL AND INSTALLATION

Parking Brake Control (12 664 0)

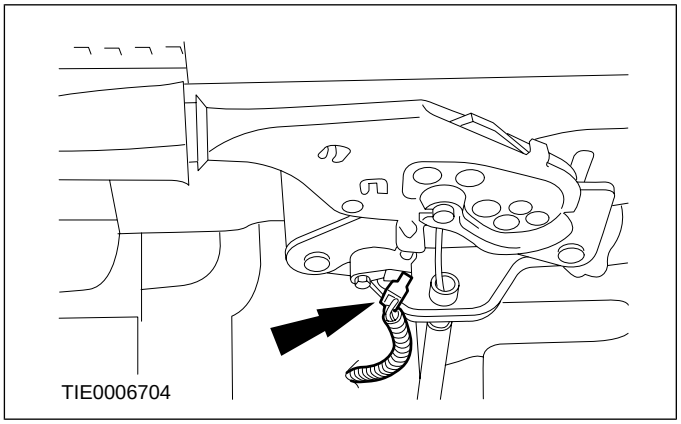
Materials	
Name	**Specification**
Molybdenum disulphide grease	WSD-M1C230-A

Removal

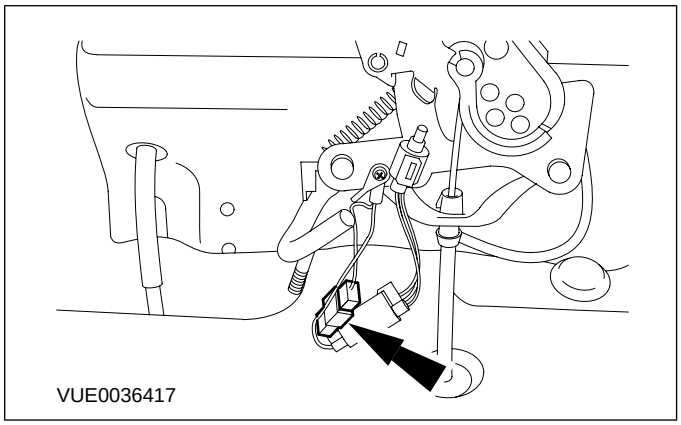
1. **Release the parking brake.**
2. **Remove the parking brake control boot.**



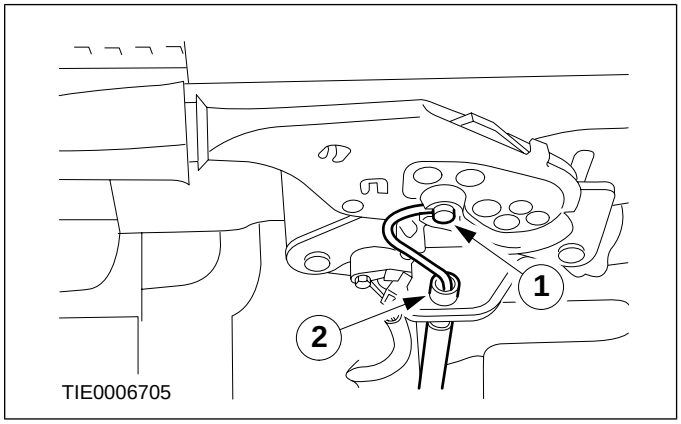
3. **Disconnect the parking brake warning indicator switch electrical connector.**



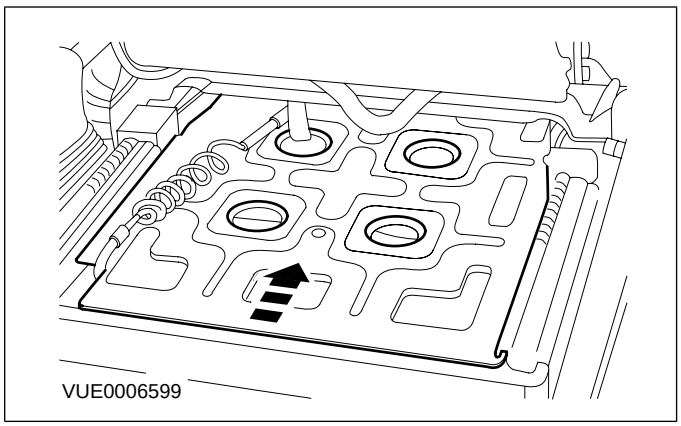
4. **Disconnect the parking brake warning indicator switch electrical connector.**



5. **Detach the front parking brake cable.**
   1. Detach the front parking brake cable from the parking brake control.
   2. Detach the front parking brake cable from the parking brake control bracket.

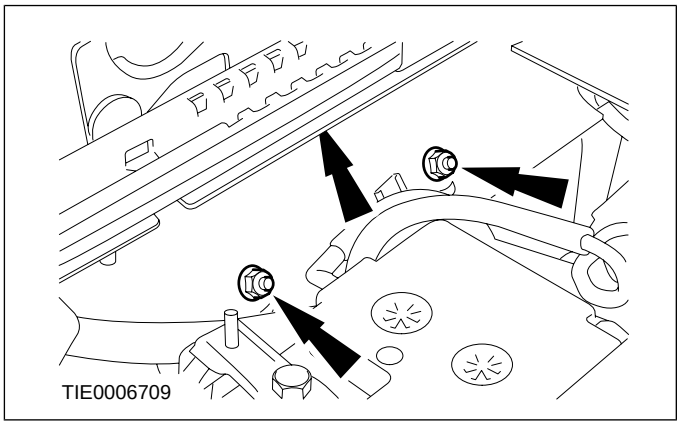


6. **Slide the driver seat forwards.**
7. **Slide the battery cover forwards.**



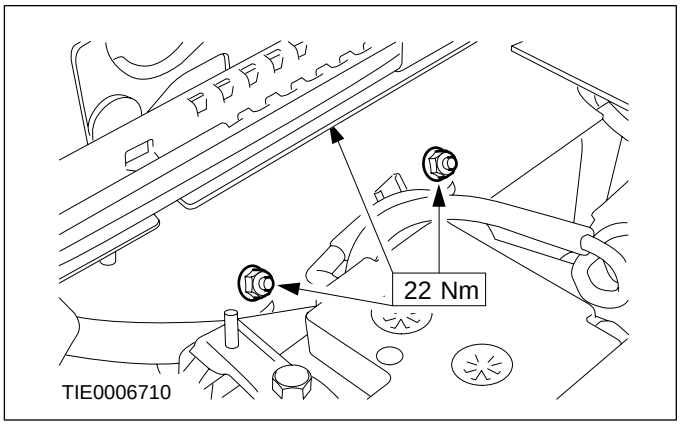
REMOVAL AND INSTALLATION

8. Remove the parking brake control.



Installation

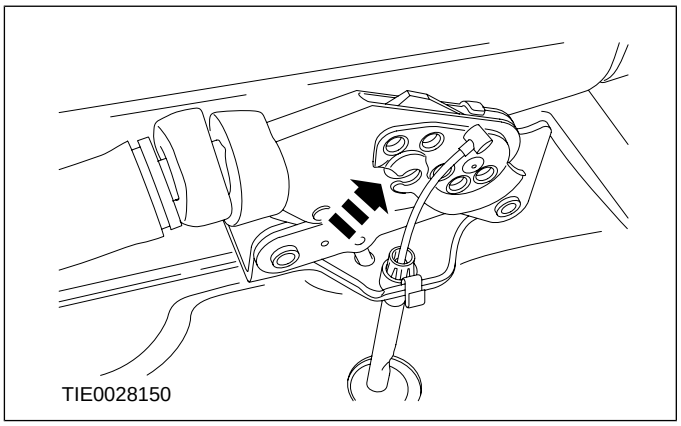
1. Install the parking brake control.



2. Slide the battery cover rearwards.

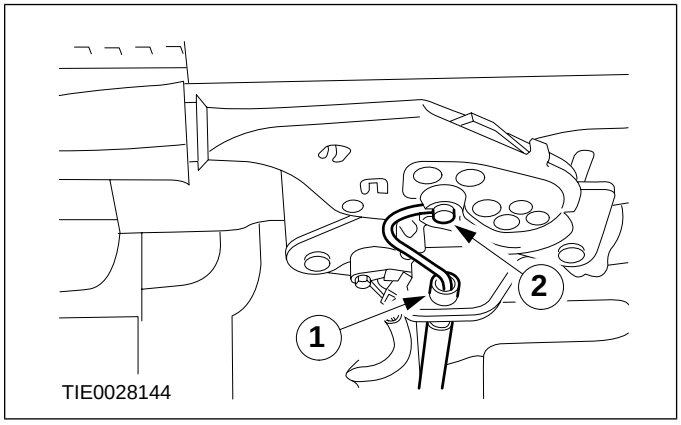
3. Slide the driver seat rearwards.

4. Apply Molybdenum disulphide grease to the mating surfaces of the parking brake control and the front parking brake cable end.

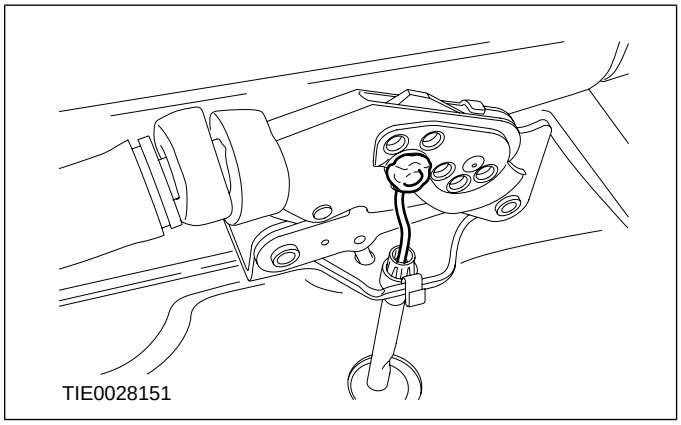


5. Attach the front parking brake cable.

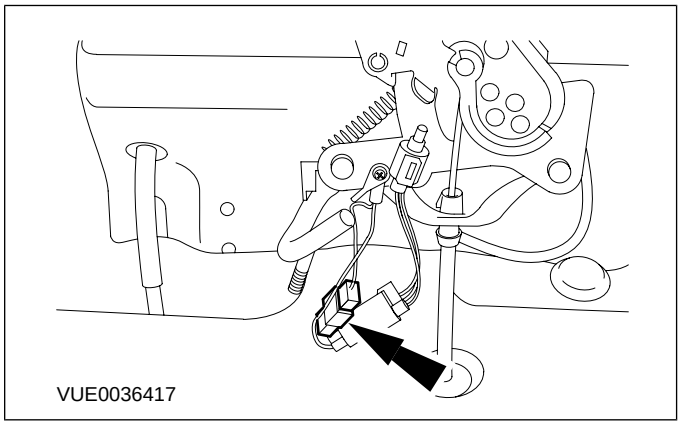
1. Attach the front parking brake cable to the parking brake control bracket.
2. Attach the front parking brake cable to the parking brake control.



6. Apply excess Molybdenum disulphide grease over the exposed surface of the front parking brake cable end.

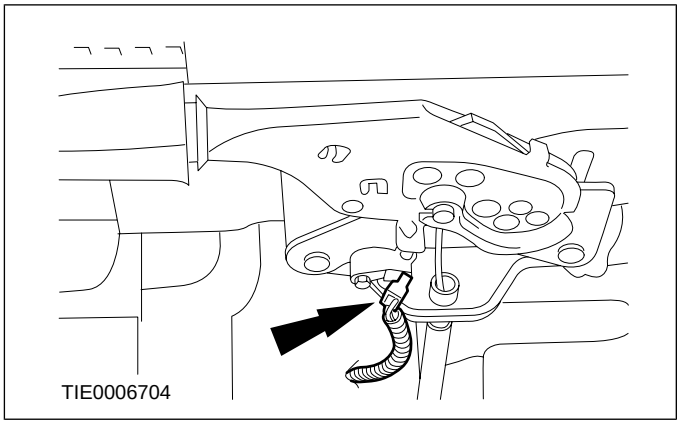


7. Connect the parking brake warning indicator switch electrical connector.

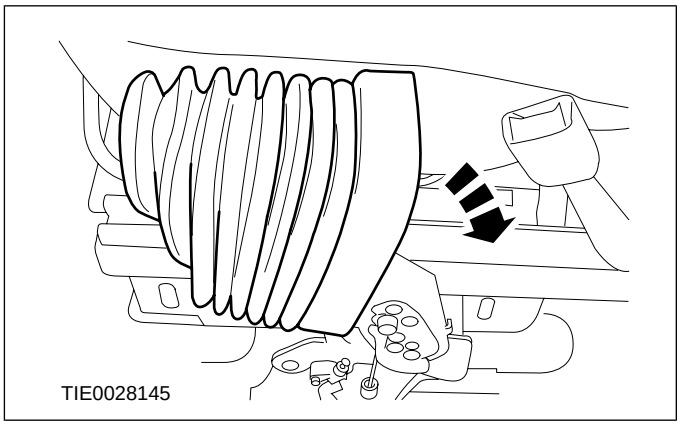


REMOVAL AND INSTALLATION

8. Connect the parking brake warning indicator switch electrical connector.



9. Install the parking brake control boot.



10. Adjust the parking brake.

For additional information, refer to Parking Brake Cable Adjustment - in this section.

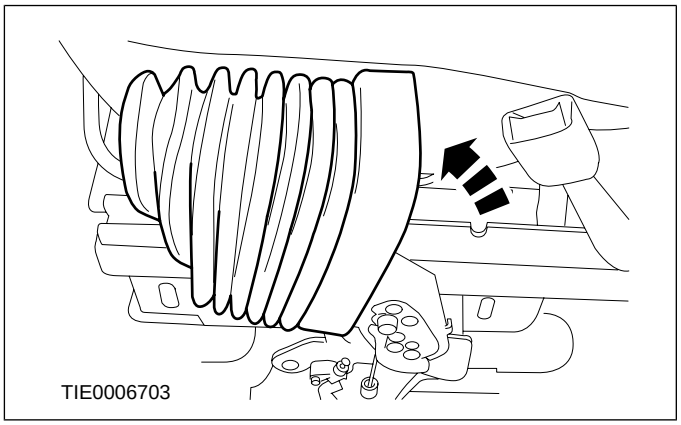
REMOVAL AND INSTALLATION

Parking Brake Front Cable

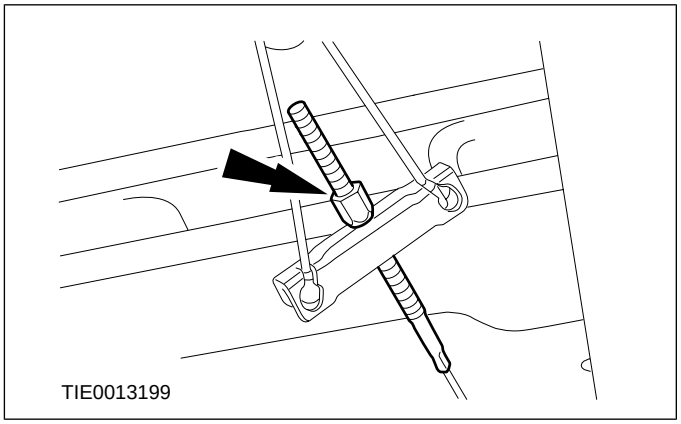
Materials	
Name	**Specification**
Molybdenum disulphide grease	WSD-M1C230-A

Removal

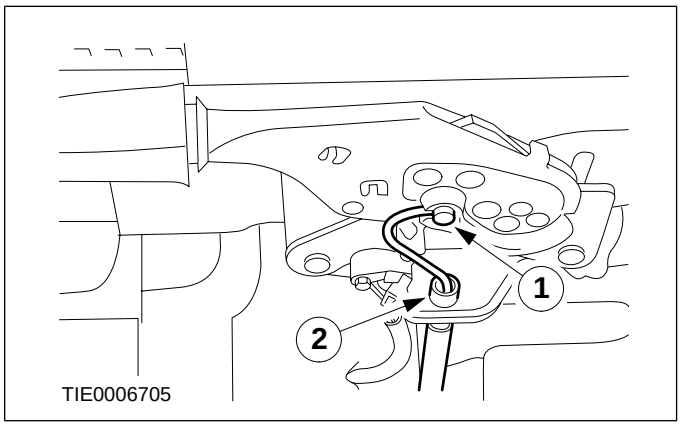
1. **Release the parking brake.**
2. **Remove the parking brake control boot.**



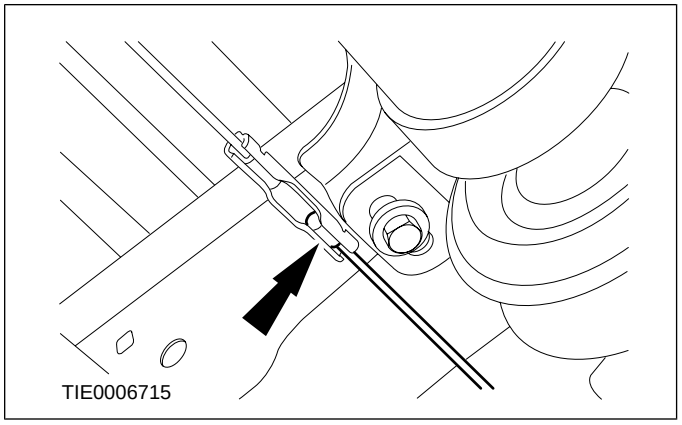
3. **Loosen the parking brake cable adjustment nut.**



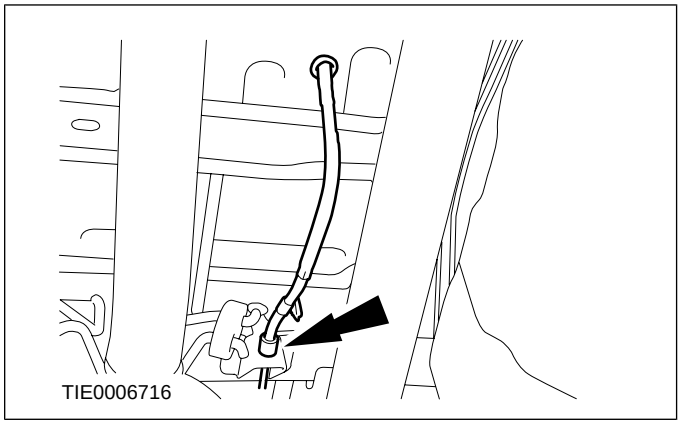
4. **Detach the front parking brake cable.**
   1. Detach the front parking brake cable from the parking brake control.
   2. Detach the front parking brake cable from the parking brake control bracket.



5. **Detach the intermediate parking brake cable from the retainer.**



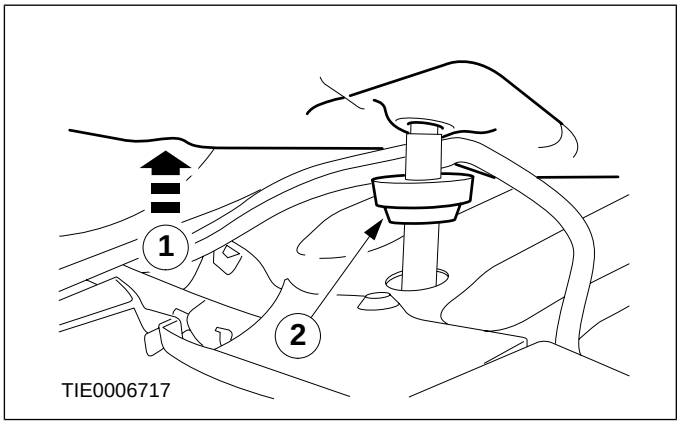
6. **Detach the front parking brake cable from the retaining bracket.**



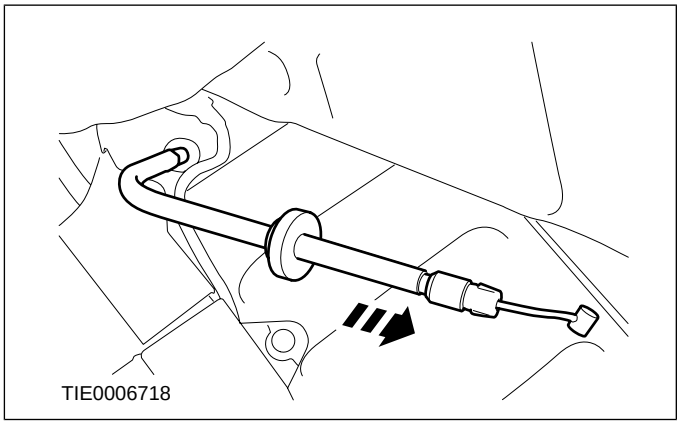
7. **Detach the front parking brake cable from the floor.**
   1. Detach the floor covering.

REMOVAL AND INSTALLATION

2. Detach the cable grommet from the floor.

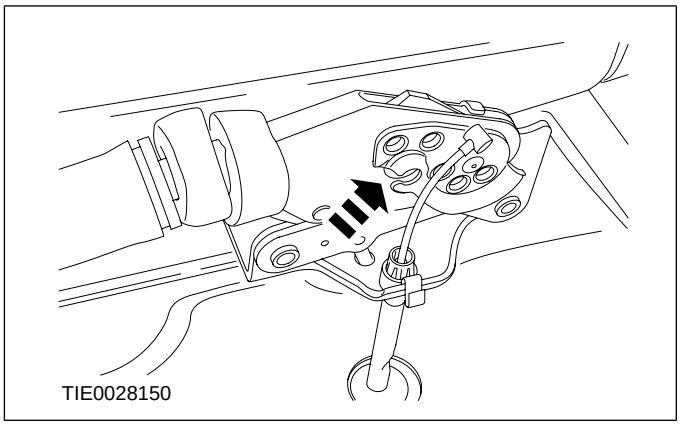


8. Remove the front parking brake cable.

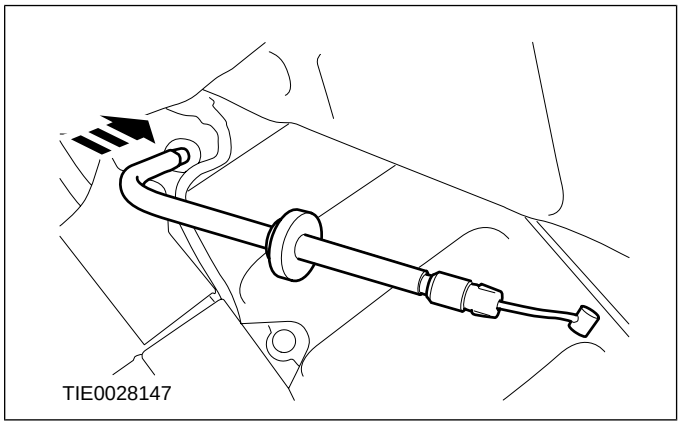


Installation

1. Apply Molybdenum disulphide grease to the mating surfaces of the parking brake control and the front parking brake cable end.

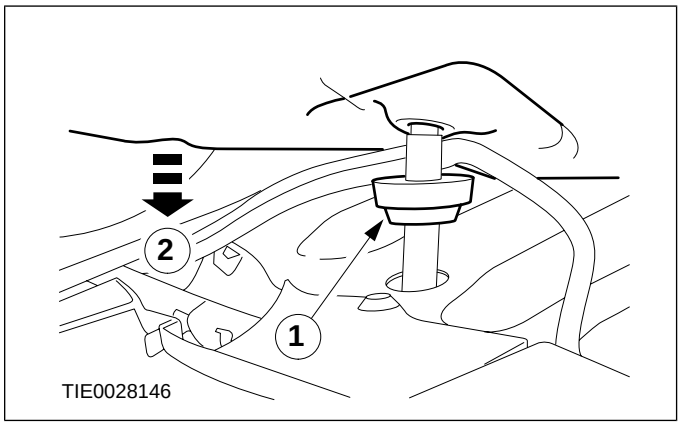


2. Install the front parking brake cable.

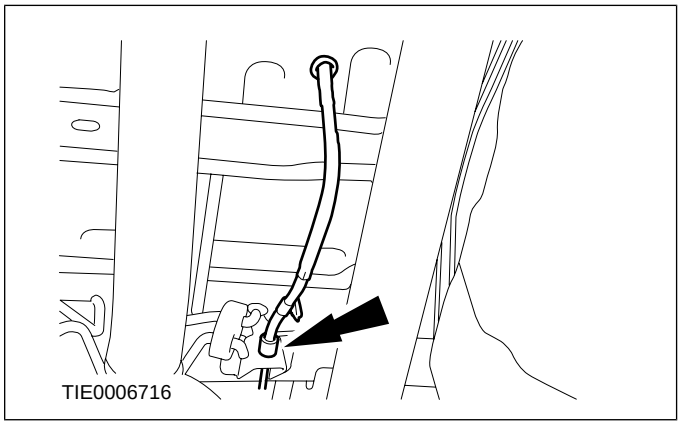


3. Attach the front parking brake cable to the floor.

1. Attach the cable grommet to the floor.
2. Attach the floor covering.

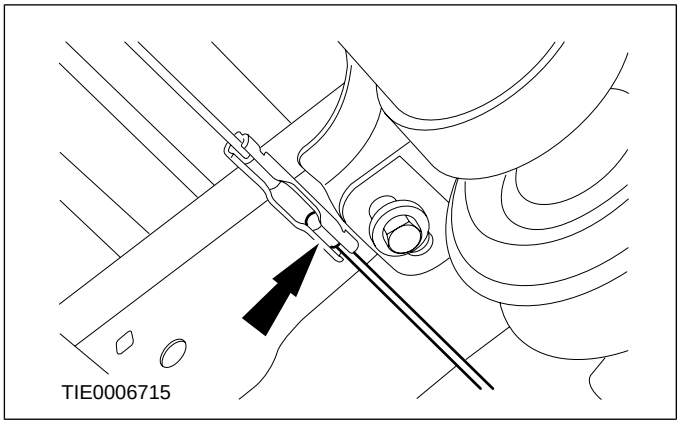


4. Attach the front parking brake cable to the retaining bracket.

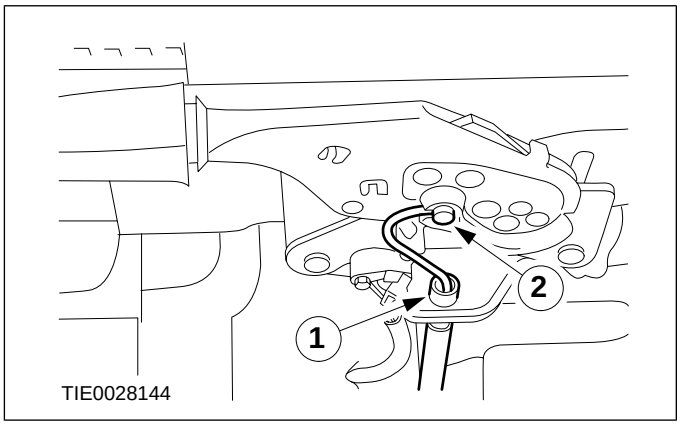


REMOVAL AND INSTALLATION

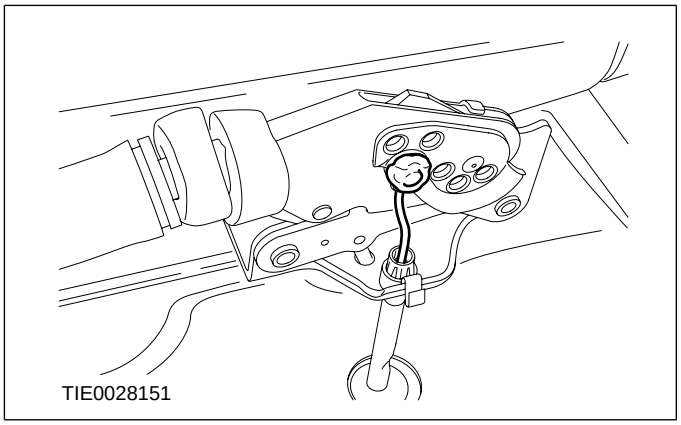
5. **Attach the intermediate parking brake cable to the retainer.**



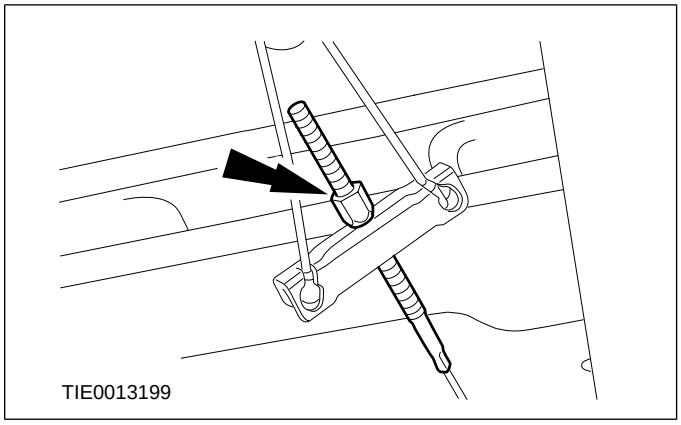
6. **Attach the front parking brake cable.**
   1. Attach the front parking brake cable to the parking brake control bracket.
   2. Attach the front parking brake cable to the parking brake control.



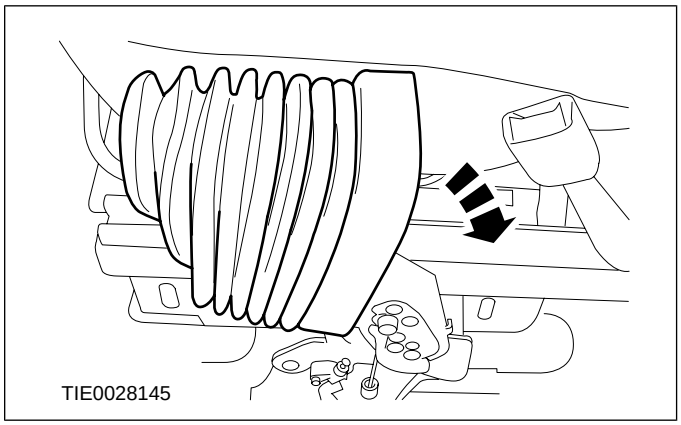
7. **Apply excess Molybdenum disulphide grease over the exposed surface of the front parking brake cable end.**



8. **Tighten the parking brake cable adjustment nut.**



9. **Install the parking brake control boot.**



10. **Adjust the parking brake.**

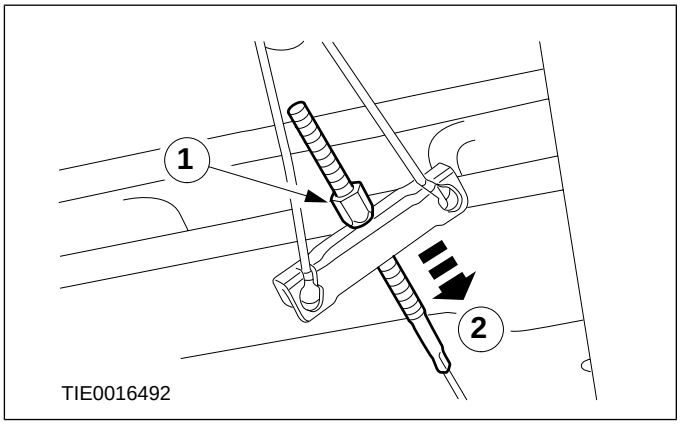
    For additional information, refer to Parking Brake Cable Adjustment in this section.

REMOVAL AND INSTALLATION

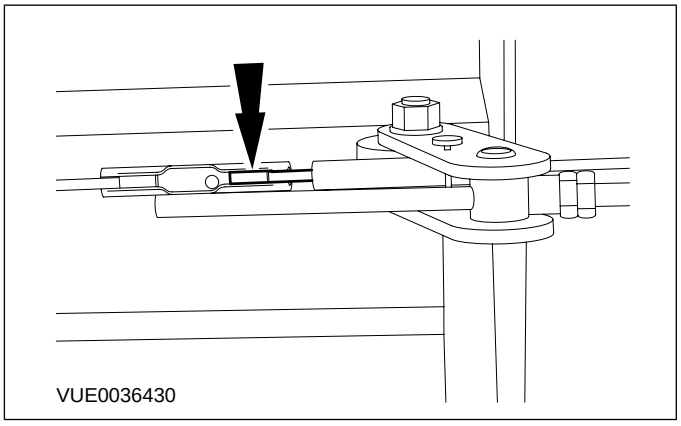
Parking Brake Intermediate Cable

Removal

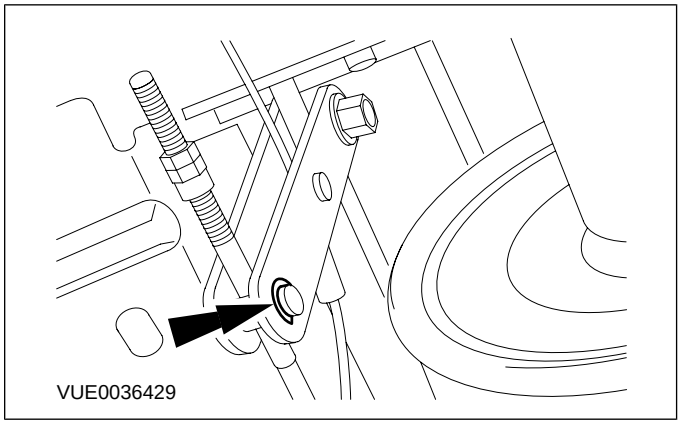
1. **Release the parking brake.**
2. **Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].**
3. **Detach the parking brake intermediate cable from the equalizer.**
   1. Remove the adjustment nut.
   2. Detach the cable.



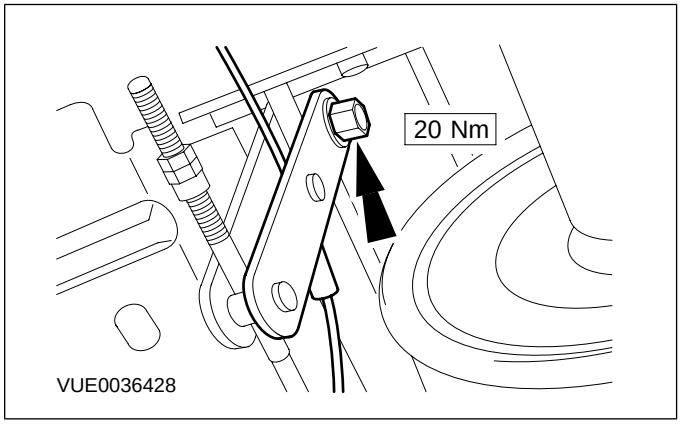
4. **Detach the parking brake intermediate cable.**



5. **Remove the circlip.**



6. **Loosen the parking brake equalizer bracket retaining nut and remove the parking brake intermediate cable.**



Installation

1. **To install, reverse the removal procedure.**
2. **Adjust the parking brake.**

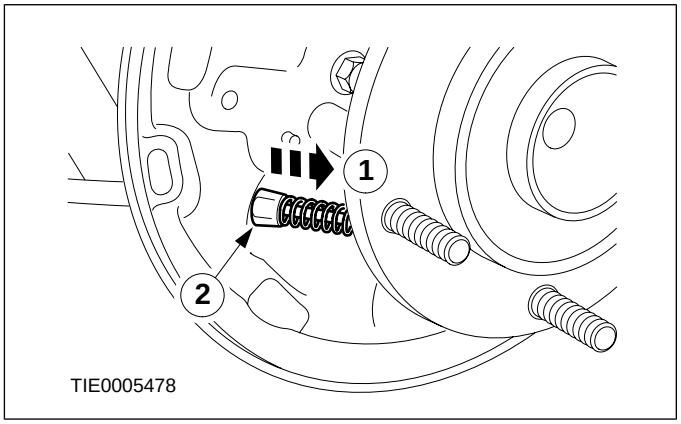
   For additional information, refer to Parking Brake Cable Adjustment - in this section.

REMOVAL AND INSTALLATION

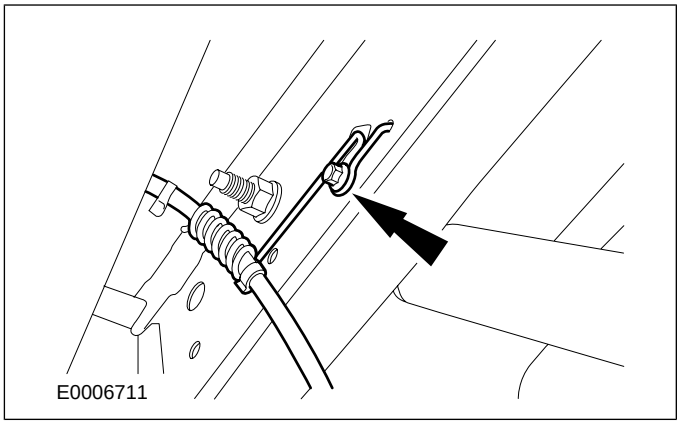
Parking Brake Rear Cables

Removal

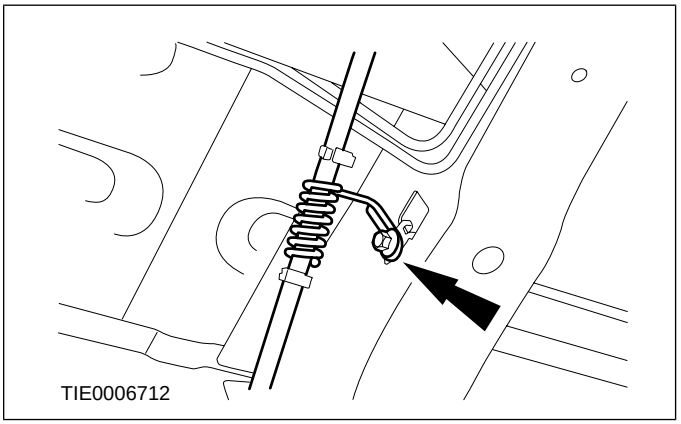
1. **Remove the brake shoes. For additional information, refer to Section 206-02 [Drum Brake].**
2. **Detach the parking brake rear cables from the brake backing plates.**
   1. Pull back the spring.
   2. Detach the clip.



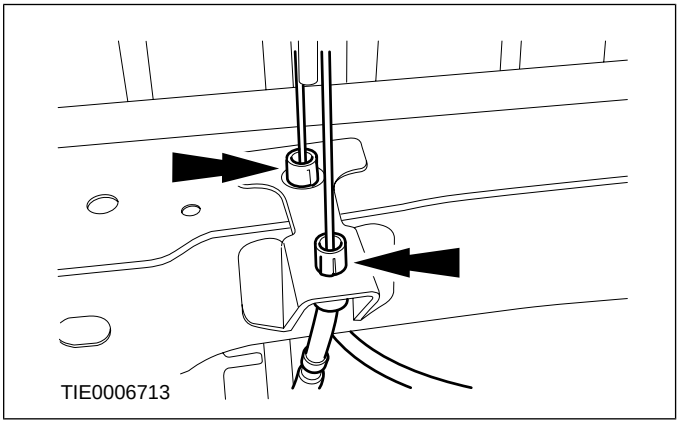
3. **Detach the parking brake right-hand rear cable from the chassis.**



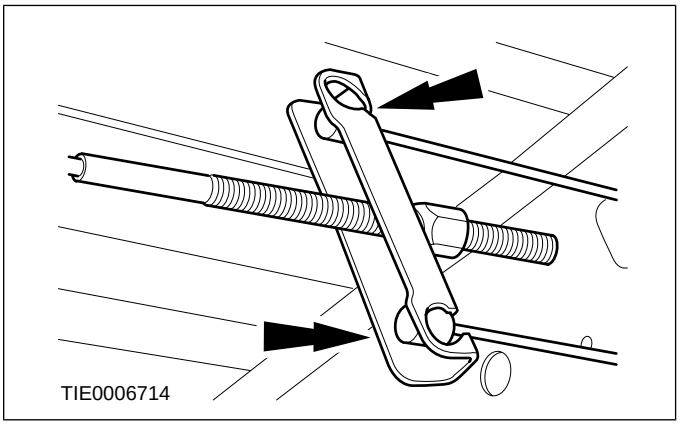
4. **Detach the parking brake left-hand rear cable from the chassis.**



5. **Detach the parking brake rear cables from the retaining bracket.**



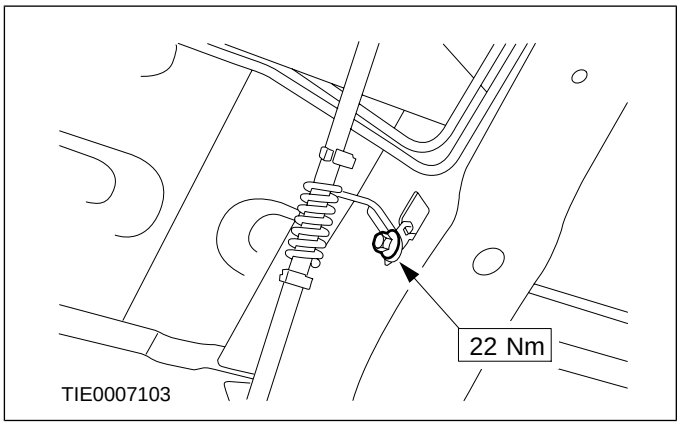
6. **Remove the parking brake rear cables.**

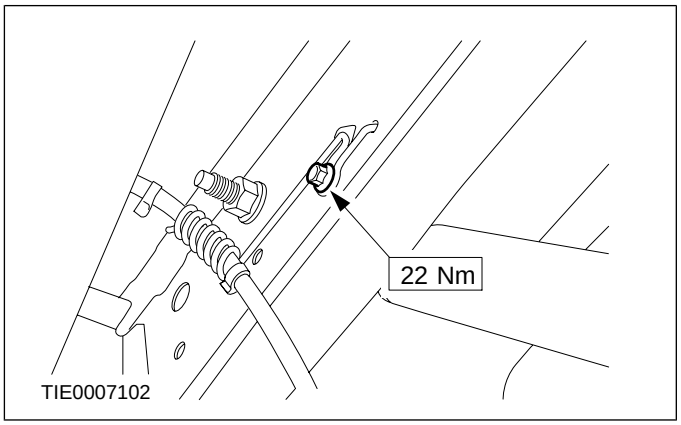


REMOVAL AND INSTALLATION

Installation

1. To install, reverse the removal procedure.





2. Adjust the parking brake.

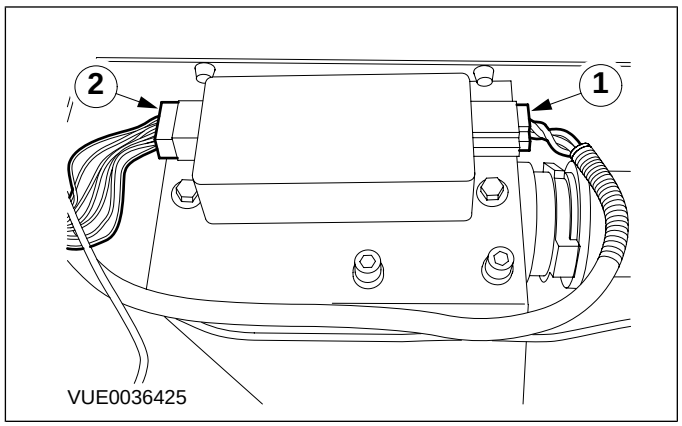
   For additional information, refer to Parking Brake Cable Adjustment in this section.

REMOVAL AND INSTALLATION

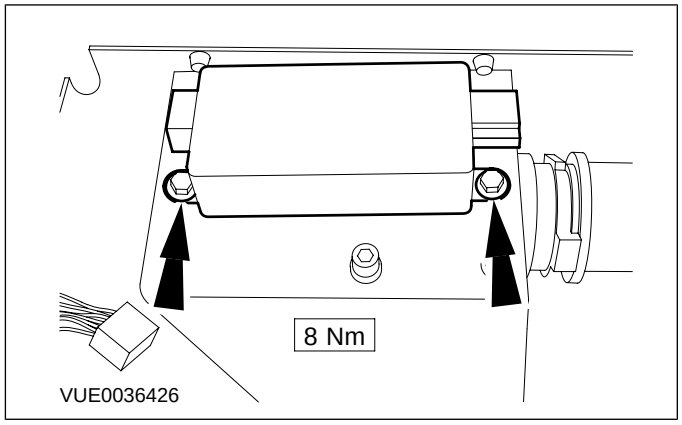
Parking Brake Module

Removal

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 [Battery, Mounting and Cables].
2. Remove the driver seat. For additional information, refer to Section 501-10 [Seating].
3. Disconnect the parking brake module electrical connectors in the sequence shown.



4. Remove the parking brake module.



Installation

1. To install, reverse the removal procedure.
2. Adjust the parking brake cable.

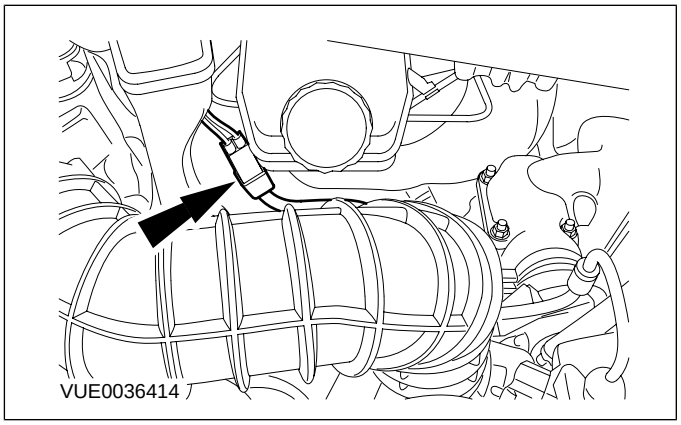
   For additional information, refer to Parking Brake Cable Adjustment - in this section.

REMOVAL AND INSTALLATION

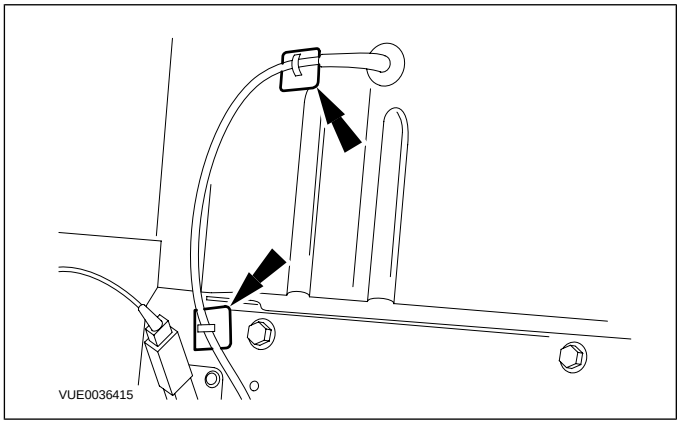
Parking Brake Wheel Speed Sensor

Removal

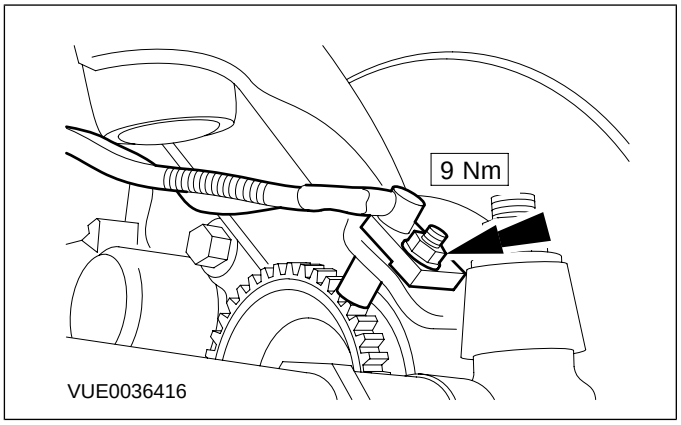
1. **Disconnect the parking brake wheel speed sensor electrical connector.**



2. **Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].**
3. **Detach the parking brake wheel speed sensor wiring harness from the inner fender.**



4. **Remove the parking brake wheel speed sensor.**



Installation

1. **NOTE:Make sure the wheel knuckle wheel speed sensor mounting is clean and free from foreign material.**

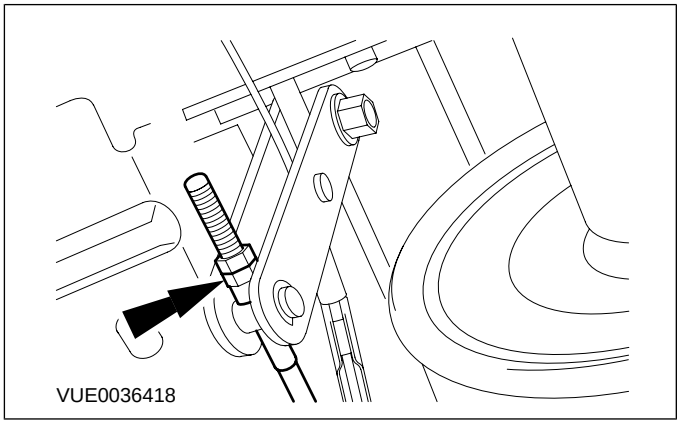
   To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

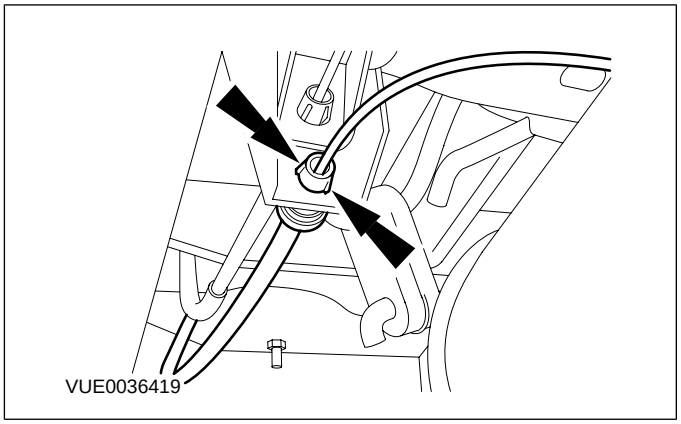
Parking Brake Actuator

Removal

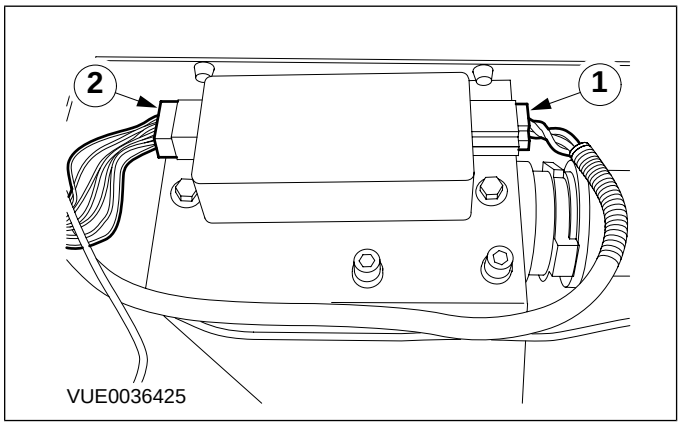
1. Release the parking brake.
2. Disconnect the battey ground cable. For additional information, refer to Section 414-01 [Battery, Mounting and Cables].
3. Remove the driver seat. For additional information, refer to Section 501-10 [Seating].
4. Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].
5. Detach the parking brake cable from the parking brake equalizer.



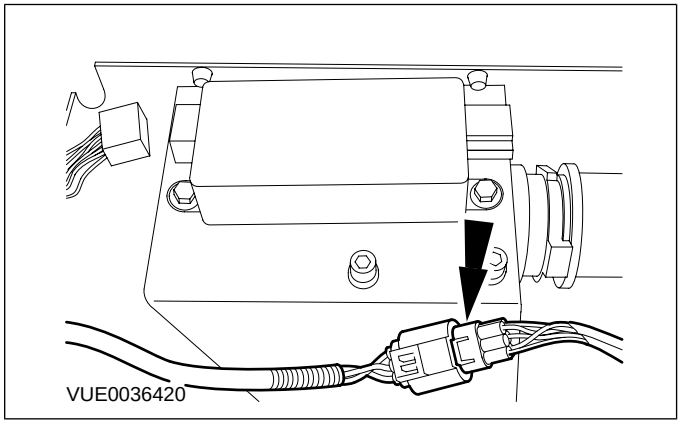
6. Detach the parking brake cable from the retaining bracket.



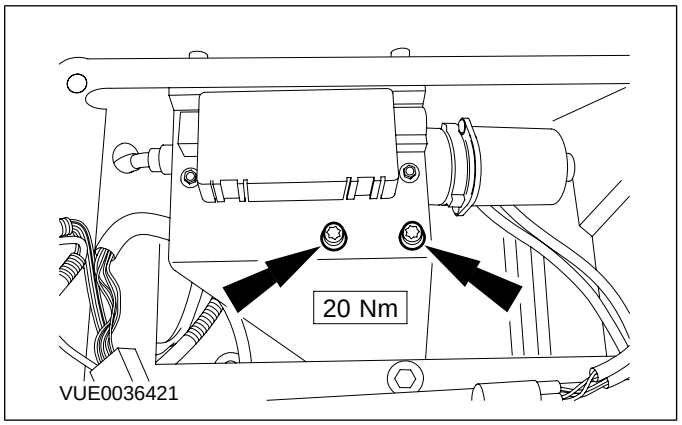
7. Lower the vehicle.
8. Disconnect the parking brake module electrical connectors in the sequence shown.



9. Disconnect the parking brake actuator electrical connector.

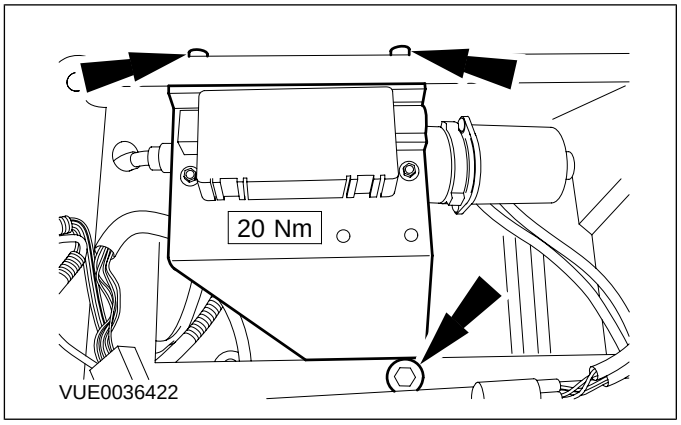


10. Remove the parking brake actuator retaining bolts.

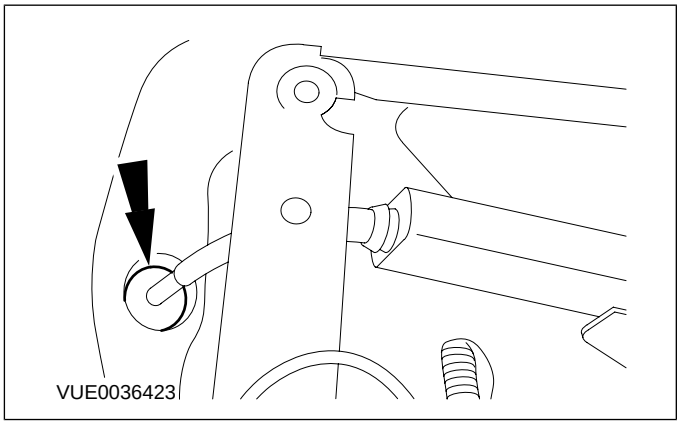


REMOVAL AND INSTALLATION

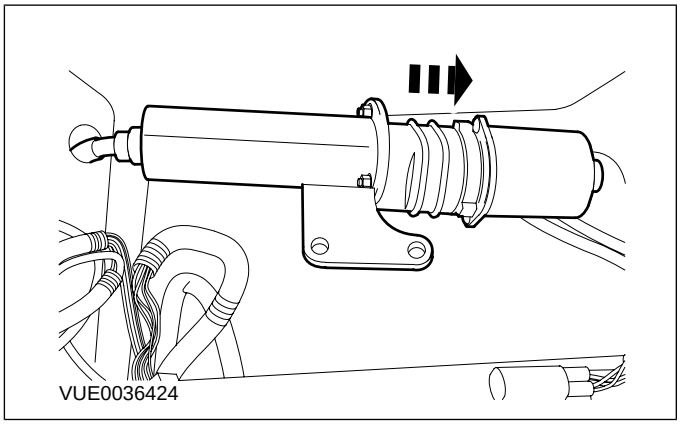
11. Remove the parking brake actuator support bracket.



12. Detach the parking brake cable grommet from the floorpan.



13. Remove the parking brake actuator.



Installation

1. To install, reverse the removal procedure.
2. Adjust the parking brake.

   For additional information, refer to Parking Brake Cable Adjustment - in this section.

SECTION 206-06 Hydraulic Brake Actuation

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 206-06-2

DESCRIPTION AND OPERATION

Hydraulic Brake Actuation..... 206-06-3

DIAGNOSIS AND TESTING

Hydraulic Brake Actuation..... 206-06-4

REMOVAL AND INSTALLATION

Brake Master Cylinder..... 206-06-5
Brake Fluid Reservoir..... 206-06-6
Brake Pedal and Bracket..... 206-06-8

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

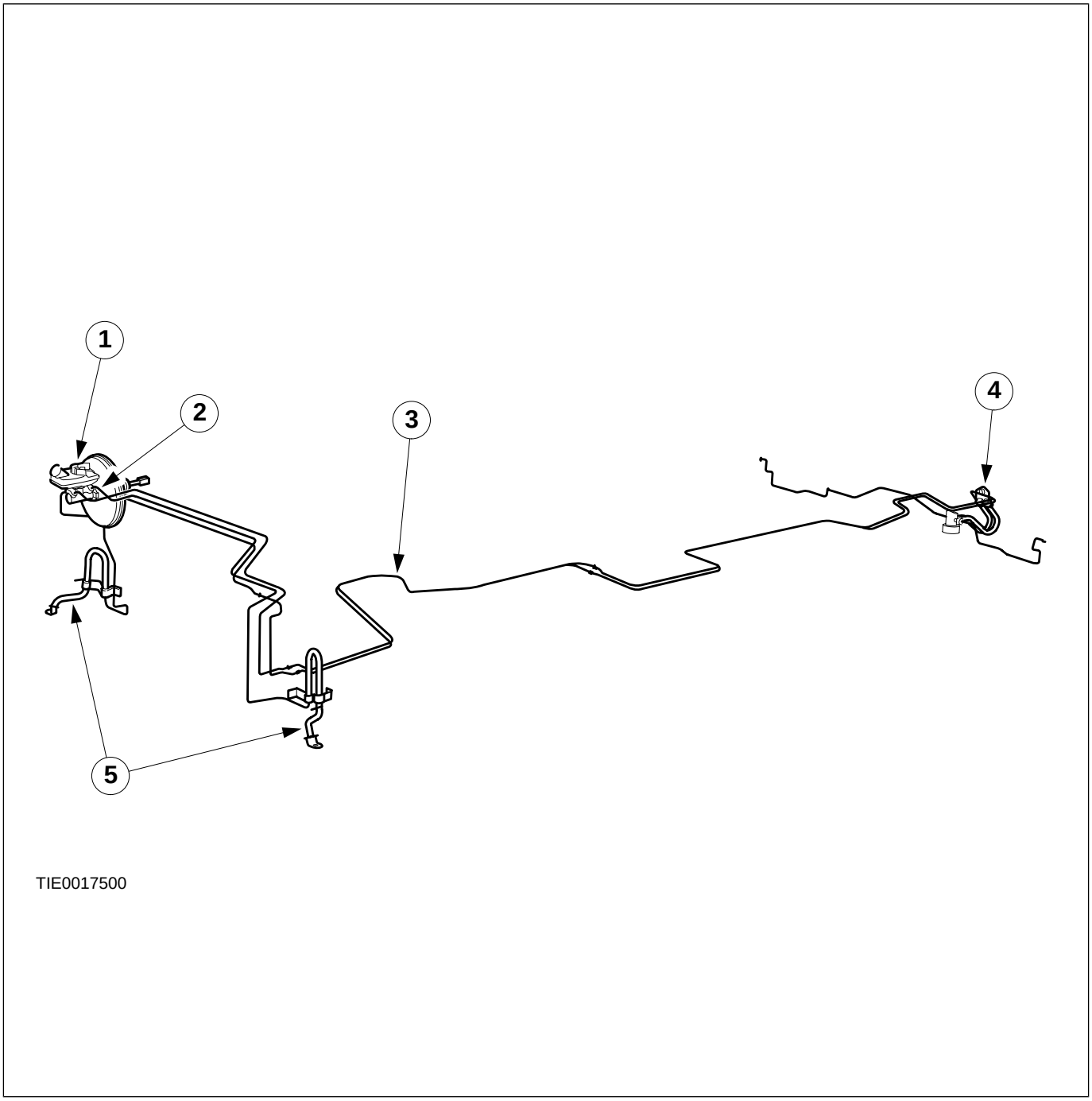
Item	Specification
Super DOT 4 brake fluid	ESD-M6C57-A
High temperature grease	ESE-M12A4-A

Torque Specifications

Description	Nm	lb-ft	lb-in
Brake master cylinder retaining nuts	20	15	-
Brake master cylinder union	15	11	-
Brake pedal bracket retaining nuts	20	15	-
Clutch pedal pivot shaft retaining bolt	20	15	-
Brake pedal pivot shaft retaining bolt	20	15	-

DESCRIPTION AND OPERATION

Hydraulic Brake Actuation



Item	Description
1	Brake fluid reservoir
2	Brake master cylinder
3	Brake hydraulic tubes
4	Rear brake hoses
5	Front brake hoses

DIAGNOSIS AND TESTING

Hydraulic Brake Actuation

REFER to Section 206-00 [Brake System - General Information].

REMOVAL AND INSTALLATION

Brake Master Cylinder

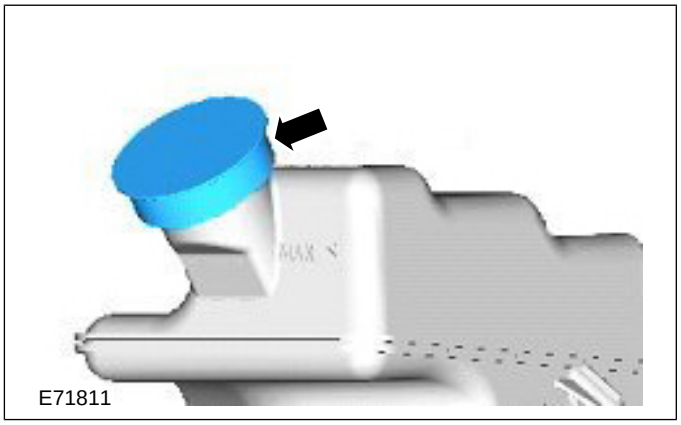
Removal

CAUTION:

Refer to:Brake System Health and Safety Precautions (100-00 General Information, Description and Operation).

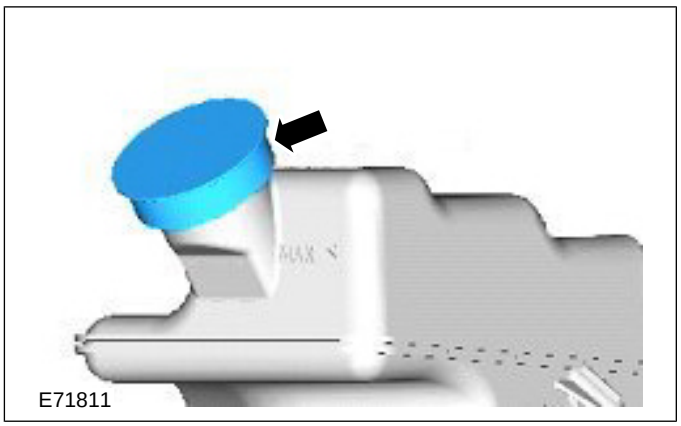
NOTE: Removal steps in this procedure may contain installation details.

1.

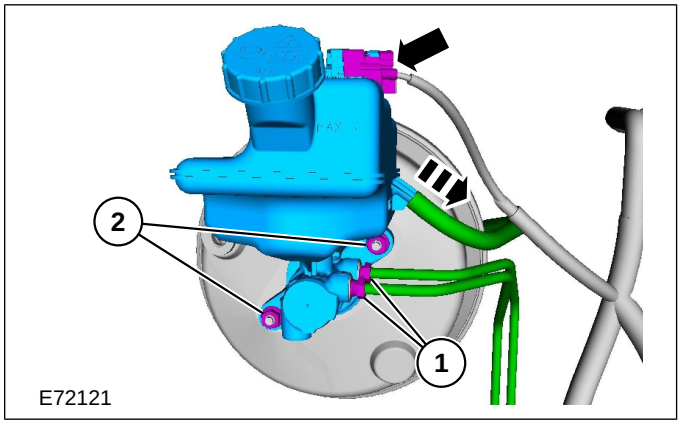


2.
1. Connect one end of a suitable piece of clear plastic pipe to the brake caliper bleed nipple and place the other end into a suitable container.
2. Loosen the brake caliper bleed nipple.
3. Depress the brake pedal until all the brake fluid is drained from the brake fluid reservoir.
4. Tighten the brake caliper bleed nipple.
5. Repeat the draining procedure on the opposite side brake caliper.

3.



4. **CAUTION:Make sure that all openings are sealed.**
1. Torque: 15 Nm
2. Remove and discard the brake master cylinder to brake booster seal.
   Torque: 20 Nm



Installation

1. **NOTE:**Use a new seal.

NOTE: Make sure that the seal is correctly located.

To install, reverse the removal procedure.

2. Bleed the brake system.

Refer to:Brake System Bleeding (206-00 Brake System - General Information, General Procedures).
Refer to:Brake System Pressure Bleeding (206-00 Brake System - General Information, General Procedures).

REMOVAL AND INSTALLATION

Brake Fluid Reservoir

Materials	
Name	**Specification**
Brake Fluid - Super DOT4	ESD-M6C57-A

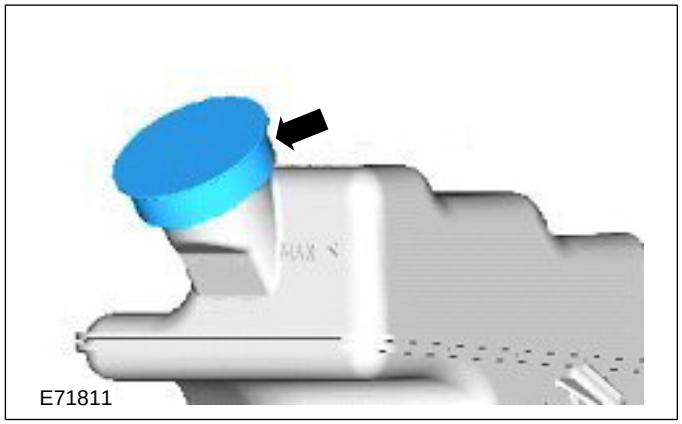
Removal

CAUTION:

Refer to:Brake System Health and Safety Precautions (100-00 General Information, Description and Operation).

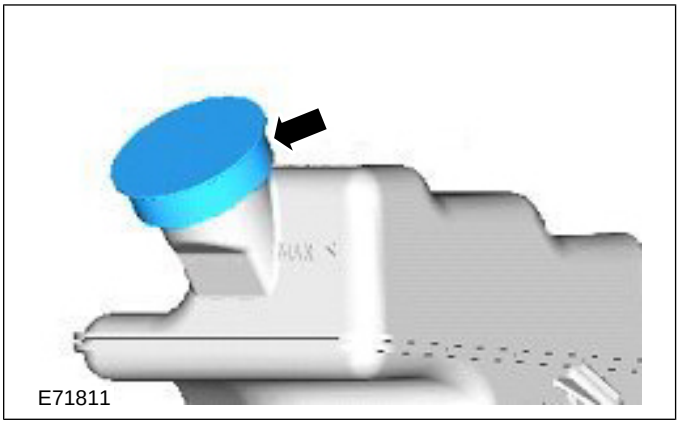
NOTE: Removal steps in this procedure may contain installation details.

1.

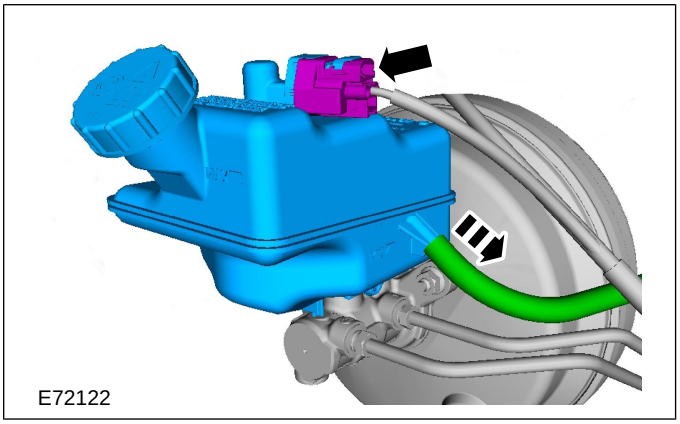


2.
1. Connect one end of a suitable piece of clear plastic pipe to the brake caliper bleed nipple and place the other end into a suitable container.
2. Loosen the brake caliper bleed nipple.
3. Depress the brake pedal until all the brake fluid is drained from the brake fluid reservoir.
4. Tighten the brake caliper bleed nipple.
5. Repeat the draining procedure on the opposite side brake caliper.

3.



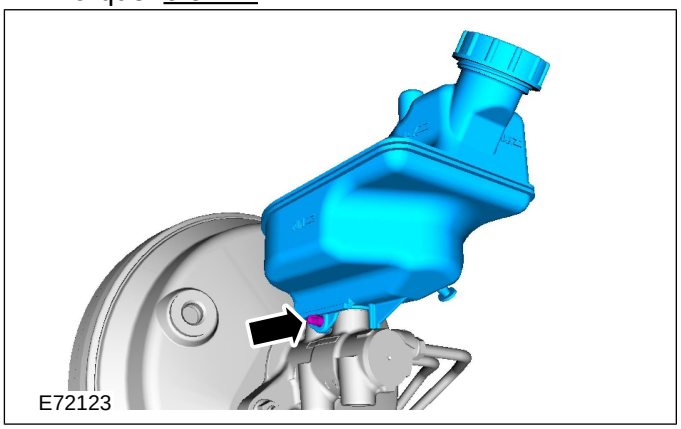
4. CAUTION:Make sure that all openings are sealed.



5. CAUTION:Make sure that all openings are sealed.

REMOVAL AND INSTALLATION

Remove and discard the brake reservoir seals.
Torque: 6.5 Nm



Installation

1. **CAUTION:Only use the specified material to lubricate the seals.**
   1. Install new brake reservoir seals.
   2. Lightly lubricate the seals to aid installation.

      Material: Brake Fluid - Super DOT4
2. To install, reverse the removal procedure.
3. Bleed the brake system.

   Refer to:Brake System Bleeding (206-00 Brake System - General Information, General Procedures).
   Refer to:Brake System Pressure Bleeding (206-00 Brake System - General Information, General Procedures).

REMOVAL AND INSTALLATION

Brake Pedal and Bracket

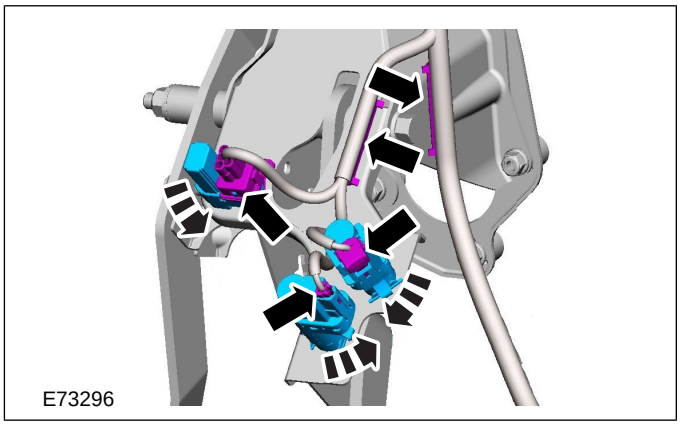
Removal

NOTE: Removal steps in this procedure may contain installation details.

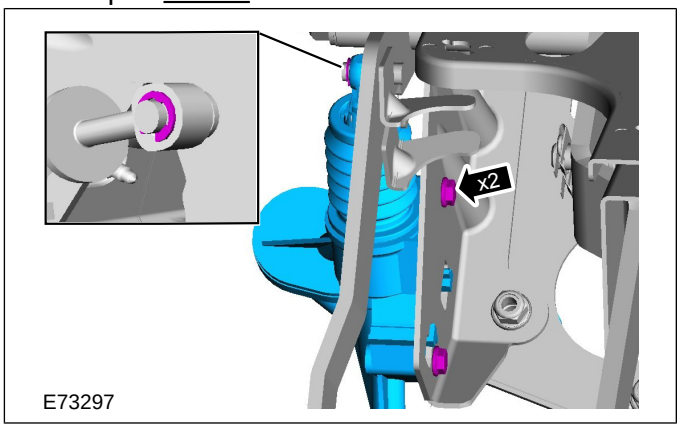
1. Remove the steering column.

   Refer to:Steering Column (211-04 Steering Column, Removal and Installation).

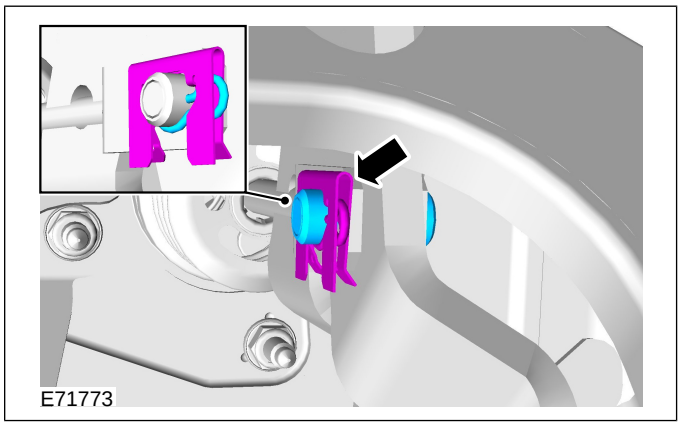
2. **CAUTION:Make sure that the brake pedal remains in the rest position during the removal of the brake pedal switches.**



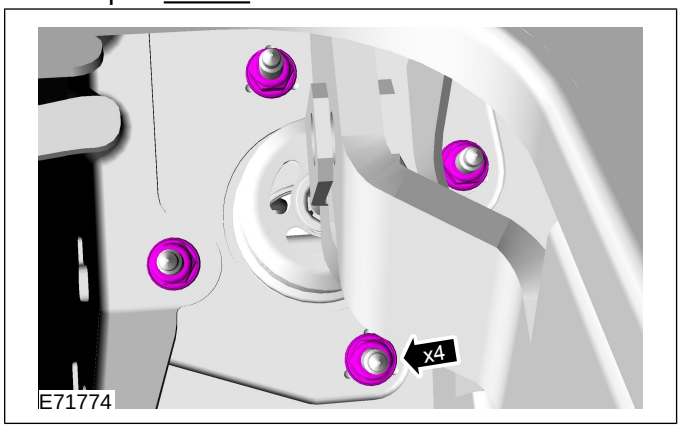
3. Torque: 30 Nm



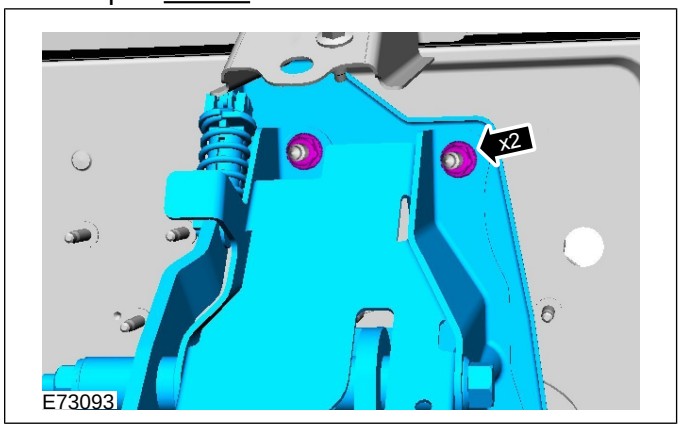
4.



5. Torque: 23 Nm

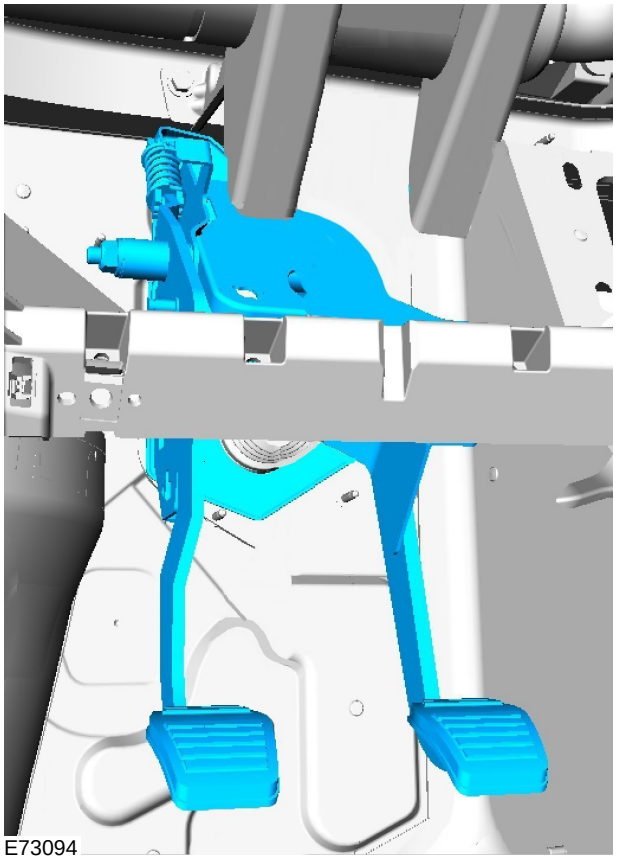


6. Torque: 23 Nm



REMOVAL AND INSTALLATION

7.



Installation

1. ⚠ **CAUTION:Make sure that the brake pedal remains in the rest position during the installation of the brake pedal switches.**

   NOTE: When the brake pedal switches are synchronized, the stoplamp switch status is changed before the brake pedal position (BPP) switch status.

   To install, reverse the removal procedure.

SECTION 206-07 Power Brake Actuation

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 206-07-2

DESCRIPTION AND OPERATION

Brake Booster..... 206-07-3

DIAGNOSIS AND TESTING

Power Brake System..... 206-07-4

REMOVAL AND INSTALLATION

Brake Vacuum Pump — 2.4L Duratorq-TDCi (Puma) Diesel..... 206-07-5
Brake Booster..... 206-07-6

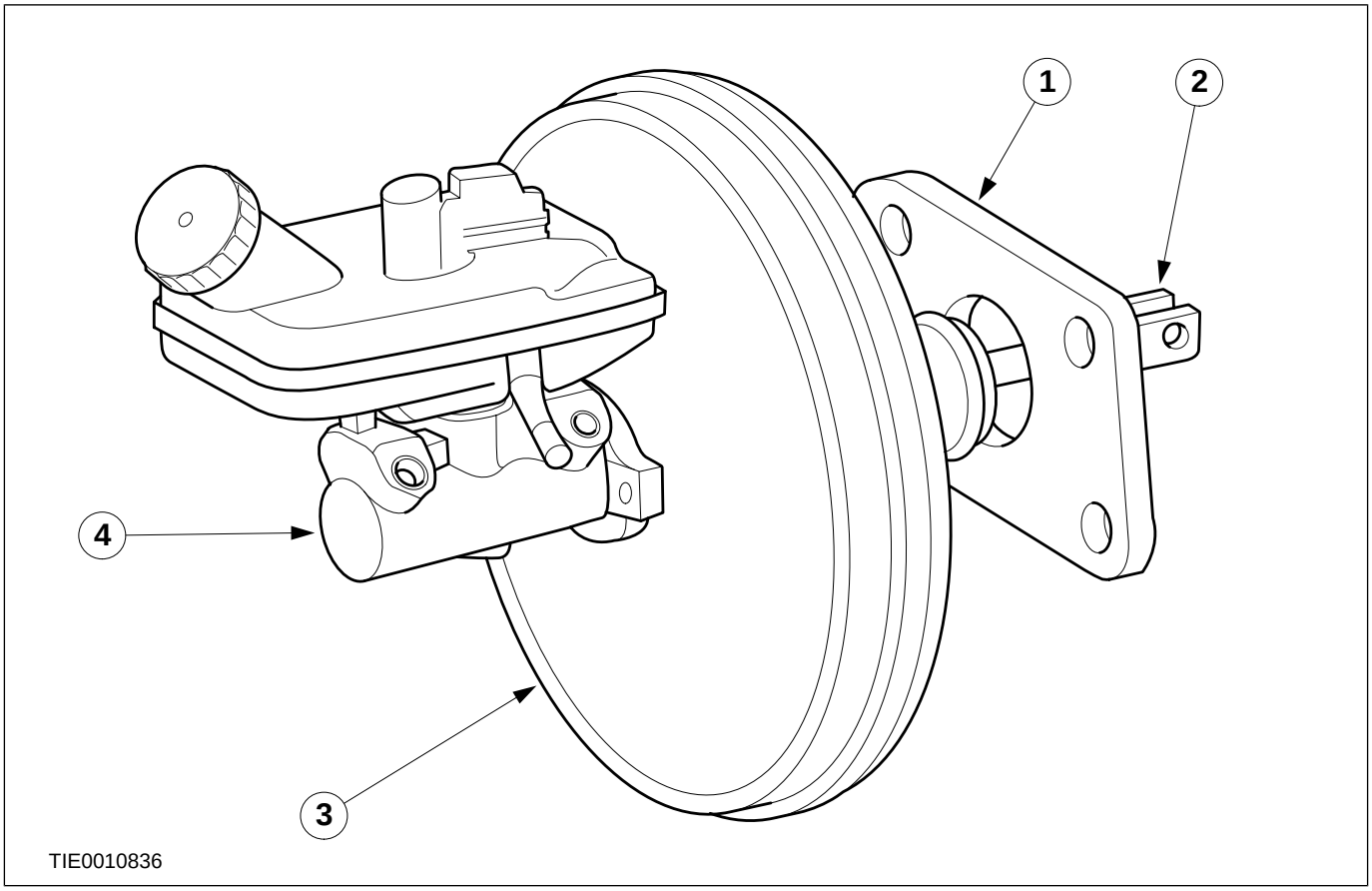
SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Brake vacuum pump retaining bolts — vehicles with 2.4L diesel engine	20	15	–
Brake vacuum pump retaining bolts — vehicles with 2.2L diesel engine	22	16	–
Brake vacuum pump union	18	13	–
Brake booster retaining nuts	23	17	–

DESCRIPTION AND OPERATION

Brake Booster



Item	Part Number	Description
1	-	Brake booster gasket
2	-	Brake booster actuating rod
3	-	Brake booster
4		Brake master cylinder

DIAGNOSIS AND TESTING

Power Brake System

REFER to Section 206-00 [Brake System - General Information].

REMOVAL AND INSTALLATION

Brake Vacuum Pump — 2.4L Duratorq-TDCi (Puma) Diesel

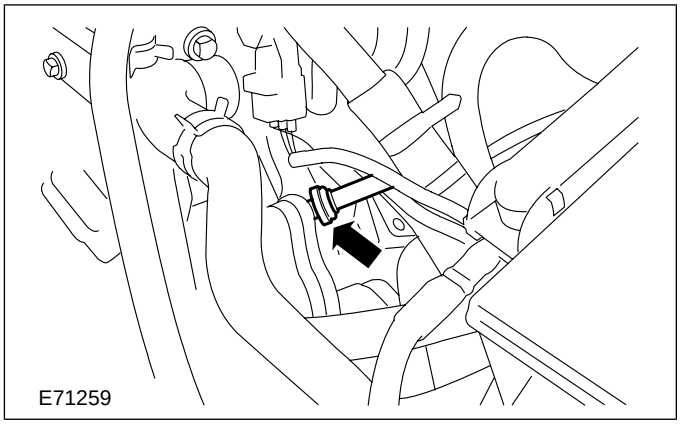
Removal

NOTE: Removal steps in this procedure may contain installation details.

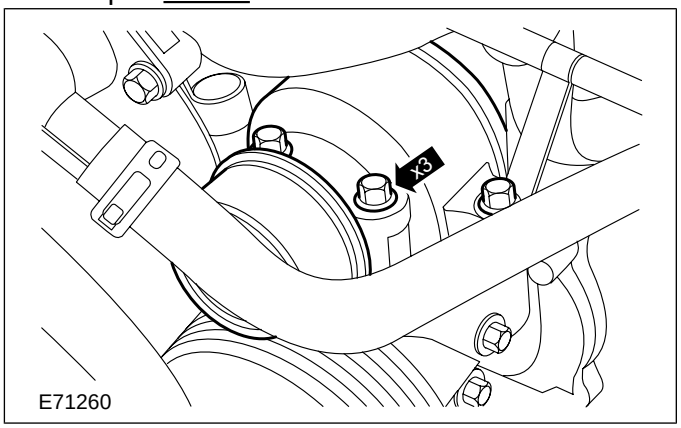
1. Remove the accessory drive belt.

   Refer to: Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).

2.



3. Torque: 20 Nm



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Brake Booster

Removal

NOTE: Removal steps in this procedure may contain installation details.

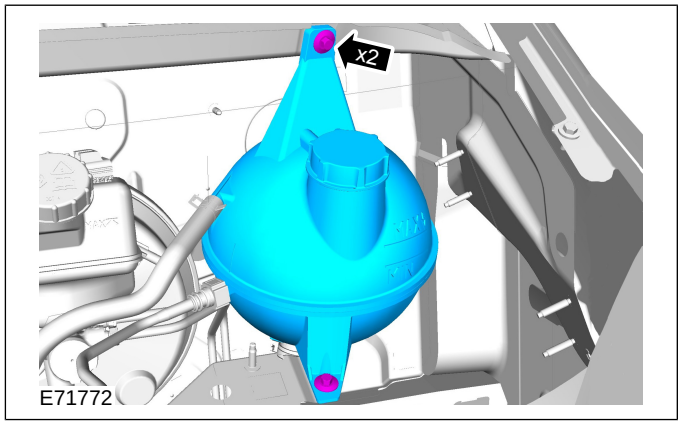
All vehicles

1. Remove the brake master cylinder.

   Refer to: Brake Master Cylinder (206-06 Hydraulic Brake Actuation, Removal and Installation).

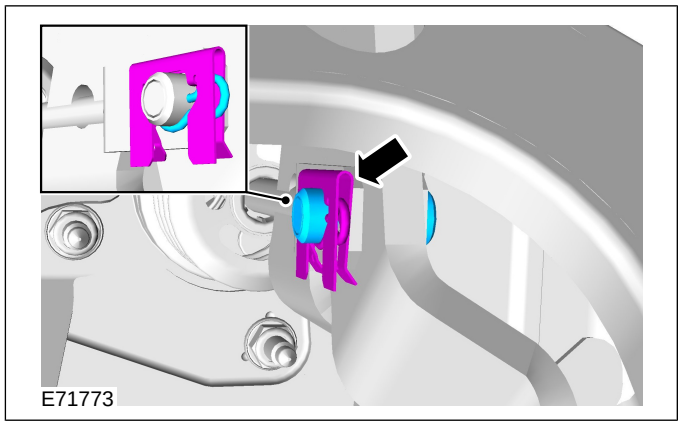
Left-hand drive vehicles

2.

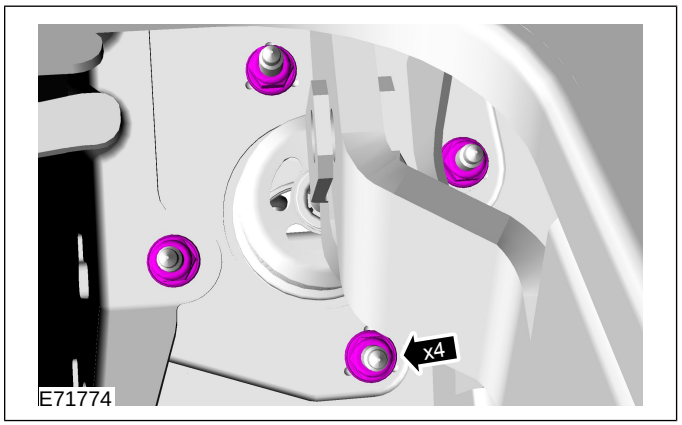


All vehicles

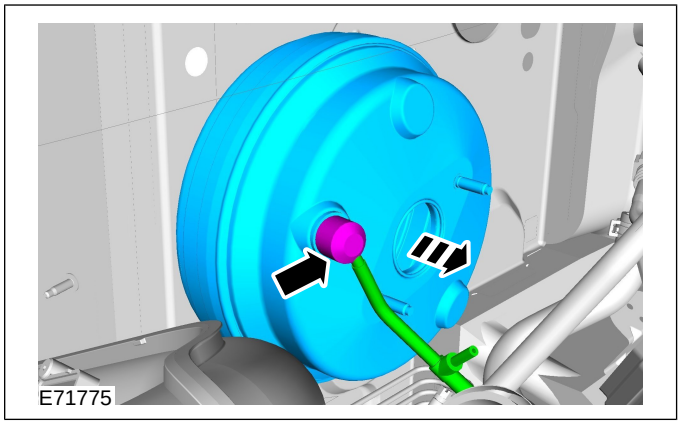
3.



4.

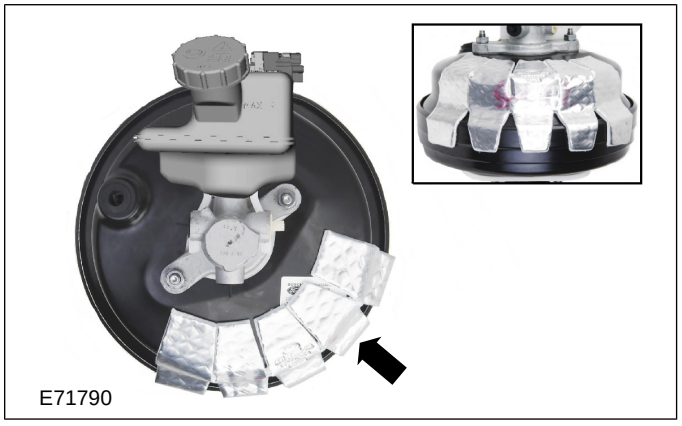


5.



Installation

1. This step is only required when installing a new brake booster to both right-hand drive and rear wheel drive vehicles.



2. **NOTE:**Make sure that the seal is correctly located.

REMOVAL AND INSTALLATION

To install, reverse the removal procedure.

SECTION 206-09 Anti-Lock Control

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 206-09-2

DESCRIPTION AND OPERATION

Anti-Lock Control 206-09-3

DIAGNOSIS AND TESTING

Anti-Lock Control 206-09-5
Inspection and Verification 206-09-5

REMOVAL AND INSTALLATION

Hydraulic Control Unit (HCU) 206-09-6
Front Wheel Speed Sensor 206-09-8
Rear Wheel Speed Sensor 206-09-9
Anti-Lock Brake System (ABS) Module 206-09-10

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

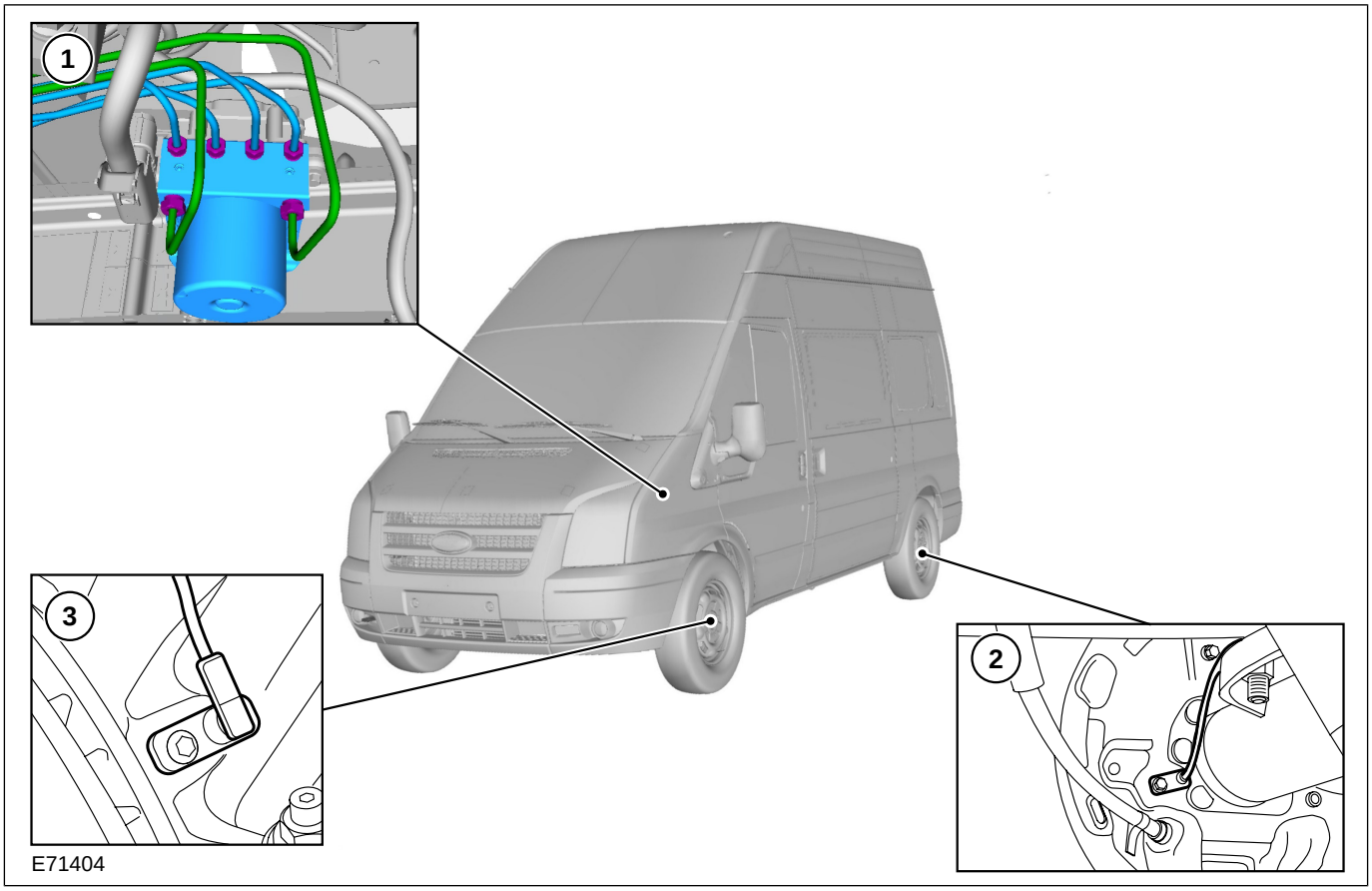
Item	Specification
Super DOT 4 brake fluid	ESD-M6C57-A

Torque Specifications

Description	Nm	lb-ft	lb-in
Hydraulic control unit (HCU) and anti-lock brake system (ABS) module support bracket bolts	20	15	-
HCU and ABS module to support bracket bolts	9	-	80
ABS module to HCU bolts	3	-	27
Brake tube to HCU union	18	13	-
Wheel speed sensor bolt	11	8	-

DESCRIPTION AND OPERATION

Anti-Lock Control



Item	Description
1	Hydraulic control unit (HCU)
2	Rear wheel speed sensor
3	Front wheel speed sensor

In addition to the conventional brake system with two diagonally split brake circuits, the Anti-lock Brake System (ABS) consists of an Hydraulic Control Unit (HCU) with integrated electronic control unit (ABS module), four wheel sensors and the ABS and Electronic Brake Distribution (EBD) warning lamps in the instrument cluster.

EBD is integrated in the software of the ABS control unit, which electronically regulates and optimises the pressure applied to the wheel brakes on the rear axle in accordance with the operating conditions.

Function

The ABS is a closed loop control system in the brake system which prevents the wheels from locking up under braking and therefore maintains steerability and driving stability in extreme situations.

ABS control unit

The ABS control unit continuously compares a reference deceleration value with those detected at individual wheels. This allows the lock-up tendency of each wheel to be detected separately.

If the ABS control unit detects that a wheel is threatening to lock up, then the corresponding hydraulic valves in the valve block are either closed or opened.

The ABS control unit also passes on the wheel speed signals obtained from the wheel sensors to the Powertrain Control Module (PCM).

The warning lamps in the instrument cluster are actuated by the ABS control unit after switching on the ignition. They remain on up to the end of the ABS self-test, and are also actuated in the event of system errors.

The ABS broadcasts its lamp control signals onto the high speed CAN bus. The high speed CAN bus signals are converted to medium speed CAN bus signals by the PJB. The medium speed CAN bus signals are read by the instrument cluster.

DESCRIPTION AND OPERATION

The ABS control unit continuously monitors the system for possible faults and stores these as and when they occur. The corresponding trouble codes can be interrogated with the aid of Worldwide Diagnostic System (WDS) via the Data Link Connector (DLC).

The ABS control unit self-configures to the exact vehicle specification using Central Car Configuration data broadcast by the PJB. This allows the correct brake control calibration for the vehicle to be selected. If the Central Car Configuration is incorrect, or the wrong ABS module is fitted, a calibration will not be found and the ABS will not function. In this case, a limp-home EBD function is provided - but both ABS and EBD warning lamps will be illuminated and a DTC stored.

The ABS control unit is directly connected via a diagnostic data link to the DLC.

The HCU is pre-filled for service.

All-wheel Drive (AWD) vehicles

Vehicles fitted with AWD have an additional Motor-Induced Slip Regulation (MSR) function incorporated within the ABS.

Motor-Induced Slip Regulation (MSR)

During downshifting, or when releasing the accelerator pedal on a slippery surface, the engine braking effect can cause the wheels to lock. The MSR function of the ABS corrects this behaviour by increasing the engine torque to a safe value. This may be noticed by a driver as a slight increase, or a slow ramp down, of engine rpm during deceleration.

DIAGNOSIS AND TESTING

Anti-Lock Control

General Equipment

Worldwide Diagnostic System (WDS)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Wheel speed sensor(s) – Wheel speed sensor ring(s) – Tire pressure(s) – Tire size(s) – Tire damage *	– Fuse(s) – Electrical connector(s) – Wiring harness

*

REFER to: Wheels and Tires (204-04 Wheels and Tires, Diagnosis and Testing).

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, carry out a diagnostic test using Worldwide Diagnostic System (WDS)

REMOVAL AND INSTALLATION

Hydraulic Control Unit (HCU)

General Equipment

Worldwide Diagnostic System (WDS)

Removal

WARNING:

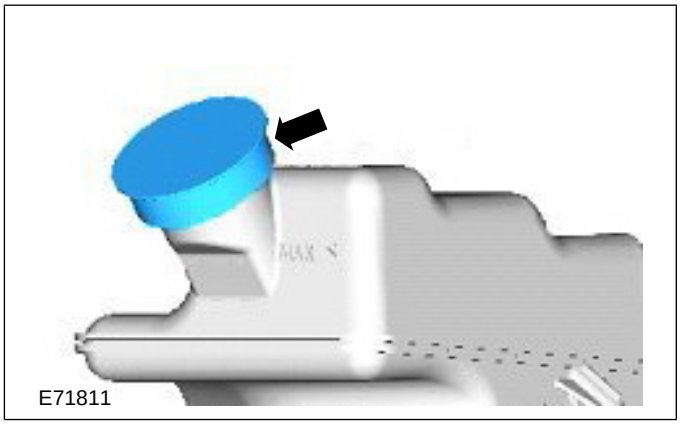
Refer to: Brake System Health and Safety Precautions (100-00 General Information, Description and Operation).

NOTE: Removal steps in this procedure may contain installation details.

1. Remove the left-hand headlamp.

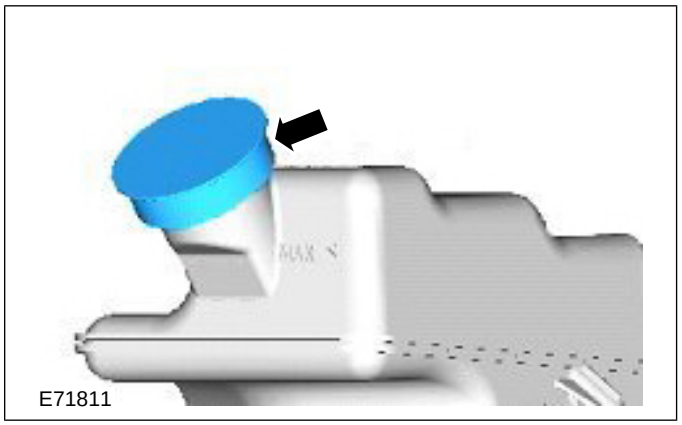
Refer to: Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).

2.



3.
1. Connect one end of a suitable piece of clear plastic pipe to the brake caliper bleed nipple and place the other end into a suitable container.
2. Loosen the brake caliper bleed nipple.
3. Depress the brake pedal until all the brake fluid is drained from the brake fluid reservoir.
4. Tighten the brake caliper bleed nipple.
5. Repeat the draining procedure on the opposite side brake caliper.

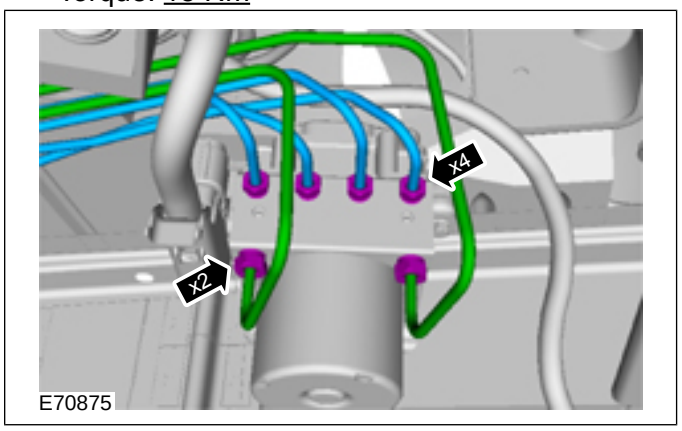
4.



5. **CAUTION:Make sure that all openings are sealed.**

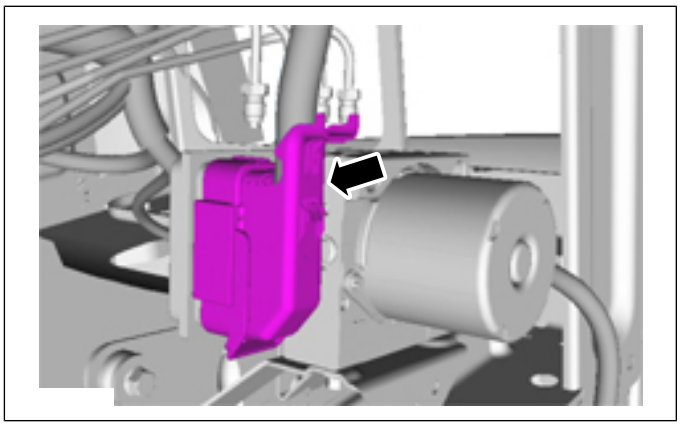
NOTE: Note the position of the brake tubes to aid installation.

Torque: 18 Nm

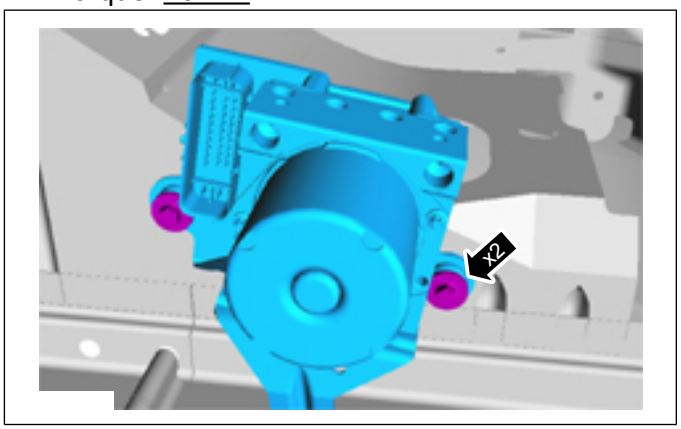


REMOVAL AND INSTALLATION

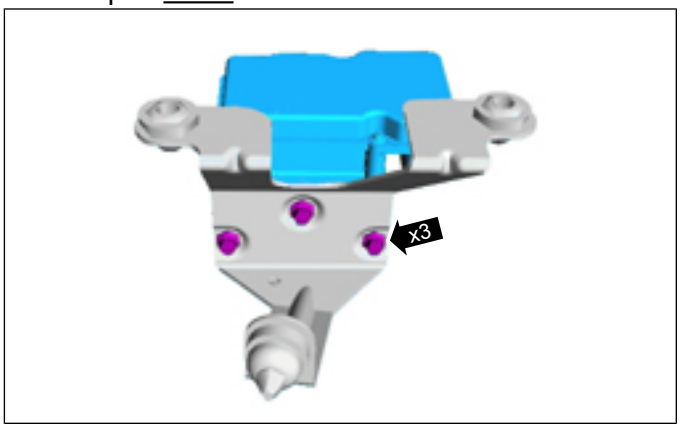
6. **CAUTION:Make sure that all openings are sealed.**



7. Torque: 20 Nm



8. Torque: 9 Nm



Installation

1. **CAUTIONS:**

   If accidentally dropped or knocked install a new hydraulic control unit (HCU) and module assembly.

   The blanking caps/plugs must not be removed until the brake tubes are ready to be connected.

   To install, reverse the removal procedure.

2. Bleed the brake system.

   Refer to: Brake System Pressure Bleeding (206-00 Brake System - General Information, General Procedures).

3. 1. Turn the ignition key to position II for 30 seconds.
   2. Turn the ignition key to position 0.
   3. Turn the ignition key to position II for 30 seconds. Check that the ABS lamp extinguishes after 3 seconds and does not illuminate again.
   4. Test the system for normal operation. If the ABS lamp illuminates, refer to WDS.

      General Equipment: Worldwide Diagnostic System (WDS)

REMOVAL AND INSTALLATION

Front Wheel Speed Sensor

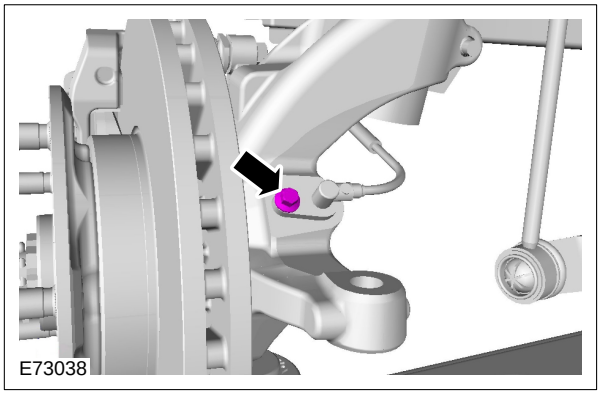
Removal

NOTE: Removal steps in this procedure may contain installation details.

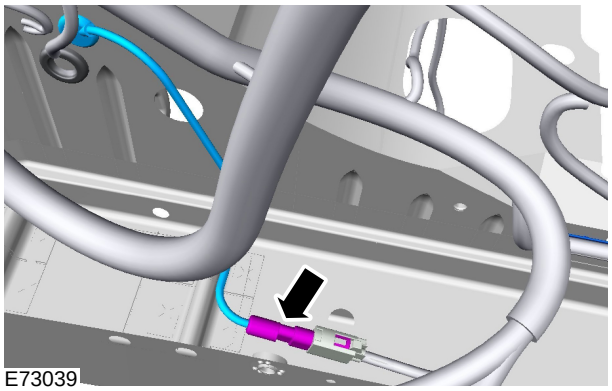
1. Remove the wheel and tire.

   Refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

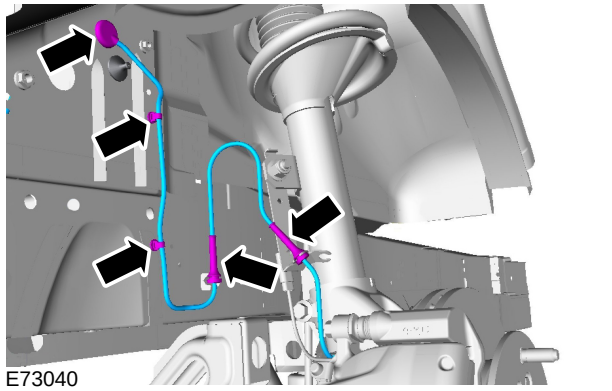
2. Torque: 11 Nm



3.



4.



Installation

1. To install, reverse the removal procedure.

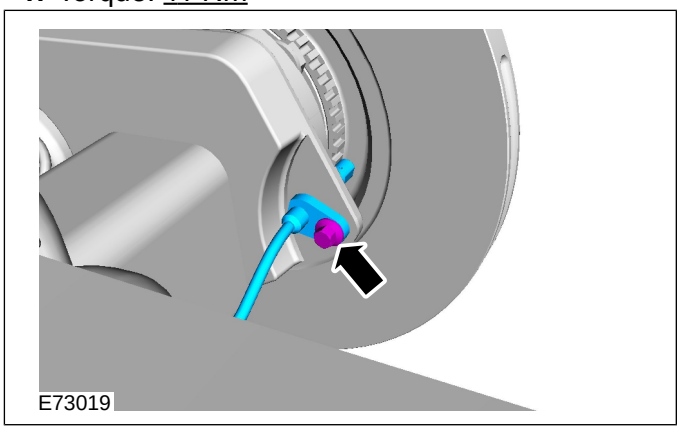
REMOVAL AND INSTALLATION

Rear Wheel Speed Sensor

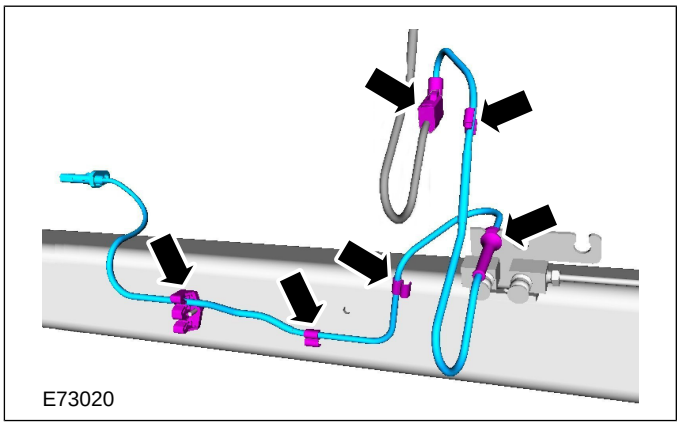
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Torque: 11 Nm



2.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Anti-Lock Brake System (ABS) Module

General Equipment

Worldwide Diagnostic System (WDS)

Removal

1. Remove the hydraulic control unit (HCU).

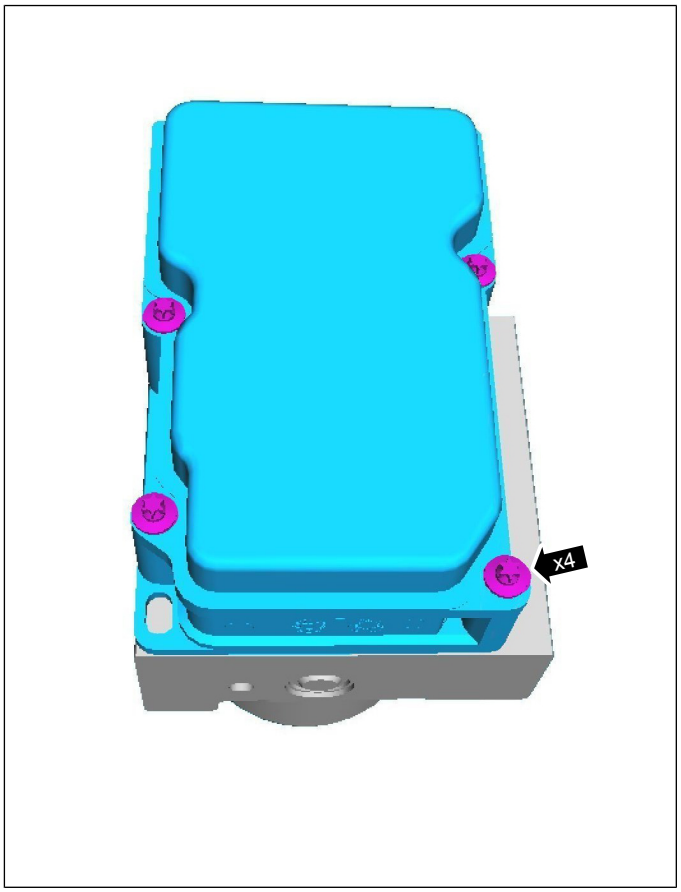
   Refer to: Hydraulic Control Unit (HCU) (206-09 Anti-Lock Control, Removal and Installation).

2. Wear an anti-static bracelet, connected to a suitable earthing point, to prevent electrostatic discharge (ESD) damage to internal components and integrated circuits.

3. **CAUTION:Extreme cleanliness must be exercised when handling these components.**

   Clamp the HCU body in a vise with the anti-lock brake system (ABS) module level and facing upwards.

4. **CAUTION:Make sure that all openings are sealed.**



5. **WARNING: Make sure that the mating faces are clean and free of corrosion and foreign material.**

   CAUTION:Use lint free cloth.

   1. Remove any contamination or debris - DO NOT USE A CLEANING AGENT.
   2. If the contact surface or contact pins show any signs of damage or corrosion, a new HCU must be installed.

Installation

1. **WARNING: Make sure that the module is correctly located on the hydraulic control unit (HCU).**

   CAUTIONS:

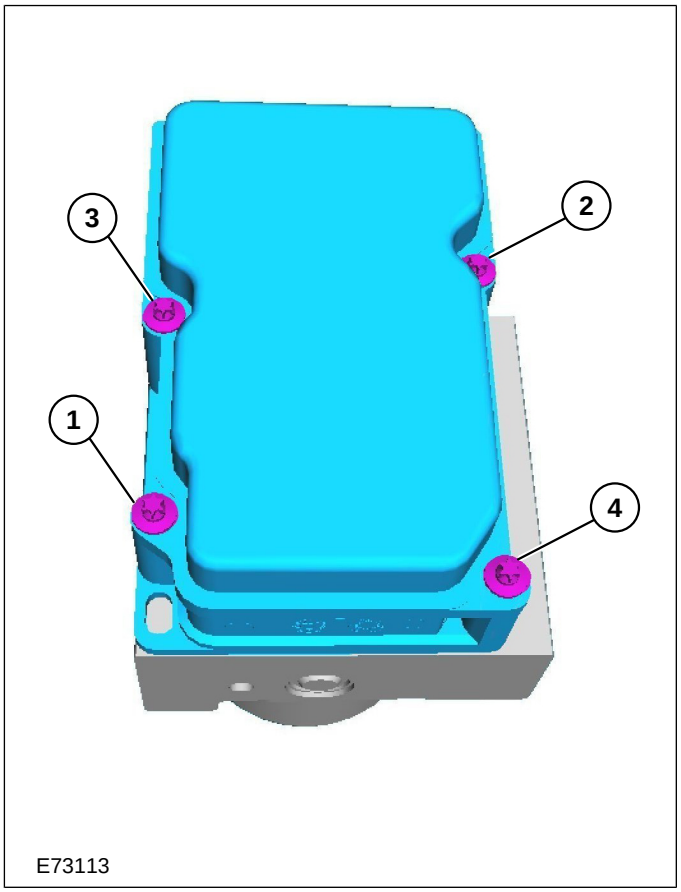
   Make sure that the mating faces are clean and free of foreign material.

   If accidentally dropped or knocked install a new module.

REMOVAL AND INSTALLATION

Take extra care not to damage the seal.

1. Using the outer edges of the ABS module, lower the module onto the HCU pump body. DO NOT APPLY PRESSURE ONTO THE MODULE COVER.
2. If the module cover is damaged or deformed, install a new module.
   Torque:
   - Stage1: 1.5 Nm
   - Stage2: 2.0 Nm
   - Stage3: 3.0 Nm



E73113

2. Install the HCU.

Refer to: Hydraulic Control Unit (HCU) (206-09 Anti-Lock Control, Removal and Installation).

3. Carry out the ABS Function Test.

General Equipment: Worldwide Diagnostic System (WDS)

4. Carry out a road test.

Refer to: Road/Roller Testing (100-00 General Information, Description and Operation).

SECTION 211-00 Steering System - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 211-00-2

DIAGNOSIS AND TESTING

Steering System 211-00-3
Inspection and Verification 211-00-3
Symptom Chart 211-00-3
Components Tests 211-00-9
Steering Gear Checks After a Collision 211-00-13

GENERAL PROCEDURES

Power Steering System Flushing — 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel ..... (13 001 0) 211-00-15
Power Steering System Flushing — 2.3L Duratec-HE (MI4) ..... (13 001 0) 211-00-18
Power Steering System Bleeding ..... (13 416 1) 211-00-20
Power Steering System Filling ..... (13 002 0) 211-00-22

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Power steering fluid	WSA-M2C195-A

Steering Wheel Freeplay

	mm
Measured at the steering wheel outer rim with the engine running	±3

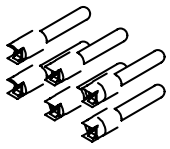
Turning Effort Test

	Effort (Nm)	Effort (lb-in)
Turning effort	10	89

DIAGNOSIS AND TESTING

Steering System

Special Tool(s)

 501073	Simulator, Driver and Passenger Air Bags and Side Air Bags 501-073 (40-016)

General Equipment

Worldwide Diagnostic System (WDS)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Tire pressure(s) – Accessory drive belt – Loose tie-rod end(s) – Tie-rod(s) – Steering gear housing – Loose strut and spring assemblies or ball joints – Loose pinch bolts on steering column shaft flexible coupling – Wheels and tires – Power steering lines fluid leaks – Steering gear bellows	– Power steering pressure (PSP) switch

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• Drift left or right	• Vehicle attitude incorrect (front or rear is high or low).	• CHECK for abnormal loading, coil spring sag or non-standard springs.
	• Incorrect wheel alignment.	• CHECK the wheel alignment and ADJUST if necessary. REFER to: Front Toe Adjustment (204-00 Suspension System - General Information, General Procedures).
	• Worn front wheel bearings.	• CHECK and INSTALL new wheel bearings as necessary. REFER to: Wheel Bearing Inspection (204-00 Suspension System - General Information, General Procedures).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Brake system.	• CHECK the brake system. REFER to:Brake System - Vehicles Built Up To: 04/2006 (206-00 Brake System - General Information, Diagnosis and Testing).
	• Steering linkage.	• CARRY OUT the Steering Linkage Component Test. REFER to Steering Linkage Component Test in this procedure.
	• Steering gear.	• CARRY OUT the Steering Linkage Component Test. REFER to Steering Linkage Component Test in this procedure.
	• Wheels and tires.	• REFER to:Wheels and Tires (204-04 Wheels and Tires, Diagnosis and Testing).
• Steering wheel off center	• Vehicle attitude incorrect (front or rear is high or low).	• CHECK for abnormal loading, coil spring sag or non-standard springs.
	• Incorrect wheel alignment.	• CHECK the wheel alignment and ADJUST if necessary. REFER to:Front Toe Adjustment (204-00 Suspension System - General Information, General Procedures).
	• Suspension lower arm ball joint.	• CARRY OUT the Ball Joint Inspection Component Test. REFER to:Suspension System (204-00 Suspension System - General Information, Diagnosis and Testing).
	• Steering linkage.	• CARRY OUT the Steering Linkage Component Test. REFER to Steering Linkage Component Test in this procedure.
	• Steering gear.	• CARRY OUT the Steering Linkage Component Test. REFER to Steering Linkage Component Test in this procedure.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Vibration	• Incorrect wheel alignment.	• CHECK the wheel alignment and ADJUST if necessary. REFER to:Front Toe Adjustment (204-00 Suspension System - General Information, General Procedures).
	• Wheels and tires.	• CHECK the wheels and tires. BALANCE or INSTALL new wheels and tires as necessary. REFER to:Suspension System (204-00 Suspension System - General Information, Diagnosis and Testing).
	• Damaged or worn front wheel bearings.	• CHECK and INSTALL new wheel bearings as necessary. REFER to:Wheel Bearing Inspection (204-00 Suspension System - General Information, General Procedures).
	• Front strut and spring assemblies.	• CHECK and INSTALL new suspension components as necessary.
	• Damaged front suspension lower arm(s).	• CHECK and INSTALL new suspension components as necessary.
	• Steering linkage.	• CARRY OUT the Steering Linkage Component Test. REFER to Steering Linkage Component Test in this procedure.
• Steering effort is high/low	• Power steering hose restriction.	• CHECK the power steering hoses for damage, kinks or restrictions. INSTALL new components as necessary.
	• Power steering fluid contamination.	• FLUSH the power steering system. REFER to:(211-00 Steering System - General Information) Power Steering System Flushing - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (General Procedures), Power Steering System Flushing - 2.3L Duratec-HE (MI4) (General Procedures).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Aeration of the power steering fluid.	• BLEED the power steering system. REFER to:Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).
	• Steering gear floor seal touch condition.	• CHECK the installation of the floor seal.
	• Steering column.	• CHECK if the floor covering is obstructing the steering gear pinion. • CHECK the installation of the floor seal. • CARRY OUT the Steering Column Universal Joint Component Test. REFER to Steering Column Universal Joint Component Test.
	• Steering linkage.	• CARRY OUT the Steering Linkage Component Test. REFER to Steering Linkage Component Test in this procedure.
	• Steering gear.	• CARRY OUT the Steering Linkage Component Test. REFER to Steering Linkage Component Test in this procedure.
	• Worn power steering pump.	• INSTALL a new power steering pump. REFER to:(211-02 Power Steering) Power Steering Pump - 2.2L Duratorq-TDCi (Puma) Diesel (Removal and Installation), Power Steering Pump - 2.3L Duratec-HE (MI4) (Removal and Installation), Power Steering Pump - 2.4L Duratorq-TDCi (Puma) Diesel (Removal and Installation).
• Excessive noise	• Power steering operation noise.	• CARRY OUT the Power Steering Operation Noise Check. REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Aeration of the power steering fluid.	• BLEED the power steering system. REFER to:Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).
	• Power steering lines.	• CHECK that the power steering line clamps are secure. • CHECK the power steering lines for clearance from the vehicle body, subframe and steering gear. • CHECK the steering gear transfer lines for clearance from the steering gear.
	• Loose steering gear retaining bolts.	• CHECK and INSTALL new bolts as necessary. REFER to:Steering Gear (211-02 Power Steering, Removal and Installation).
	• Power steering pump.	• INSTALL a new power steering pump. REFER to:(211-02 Power Steering) Power Steering Pump - 2.2L Duratorq-TDCi (Puma) Diesel (Removal and Installation), Power Steering Pump - 2.3L Duratec-HE (MI4) (Removal and Installation), Power Steering Pump - 2.4L Duratorq-TDCi (Puma) Diesel (Removal and Installation).
	• Tie-rod.	• CARRY OUT the Tie-Rod Component Test. REFER to Tie-Rod Component Test in this procedure.
• Steering does not vary with increased wheel rotation	• Worn tie-rod ends.	• INSTALL new components as necessary. REFER to:Tie Rod End (211-03 Steering Linkage, Removal and Installation).
	• Worn front suspension bushings.	• CHECK and INSTALL new components as necessary.

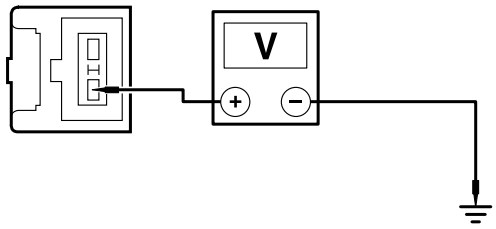
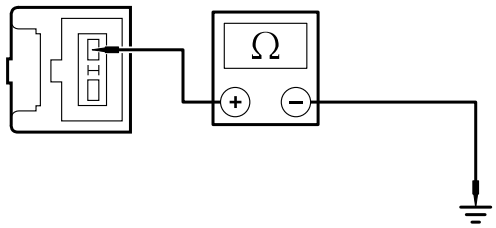
DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Suspension lower arm ball joint.	• CARRY OUT the Ball Joint Inspection Component Test. REFER to:Suspension System (204-00 Suspension System - General Information, Diagnosis and Testing).
	• Steering gear insulator bushings worn or perished.	• CHECK and INSTALL new components as necessary.
	• Loose steering gear retaining bolts.	• CHECK and INSTALL new bolts as necessary. REFER to:Steering Gear (211-02 Power Steering, Removal and Installation).
	• Loose steering column retaining bolts.	• CHECK and INSTALL new bolts as necessary. REFER to:Steering Column (211-04 Steering Column, Removal and Installation).
	• Loose steering column to steering gear pinion retaining bolt.	• CHECK and INSTALL a new bolt as necessary. REFER to:Steering Column (211-04 Steering Column, Removal and Installation).
	• Excessive steering gear backlash.	• CARRY OUT the Steering Linkage Component Test. REFER to Steering Linkage Component Test in this procedure.
• Engine stalls when parking with engine speed at idle	• Power steering pressure (PSP) switch or circuit.	• GO to Pinpoint Test A.

PINPOINT TEST A : ENGINE STALLS WHEN PARKING WITH ENGINE SPEED AT IDLE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK FOR VOLTAGE TO THE PSP SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect PSP Switch CCS09.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between the PSP switch CCS09 pin 1, circuit CCS09B (GN), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A2. → **No** REPAIR circuit CCS09B (GN).
A2: CHECK THE PSP SWITCH GROUND CIRCUIT FOR OPEN CIRCUIT OR HIGH RESISTANCE	
	1 Ignition switch in position 0.
 E73134	2 Measure the resistance between the PSP switch CCS09 pin 2, circuit GD122S (BK), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** Install a new PSP switch → **No** REPAIR circuit GD122S (BK).

Components Tests

Steering Linkage

1. Grasp the steering wheel firmly and move it up and down and to the left and right without turning the steering wheel to check the steering column bearing for wear, steering column shaft for wear, steering wheel for looseness and steering column for looseness. If the steering column bearing or the steering column shaft is worn install a new steering column.

   REFER to:Steering Column (211-04 Steering Column, Removal and Installation).

   If the steering wheel or the steering column is loose, tighten the steering wheel or the steering column retaining bolts.
2. With the road wheels in the straight ahead position, gently turn the steering wheel to the left and the right to check for free play in the steering linkage.
3. There should be no excessive free play at the steering wheel rim. If there is excessive free play, CHECK the tie-rod inner and outer ball joints, REFER to Tie-Rod Component Test in this procedure. CHECK the steering column universal joint, REFER to Steering Column Universal Joint Component Test in this procedure. If there is no free play in the tie-rod and the steering column, install a new steering gear.

   REFER to:Steering Gear (211-02 Power Steering, Removal and Installation).

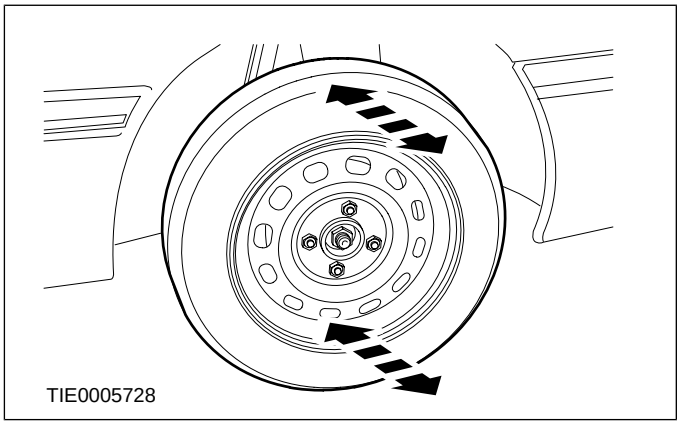
DIAGNOSIS AND TESTING

Tie-Rod

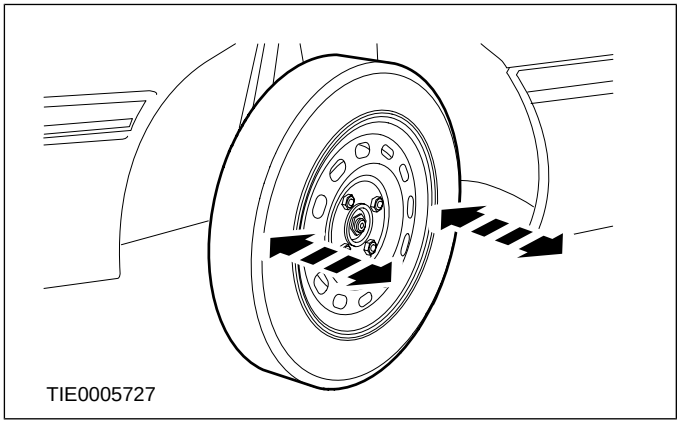
1. Noises such as knocks, which may appear to originate from the steering linkage, may also be generated by front suspension components.

   REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).
2. Raise and support the vehicle.

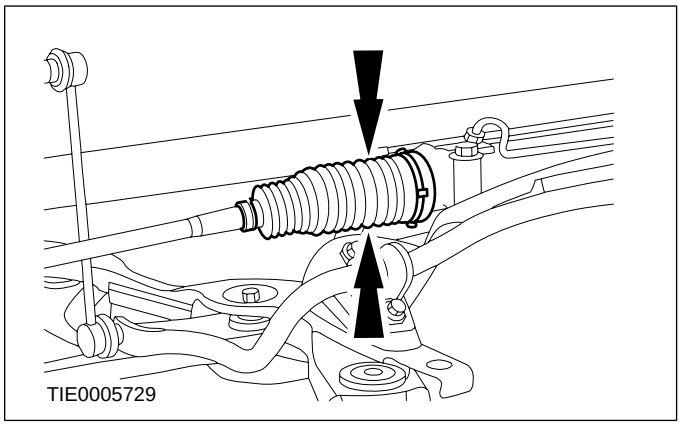
   REFER to:Lifting (100-02 Jacking and Lifting, Description and Operation).



3. Firmly grasp the road wheel and apply a rocking motion checking for any free play in the wheel bearing or suspension components.
4. Turn the steering wheel to position the steering linkage against the right-hand steering lock stop.



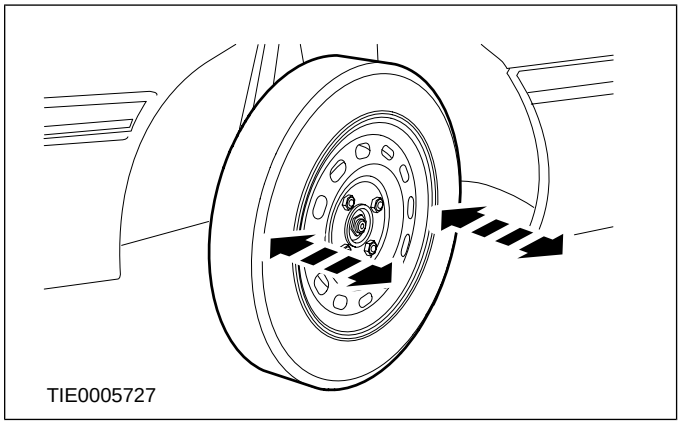
5. With the aid of another technician holding the steering linkage against the right-hand steering lock stop, firmly grasp the right-hand road wheel and apply a rocking motion checking for any free play in the steering linkage.



6. Detach the steering gear boot from the steering gear body and check for free play at the tie-rod inner ball joint.
7. If there is free play at the tie-rod inner ball joint, install a new tie-rod.

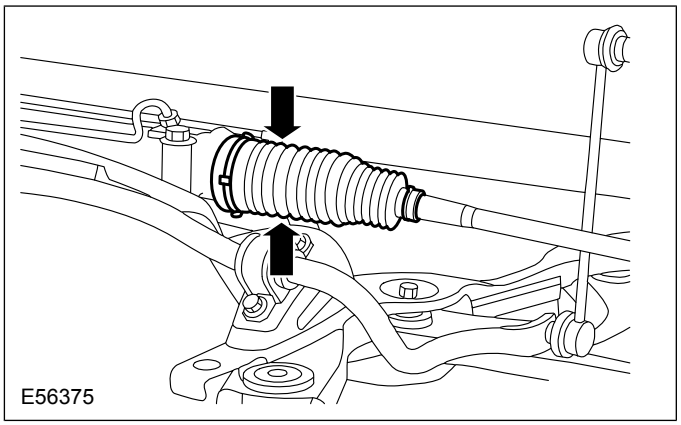
   REFER to:Tie Rod (211-03 Steering Linkage, Removal and Installation).
8. Check the tie-rod end for free play. Install a new tie-rod end if necessary.

   REFER to:Tie Rod End (211-03 Steering Linkage, Removal and Installation).
9. Attach the steering gear boot to the steering gear body. Install new steering gear boot clamps.
10. Turn the steering wheel to position the steering linkage against the left-hand steering lock stop.



11. With the aid of another technician holding the steering against the left-hand steering lock stop, firmly grasp the left-hand road wheel and apply a rocking motion checking for any free play in the steering linkage.

DIAGNOSIS AND TESTING



12. Detach the steering gear boot from the steering gear body and check for free play at the tie-rod inner ball joint.
13. If there is free play at the tie-rod inner ball joint, install a new tie-rod.

    REFER to:Tie Rod (211-03 Steering Linkage, Removal and Installation).
14. Check the tie-rod end for free play. Install a new tie-rod end if necessary.

    REFER to:Tie Rod End (211-03 Steering Linkage, Removal and Installation).
15. Attach the steering gear boot to the steering gear body. Install new steering gear boot clamps.

Turning Effort Test

1. Before carrying out the turning effort test, make sure that the following are serviceable:
- Suspension components.
- Steering column.
- Toe adjustment.

  REFER to:Front Toe Adjustment (204-00 Suspension System - General Information, General Procedures).
- Tire pressures.

2. Park the vehicle on a dry, even surface and apply the parking brake.
3. Remove the driver air bag module.

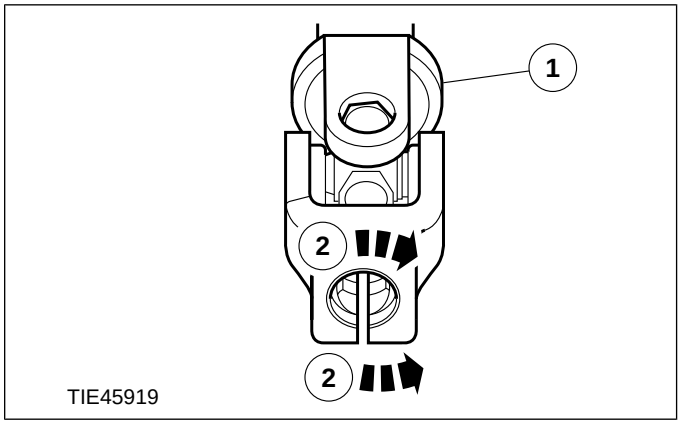
   REFER to:Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).
4. Connect the air bag simulators to the sub-harnesses in place of the driver air bag module at the top of the steering column.
5. Start the engine and turn the steering wheel from lock to lock several times until the power steering fluid has reached normal operating temperature.
6. Using a suitable torque wrench and socket, check the steering wheel turning effort.
7. If the steering wheel turning effort is greater than the specification, install a new steering gear. REFER to:

   Specifications (211-00 Steering System - General Information, Specifications),
   Steering Gear (211-02 Power Steering, Removal and Installation).

Steering Column Universal Joint

1. **WARNING:Make sure a new steering column flexible coupling bolt is installed.**

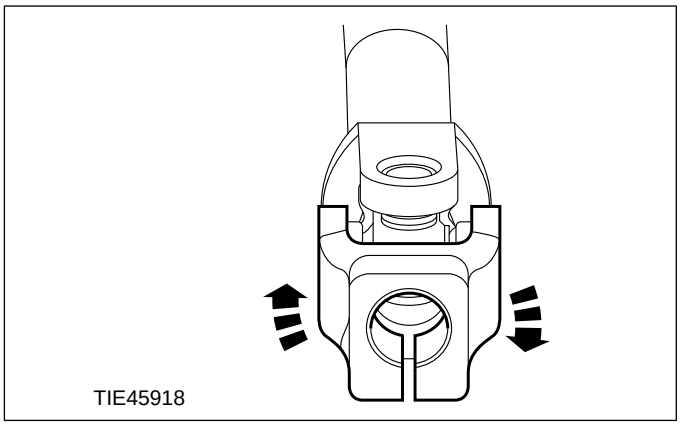
   Detach the steering column from the steering gear pinion.
   - Discard the steering column to steering gear pinion retaining bolt.



2. Check for smooth movement of the steering column universal joint.
   1. Hold the steering column universal joint yoke.
   2. Articulate the free yoke in a figure of eight movement.
   - If the movement is not smooth or resistance is felt, install a new steering column.

     REFER to:Steering Column (211-04 Steering Column, Removal and Installation).

DIAGNOSIS AND TESTING



3. Hold both of the steering column universal joint yokes and twist them clockwise and counterclockwise.
   - If movement is felt, install a new steering column.

     REFER to:Steering Column (211-04 Steering Column, Removal and Installation).

Lower Arm Ball Joint Inspection

1. Raise and support the vehicle.

   REFER to:Lifting (100-02 Jacking and Lifting, Description and Operation).
2. Firmly grasp the outer end of the suspension lower arm and try to move it up and down, watching and feeling for any movement. Free movement will usually be accompanied by an audible "click". There should be no free movement.
3. If there is any free movement, install a new lower arm.

   REFER to:Lower Arm (204-01 Front Suspension, Removal and Installation).

DIAGNOSIS AND TESTING

Steering Gear Checks After a Collision

General Equipment

Feeler gauge
Straight edge

Items to be observed when checking the steering system

The following list of steering gear conditions and the methods of testing should be taken into account when carrying out checks to the steering system:

- If the steering gear has no faults after completing the following checks, do not install a new steering gear.
- Surface corrosion and marks on the tie-rod are acceptable.
- When checking for turning effort torque peaks in the steering gear, turn the steering wheel from steering lock stop to steering lock stop in approximately 15 seconds.
- A steady increase of turning effort torque from steering center to steering lock stop is acceptable.
- When checking for power steering fluid leaks, turn the steering wheel to the steering lock stop in approximately 10 seconds.
- Noises from the power steering, for example the power steering pump relief valve, are acceptable.

STEERING GEAR HOUSING

1. Raise and support the vehicle.

   REFER to:Lifting (100-02 Jacking and Lifting, Description and Operation).
2. Visually inspect the steering gear housing for cracks and damage. If the steering gear housing is cracked or damaged, install a new steering gear.

   REFER to:Steering Gear (211-02 Power Steering, Removal and Installation).

TIE-RODS

1. Using a straight edge and feeler gauge, check the tie-rods to see if they are straight. If the distance between the tie-rod and straight edge is greater than 0.5 mm, install a new steering gear.

   REFER to:Steering Gear (211-02 Power Steering, Removal and Installation).
2. Check the tightening torque of the tie-rod end to wheel knuckle nut.

   REFER to:Tie Rod End (211-03 Steering Linkage, Removal and Installation).
3. Check the tightening torque of the tie-rod end locking nut.

   REFER to:Tie Rod End (211-03 Steering Linkage, Removal and Installation).

CHECK FOR TURNING EFFORT TORQUE PEAKS IN THE STEERING GEAR

1. Lower and support the vehicle making sure that the road wheels are just clear of the floor.
2. With the ignition switch in position I, slowly turn the steering wheel from steering lock stop to steering lock stop. If a turning effort torque peak or judder is felt while turning the steering wheel, detach the tie-rods from the wheel knuckles.
3. Slowly turn the steering wheel from steering lock stop to steering lock stop. If a turning effort torque peak or judder is felt while turning the steering wheel, install a new steering gear.

   REFER to:Steering Gear (211-02 Power Steering, Removal and Installation).

CHECK FOR POWER STEERING FLUID LEAKS

1. Lower the vehicle.
2. Run the engine at a fast idle and slowly turn the steering wheel to the left-hand steering lock stop. Hold the steering wheel in this position for 5 seconds with a turning effort torque of 15 Nm at the steering wheel rim.
3. Turn the steering wheel away from the left-hand steering lock stop for 30 seconds.
4. Run the engine at a fast idle and slowly turn the steering wheel to the right-hand steering lock stop. Hold the steering wheel in this position for 5 seconds with a turning effort torque of 15 Nm at the steering wheel rim.

DIAGNOSIS AND TESTING

5. Turn the steering wheel away from the right-hand steering lock stop.
6. Check for power steering fluid leaks at the steering gear housing and the power steering line connections to the steering gear. If there is a power steering fluid leak at the steering gear, install a new steering gear.

   REFER to:Steering Gear (211-02 Power Steering, Removal and Installation).

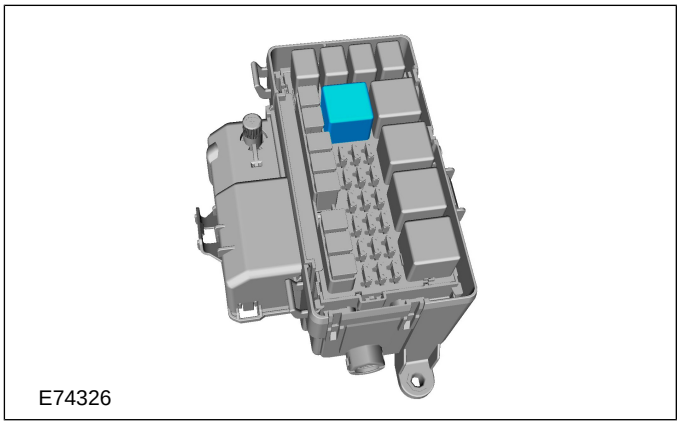
GENERAL PROCEDURES

Power Steering System Flushing — 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (13 001 0)

Materials	
Name	**Specification**
Hydraulic Fluid	WSA-M2C195-A

All vehicles

1. **Remove the glow plug relay.**



2. **Remove the glow plugs. For additional information, refer to:**

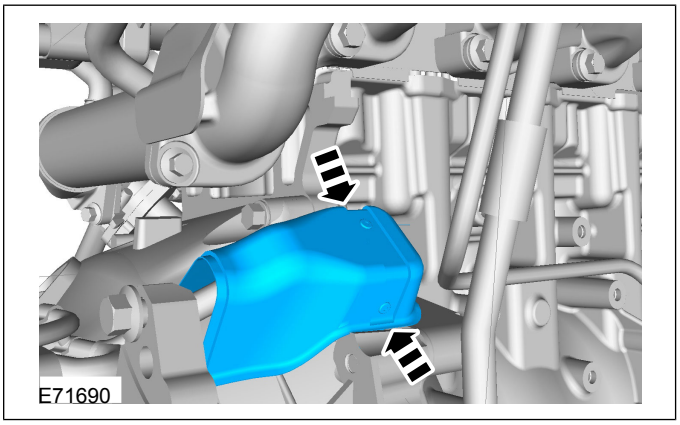
   Glow Plugs (303-07 Glow Plug System - 2.2L Duratorq-TDCi (Puma) Diesel, Removal and Installation),
   Glow Plugs (303-07 Glow Plug System - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).

3. **Raise and support the vehicle.**

   For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

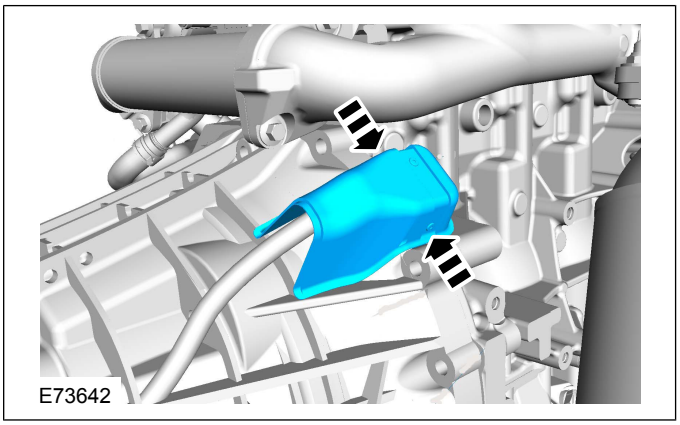
Vehicles with 2.2L diesel engine

4. **Detach the crankshaft position (CKP) sensor shield.**



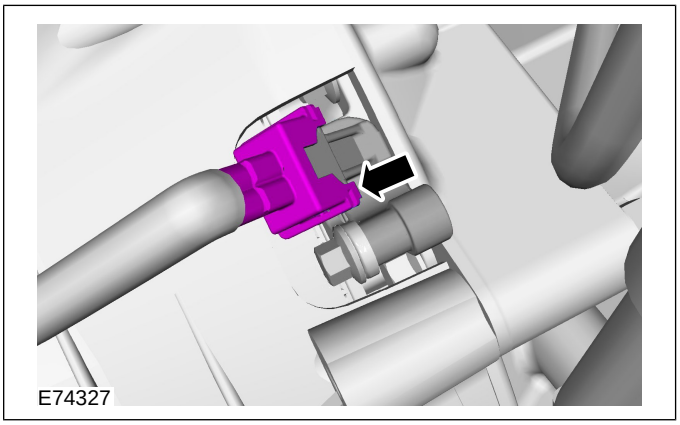
Vehicles with 2.4L diesel engine

5. **Detach the CKP sensor shield.**



All vehicles

6. **Disconnect the CKP sensor electrical connector.**

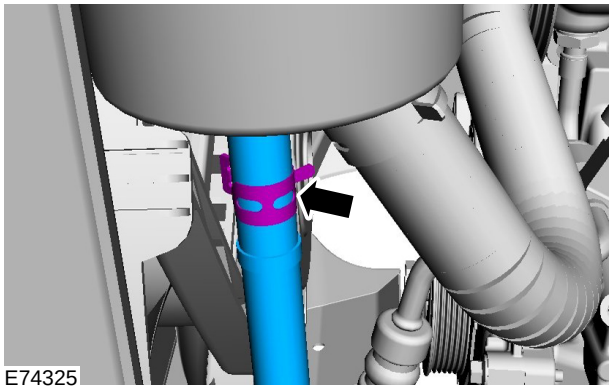


GENERAL PROCEDURES

7. **Lower the vehicle until the wheels are clear of the floor to allow the steering wheel to be rotated from lock to lock.**
8. **WARNING:Be prepared to collect escaping fluids.**

   Disconnect the power steering fluid return line from the power steering fluid reservoir.

   - Using a blanking cap, cap the power steering fluid reservoir.



9. **Place the end of the power steering fluid return line into a container.**
10. **Fill the power steering fluid reservoir to the MAX mark.**
11. **CAUTION:The fluid level must remain between the MAX and MIN marks.**

NOTE: This step requires the aid of another technician.

While cranking the engine for no more than 30 seconds turn the steering wheel slowly from lock to lock.

- With the aid of another technician, add clean hydraulic fluid.

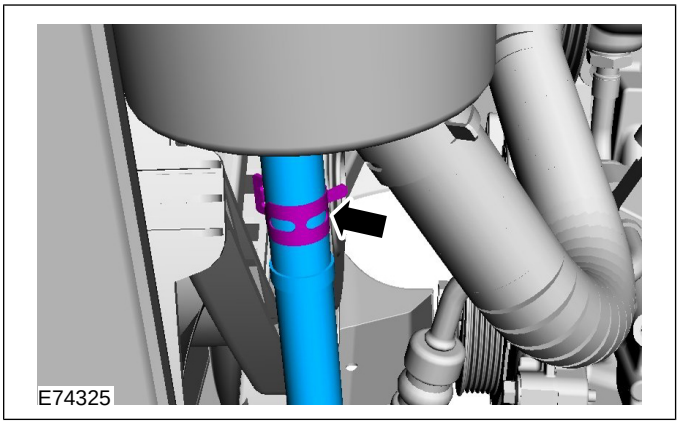
12. **Wait 60 seconds to allow the starter motor to cool.**
13. **CAUTION:The fluid level must remain between the MAX and MIN marks.**

NOTE: This step requires the aid of another technician.

While cranking the engine for a further 30 seconds turn the steering wheel slowly from lock to lock.

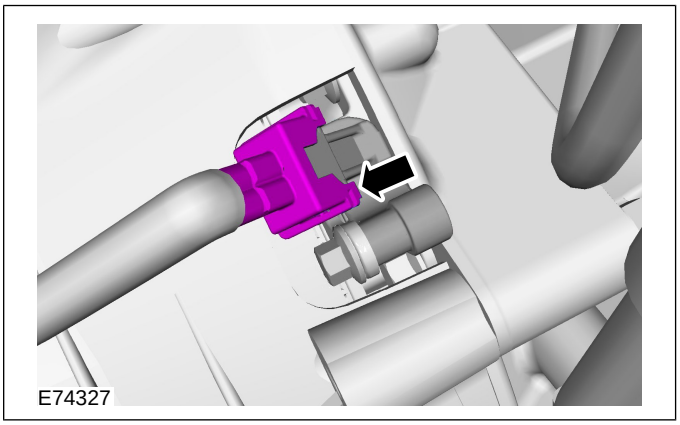
- With the aid of another technician, add clean hydraulic fluid.

14. **When the system is free of contaminated fluid, turn the ignition switch to the OFF position.**
15. **Connect the power steering fluid return line to the power steering fluid reservoir.**



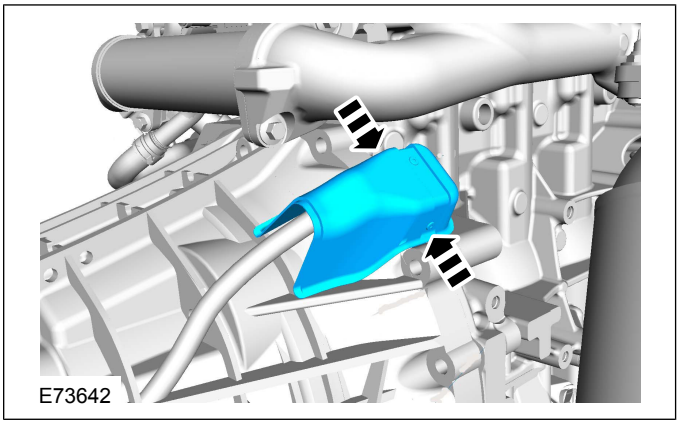
16. **Raise and support the vehicle.**

    For additional information, refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).
17. **Connect the CKP sensor electrical connector.**



Vehicles with 2.4L diesel engine

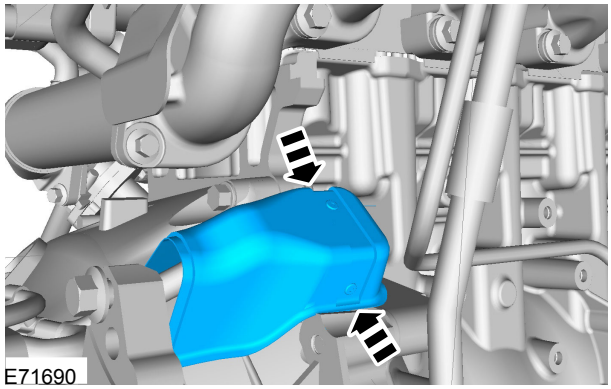
18. **Attach the CKP sensor shield.**



GENERAL PROCEDURES

Vehicles with 2.2L diesel engine

19. Attach the CKP sensor shield.



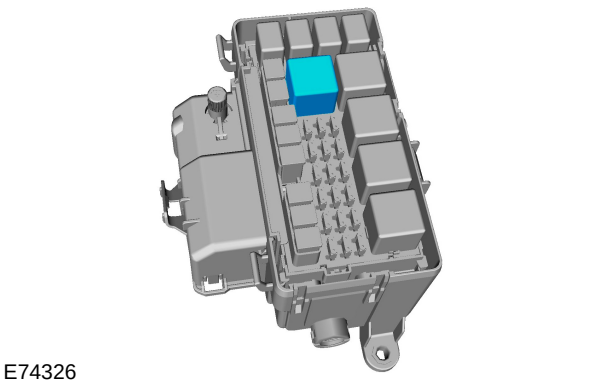
20. Lower the vehicle.

All vehicles

21. Install the glow plugs. For additional information, refer to:

Glow Plugs (303-07 Glow Plug System - 2.2L Duratorq-TDCi (Puma) Diesel, Removal and Installation),
Glow Plugs (303-07 Glow Plug System - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).

22. Install the glow plug relay.



23. Fill the power steering fluid reservoir to the MAX mark.

24. Start the engine and slowly turn the steering wheel from lock to lock.

25. Switch OFF the engine.

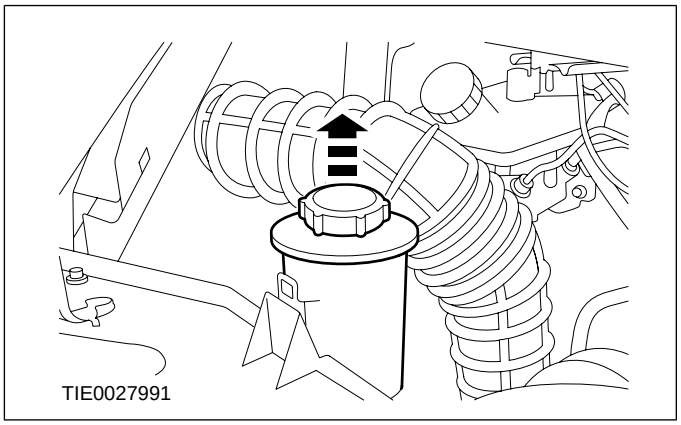
26. Check the fluid level. Fill the power steering fluid reservoir to the MAX mark as necessary.

GENERAL PROCEDURES

Power Steering System Flushing — 2.3L Duratec-HE (MI4) (13 001 0)

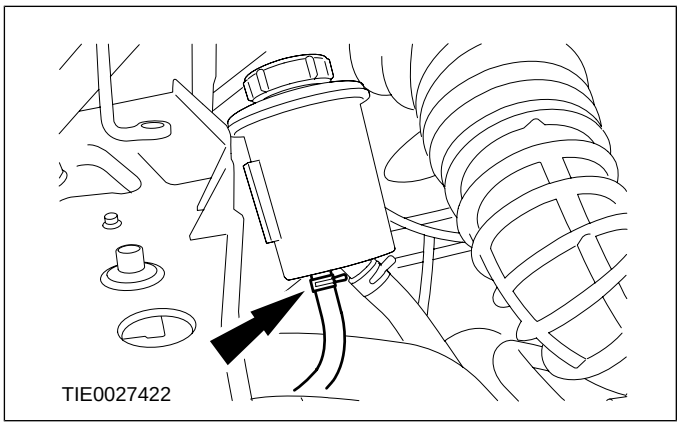
Materials	
Name	**Specification**
Power Steering Fluid	WSA-M2C195-A

1. **Detach the power steering fluid reservoir from the radiator grille opening panel.**

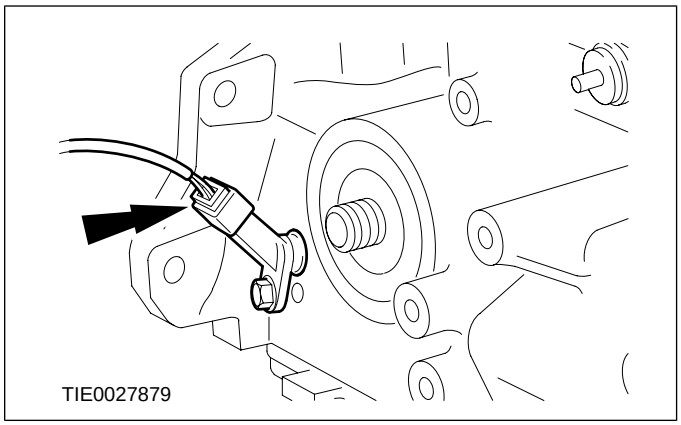


2. **NOTE:Using a suitable blanking cap, cap the power steering fluid cooler return line to reservoir connection.**

   Disconnect the power steering fluid cooler return line from the power steering fluid reservoir.



3. **Place the end of the power steering fluid cooler return line into a suitable container.**
4. **Remove the ignition coil-on-plug. For additional information, refer to Section 303-07A [Glow Plug System -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-07B [Engine Ignition -- 2.3L Duratec-HE (MI4)] / 303-07C [Glow Plug System -- 2.2L Duratorq-TDCi (Puma) Diesel].**
5. **Remove the spark plugs.**
6. **Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].**
7. **Disconnect the crankshaft position (CKP) sensor electrical connector (oil filter shown removed for clarity).**



8. **NOTE:Lower the vehicle until the wheels are clear of the floor to allow the steering wheel to be rotated from lock to lock.**

   Lower the vehicle.
9. **NOTE:When filling the power steering fluid reservoir, make sure the power steering fluid is clean and not agitated prior to use. The fluid should be poured slowly into the reservoir to minimize the possibility of aeration. The fluid level should be checked with the fluid cold.**

   Fill the power steering fluid reservoir to the MAX mark with Power Steering Fluid.
10. **⚠CAUTION:Do not continuously crank the engine for more than 30 seconds, as damage to the starter motor may result.**

NOTE: When flushing the power steering system, make sure that the power steering fluid in the reservoir does not fall below the minimum mark.

While cranking the engine for no more than 30 seconds turn the steering wheel from lock to lock.

- With the aid of another technician add 1 liter of clean Power Steering Fluid.

11. **Wait 60 seconds to allow the starter motor to cool.**

GENERAL PROCEDURES

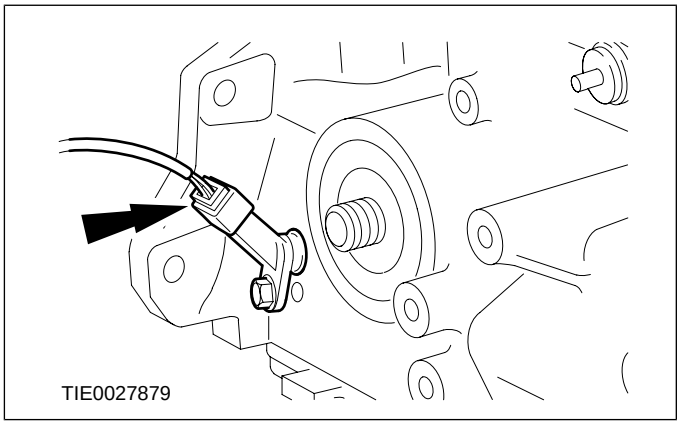
12. **⚠CAUTION:Do not continuously crank the engine for more than 30 seconds, as damage to the starter motor may result.**

NOTE: When flushing the power steering system, make sure that the power steering fluid in the reservoir does not fall below the minimum mark.

While cranking the engine for a further 30 seconds turn the steering wheel from lock to lock.

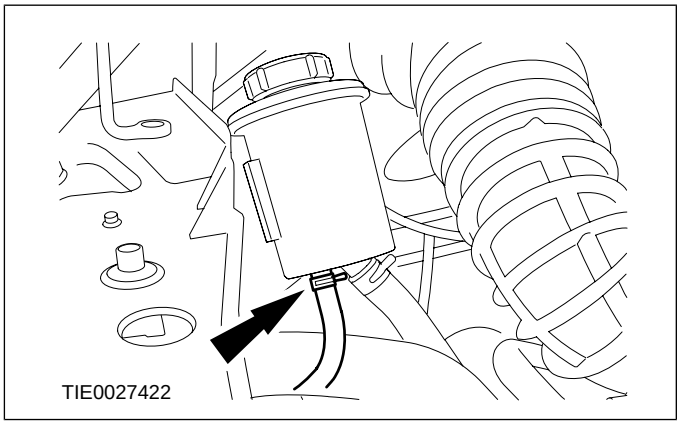
- With the aid of another technician add a further 1 liter of clean Power Steering Fluid.

13. **When all the fluid has been used, turn the ignition switch to the OFF position.**
14. **Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].**
15. **Connect the CKP sensor electrical connector (oil filter shown removed for clarity).**

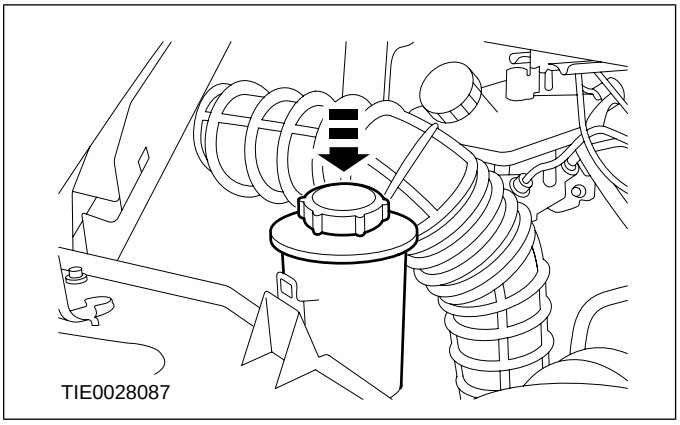

TIE0027879

16. **Lower the vehicle.**
17. **NOTE:Remove blanking cap, from the power steering fluid reservoir.**

Connect the power steering fluid cooler return line to the power steering fluid reservoir.


TIE0027422

18. **Attach the power steering fluid reservoir to the radiator grille opening panel.**


TIE0028087

19. **Install the spark plugs.**
20. **Install the ignition coil-on-plug. For additional information, refer to Section 303-07A [Glow Plug System -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-07B [Engine Ignition -- 2.3L Duratec-HE (MI4)] / 303-07C [Glow Plug System -- 2.2L Duratorq-TDCi (Puma) Diesel].**
21. **NOTE:When filling the power steering fluid reservoir, make sure the power steering fluid is clean and not agitated prior to use. The fluid should be poured slowly into the reservoir to minimize the possibility of aeration. The fluid level should be checked with the fluid cold.**

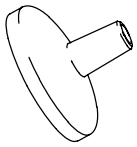
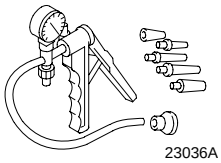
Fill the power steering fluid reservoir to the MAX mark with Power Steering Fluid.

22. **Start the engine and slowly turn the steering wheel from lock to lock.**
23. **Switch OFF the engine.**
24. **Check the fluid level. Fill up as necessary.**

GENERAL PROCEDURES

Power Steering System Bleeding (13 416 1)

Special Tool(s)

 13016	Adapter, Power Steering Bleeding 211-189 (13-016)
 23036A	Hand Vacuum Pump/Pressure Pump 416-D001 (23-036A)

Bleeding

1. **NOTE:When filling the power steering fluid reservoir, make sure that the power steering fluid is clean and not agitated prior to use. The power steering fluid should be poured slowly into the reservoir to minimize the possibility of aeration. The power steering fluid level should be checked with the power steering fluid cold.**

   Fill the power steering fluid reservoir to the MAX mark with the appropriate power steering fluid.

   For additional information, refer to:Specifications (211-00 Steering System - General Information, Specifications).

2. **Raise and support the vehicle making sure that the road wheels are just clear of the floor. For additional information, refer to:(100-02 Jacking and Lifting)**

   Jacking (Description and Operation), Lifting (Description and Operation).

3. **NOTE:Do not start the engine at this stage.**

NOTE: Make sure that the power steering fluid in the power steering fluid reservoir does not fall below the MIN mark, as air could enter the system.

Slowly turn the steering wheel from lock to lock and add power steering fluid until the power steering fluid in the power steering fluid reservoir stops dropping.

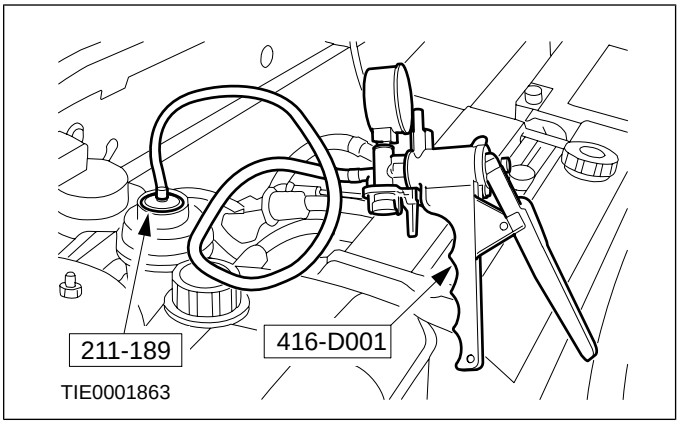
4. **Check the power steering fluid level. Fill the power steering fluid reservoir to the MAX mark with the appropriate power steering fluid.**

   For additional information, refer to:Specifications (211-00 Steering System - General Information, Specifications).

5. **NOTE:When bleeding the power steering system the vacuum will decrease. Using the special tools, maintain a sufficient vacuum of 38cm-Hg. If the vacuum decreases by more than 5cm-Hg in 5 minutes, the system should be checked for leaks.**

   Using the special tools, bleed the power steering system in the following sequence.

   1. Slowly turn the steering wheel from lock to lock once; then turn the steering wheel to the right, just off the stop.
   2. Using the special tools, create a vacuum of 38cm-Hg. Maintain the vacuum until the air is evacuated from the system (minimum of five minutes).
   3. Release the vacuum.
   4. Repeat the power steering bleeding procedure, turning the steering wheel to the left, just off the stop.



6. **Remove the special tools. Fill the power steering fluid reservoir to the MAX mark with the appropriate power steering fluid as necessary.**

   For additional information, refer to:Specifications (211-00 Steering System - General Information, Specifications).

7. **NOTE:Make sure that the power steering fluid in the power steering fluid reservoir does not fall below the MIN mark, as air could enter the system.**

GENERAL PROCEDURES

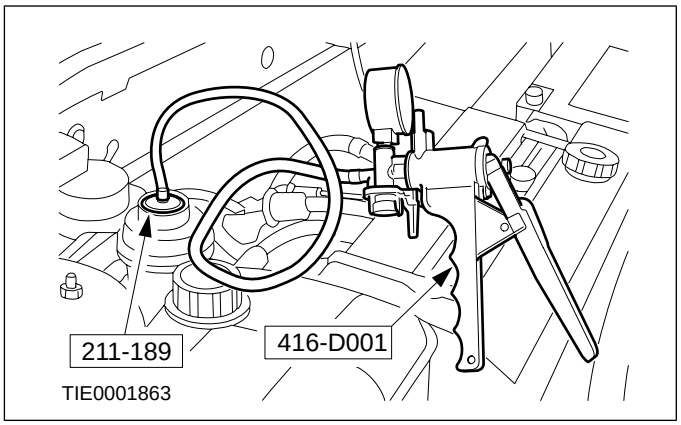
Start the engine and slowly turn the steering wheel from lock to lock and add power steering fluid until the power steering fluid in the power steering fluid reservoir does not drop.

8. **Switch OFF the engine and examine the power steering hose connections, steering gear boots, power steering valve body and power steering pump for external leaks.**
9. **Check the power steering fluid level. Fill the power steering fluid reservoir to the MAX mark with the appropriate power steering fluid.**

   For additional information, refer to:Specifications (211-00 Steering System - General Information, Specifications).
10. **NOTE:When bleeding the power steering system the vacuum will decrease. Using the special tools, maintain a sufficient vacuum of 38cm-Hg. If the vacuum decreases by more than 5cm-Hg in 5 minutes, the system should be checked for leaks.**

    Using the special tools, bleed the power steering system in the following sequence.

    1. Start the engine and slowly turn the steering wheel from lock to lock once; then turn the steering wheel to the right, just off the stop.
    2. Switch OFF the engine.
    3. Using the special tools, create a vacuum of 38cm-Hg. Maintain the vacuum until the air is evacuated from the system (minimum of five minutes).
    4. Release the vacuum.
    5. Repeat the power steering bleeding procedure, turning the steering wheel to the left, just off the stop.



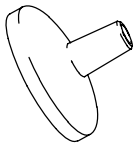
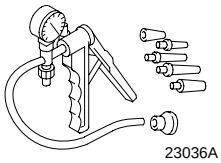
11. **Remove the special tools. Fill the power steering fluid reservoir to the MAX mark with the appropriate power steering fluid as necessary.**

    For additional information, refer to:Specifications (211-00 Steering System - General Information, Specifications).
12. **Start the engine, turn the steering wheel from lock to lock. If excessive noise is apparent, repeat the power steering bleeding procedure.**
13. **Lower the vehicle.**
14. **If the noise level is still unacceptable, leave the vehicle standing overnight then repeat the power steering system bleeding procedure.**

GENERAL PROCEDURES

Power Steering System Filling (13 002 0)

Special Tool(s)

 13016	Adapter, Power Steering Bleeding 211-189 (13-016)
 23036A	Hand Vacuum Pump/Pressure Pump 416-D001 (23-036A)

Refill

1. **NOTE:When filling the power steering fluid reservoir, make sure that the power steering fluid is clean and not agitated prior to use. The power steering fluid should be poured slowly into the reservoir to minimize the possibility of aeration. The power steering fluid level should be checked with the power steering fluid cold.**

   Fill the power steering fluid reservoir to the MAX mark with the appropriate power steering fluid.

   For additional information, refer to:Specifications (211-00 Steering System - General Information, Specifications).

2. **Raise and support the vehicle making sure that the road wheels are just clear of the floor. For additional information, refer to:(100-02 Jacking and Lifting)**

   Jacking (Description and Operation), Lifting (Description and Operation).

3. **NOTE:Do not start the engine at this stage.**

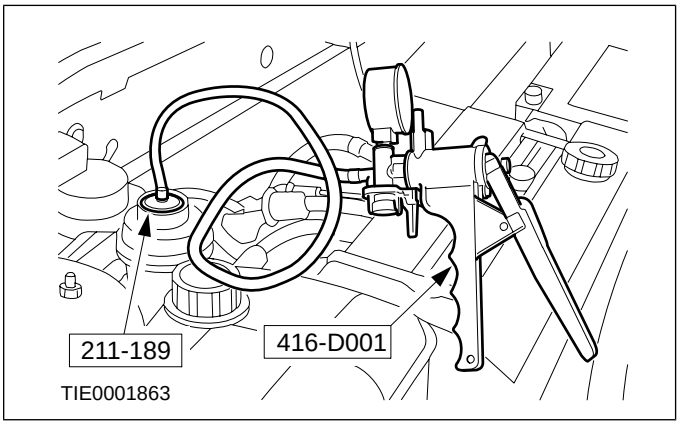
NOTE: Make sure that the power steering fluid in the power steering fluid reservoir does not fall below the MIN mark, as air could enter the system.

Slowly turn the steering wheel from lock to lock and add power steering fluid until the power steering fluid in the power steering fluid reservoir stops dropping.

4. **NOTE:Make sure that the power steering fluid in the power steering fluid reservoir does not fall below the MIN mark, as air could enter the system.**

   Start the engine and slowly turn the steering wheel from lock to lock and add power steering fluid until the power steering fluid in the power steering fluid reservoir stops dropping.

5. **Switch the engine OFF and using the special tools, create a vacuum of 62cm-Hg - 75cm-Hg for 30 seconds.**



6. **Observe the vacuum gauge reading.**
   - If the vacuum decreases by more than 5cm-Hg in 5 minutes, the system should be checked for leaks.
7. **Remove the special tools. Fill the power steering fluid reservoir to the MAX mark with the appropriate power steering fluid as necessary.**

   For additional information, refer to:Specifications (211-00 Steering System - General Information, Specifications).

8. **Lower the vehicle.**

SECTION 211-02 Power Steering

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 211-02-2

DESCRIPTION AND OPERATION

Power Steering 211-02-3

DIAGNOSIS AND TESTING

Power Steering 211-02-6

REMOVAL AND INSTALLATION

Power Steering Pump — 2.4L Duratorq-TDCi (Puma) Diesel ..... (13 434 0) 211-02-7
Power Steering Pump — 2.3L Duratec-HE (MI4) 211-02-10
Power Steering Pump to Steering Gear Pressure Line — 2.4L Duratorq-TDCi (Puma) Diesel ..... (13 440 0) 211-02-11
Power Steering Pump to Steering Gear Pressure Line — 2.4L Duratorq-TDCi (Puma) Diesel 211-02-14
Power Steering Pump to Steering Gear Pressure Line — 2.3L Duratec-HE (MI4) 211-02-16
Power Steering Fluid Cooler ..... (13 444 0) 211-02-18
Steering Gear 211-02-19
Steering Gear to Fluid Cooler Return Hose 211-02-22

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Power steering fluid	WSA-M2C195-A

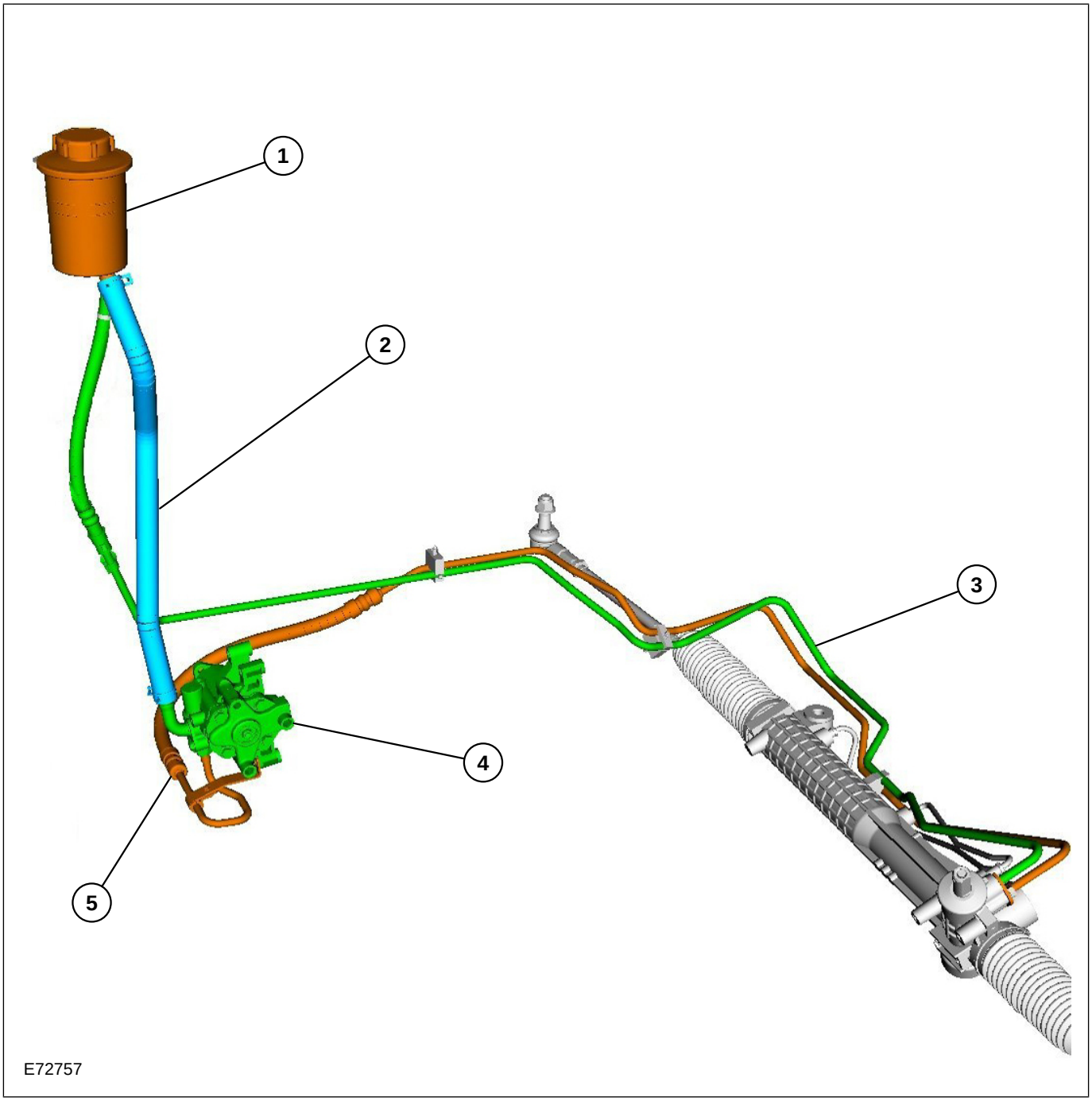
Torque Specifications

Description	Nm	lb-ft	lb-in
Steering gear high-pressure line to power steering pump union — vehicles with 2.4L diesel engine	65	48	–
Steering gear high-pressure line to power steering pump union — vehicles with 2.2L diesel engine	24	18	–
Steering gear high-pressure line to power steering pump union — vehicles with 2.3L engine	65	48	–
Power steering pump retaining bolts	23	17	–
Power steering pump to coolant pump bolts — vehicles with 2.2L diesel engine	23	17	–
Coolant pump drive shaft nut — vehicles with 2.2L diesel engine	22	16	–
Steering gear line clamp plate retaining bolt	23	17	–
Steering gear retaining bolts	115	85	–
Tie-rod end retaining nut	80	59	–
Tie-rod end locknut	80	59	–
Steering column flexible coupling upper pinch bolt	28	21	–
Steering column flexible coupling lower pinch bolt	23	17	–
Stabilizer bar connecting link nut	55	41	–
Steering column lower bearing retaining bolts	12	9	–
Steering gear line bracket to engine crossmember nut	30	22	–
Steering gear line bracket to crossmember bolt	1	–	9
Steering gear line bracket to steering gear bolt	3	–	27

DESCRIPTION AND OPERATION

Power Steering

2.2L Duratorq-TDCi (Puma) Diesel

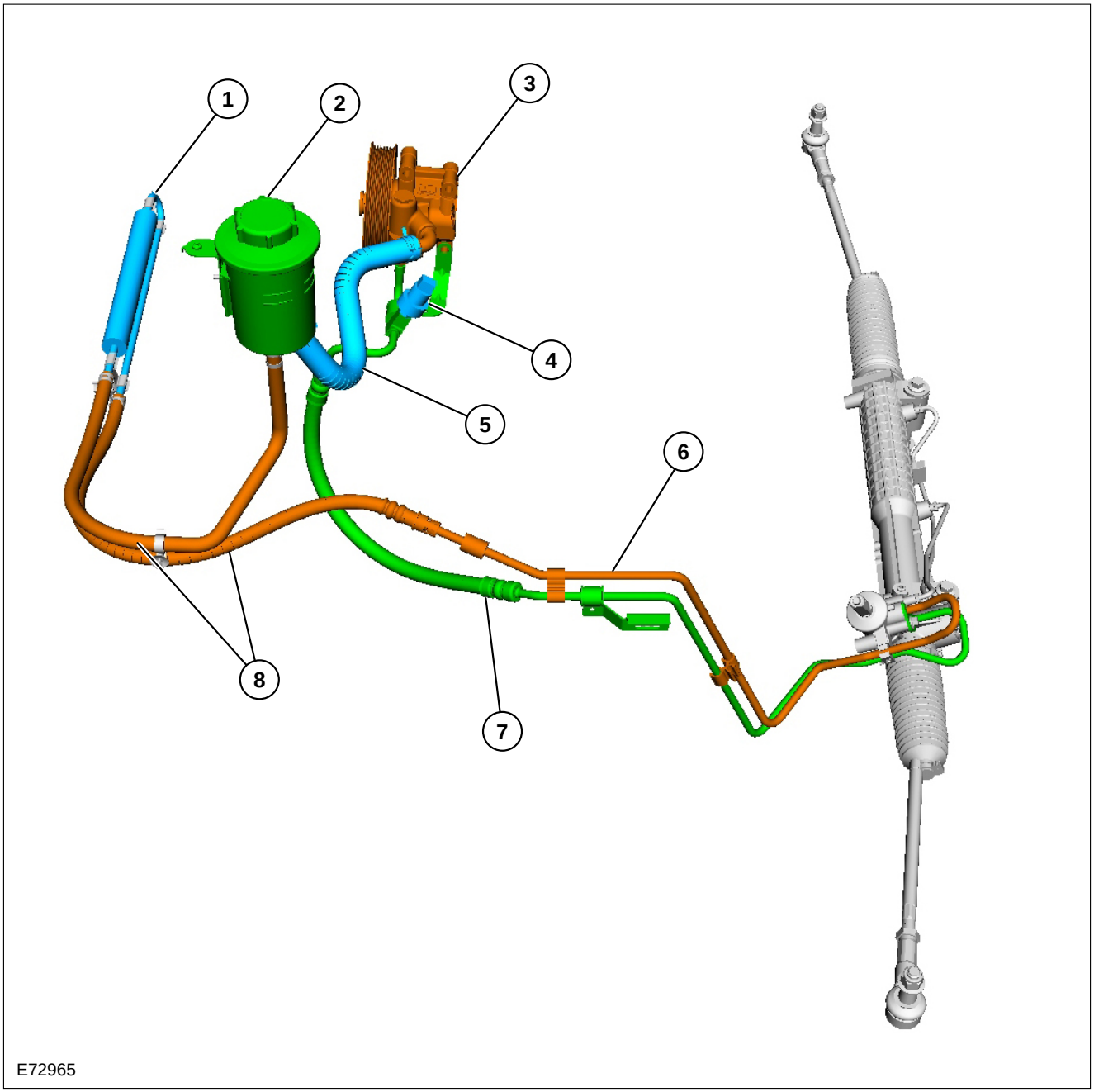


Item	Part Number	Description
1		Power steering fluid reservoir
2		Power steering fluid supply line
3		Power steering fluid return line

Item	Part Number	Description
4		Power steering pump
5		Power steering fluid pressure line

DESCRIPTION AND OPERATION

2.3L Duratec-HE (MI4)

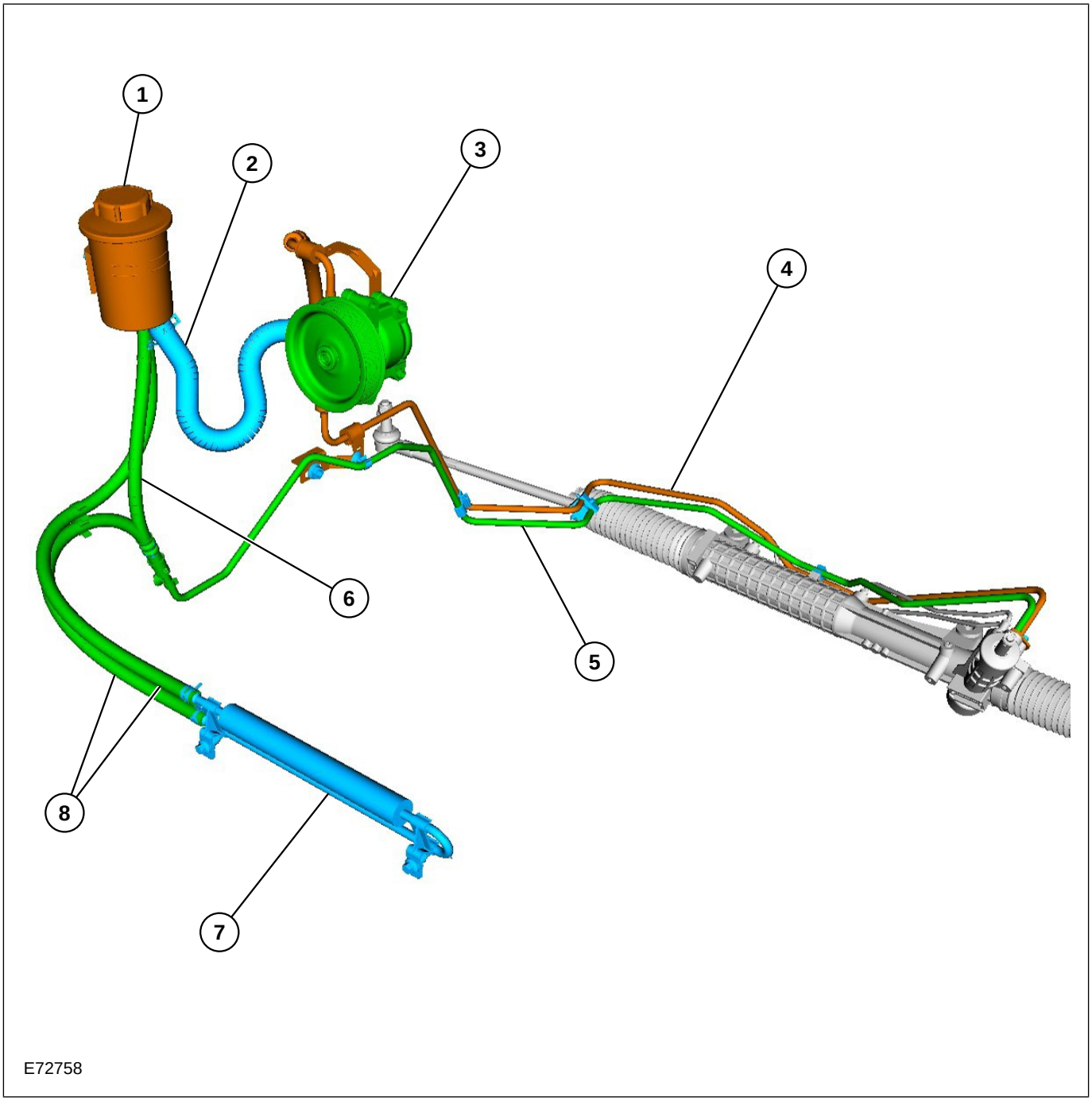


Item	Description
1	Power steering fluid cooler
2	Power steering fluid reservoir
3	Power steering pump
4	Power steering pressure switch

Item	Description
5	Power steering fluid supply line
6	Power steering fluid return line
7	Power steering fluid pressure line
8	Power steering fluid return lines – vehicles with power steering fluid cooler

DESCRIPTION AND OPERATION

2.4L Duratorq-TDCi (Puma) Diesel



Item	Description
1	Power steering fluid reservoir
2	Power steering fluid supply line
3	Power steering pump
4	Power steering pressure line
5	Power steering fluid return line
6	Power steering fluid return line – vehicles without power steering fluid cooler

Item	Description
7	Power steering fluid cooler
8	Power steering fluid return lines – vehicles with power steering fluid cooler

DIAGNOSIS AND TESTING

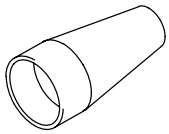
Power Steering

REFER to Section 211-00 [Steering System - General Information].

REMOVAL AND INSTALLATION

Power Steering Pump — 2.4L Duratorq-TDCi (Puma) Diesel (13 434 0)

Special Tool(s)

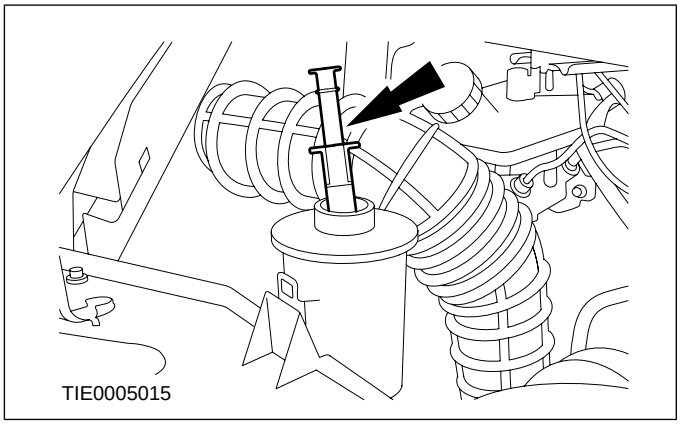
 13015	Expander, Teflon Seal 211-188 (13-015)

General Equipment

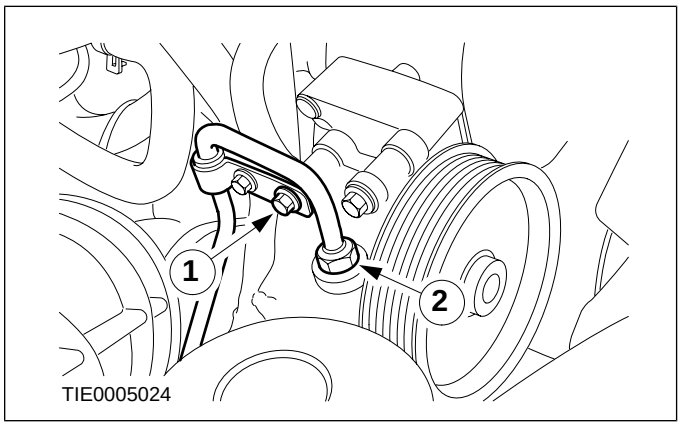
Syringe

Removal

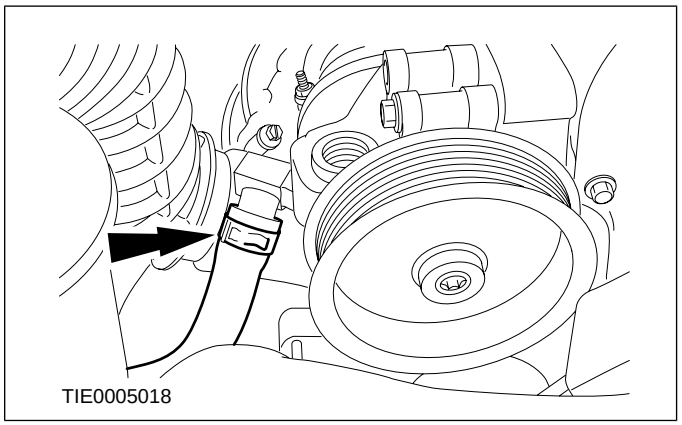
1. **Remove the accessory drive belt. For additional information, refer to Section 303-05 [Accessory Drive].**
2. **Using a suitable syringe, remove the fluid from the power steering fluid reservoir.**



3. **Disconnect the power steering line from the power steering pump.**
   1. Remove the bolt.
   2. Disconnect the union.
   - Allow the fluid to drain into a suitable container.
   - Discard the O-ring seal.

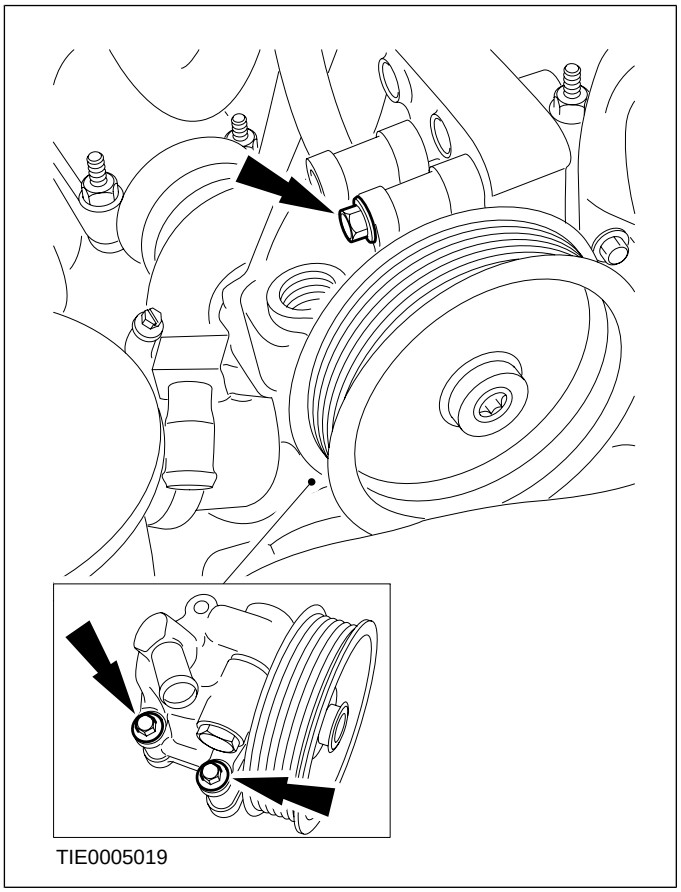


4. **Disconnect the power steering hose from the power steering pump.**
   - Allow the fluid to drain into a suitable container.

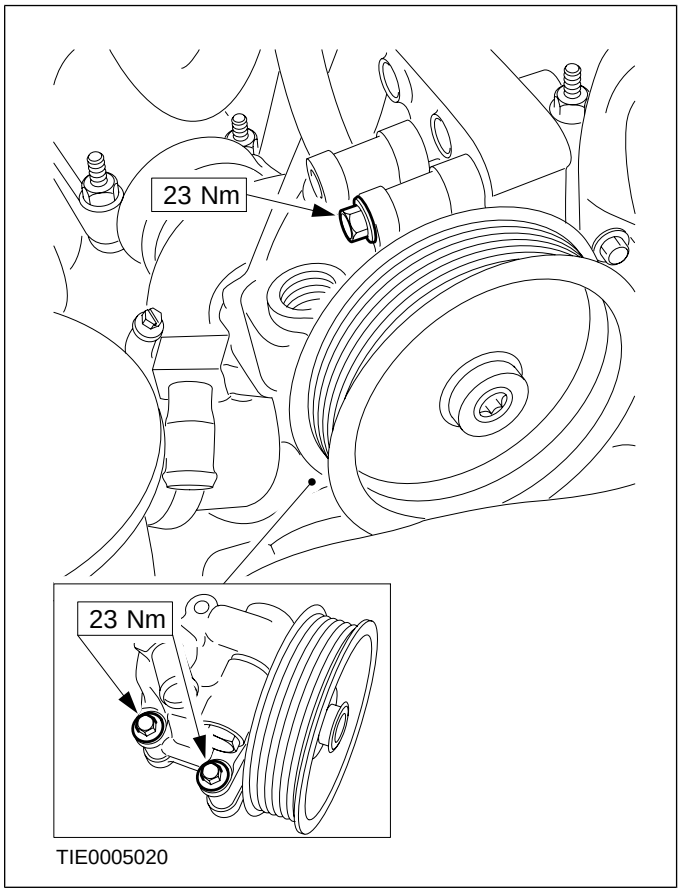


REMOVAL AND INSTALLATION

5. Remove the power steering pump.


TIE0005019

2. Install the power steering pump.

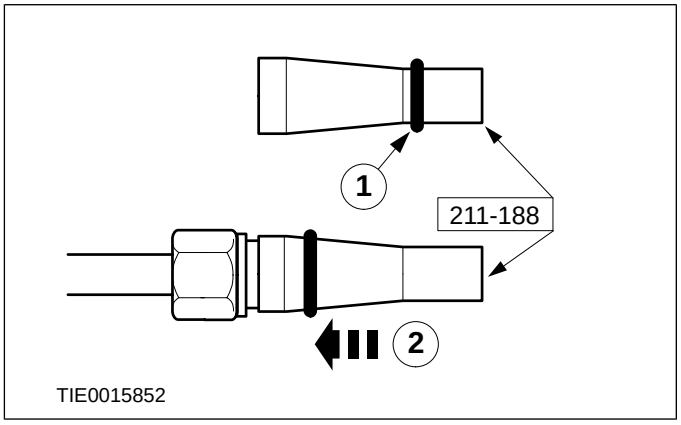


TIE0005020

Installation

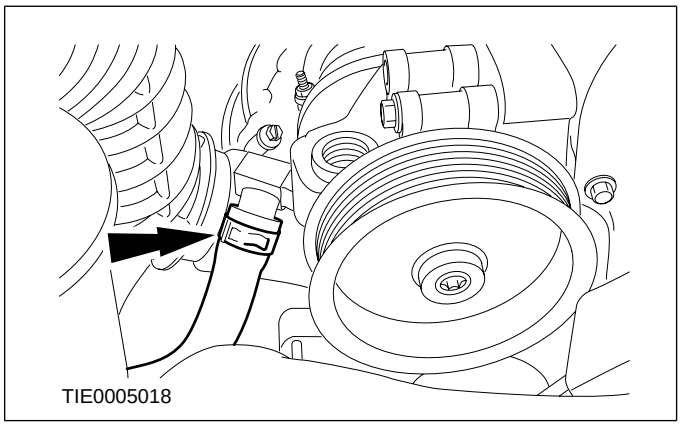
1. Using the special tool, install a new O-ring seal onto the steering gear to power steering pump union.

1. Push the new O-ring seal onto the special tool.
2. Locate the special tool onto the union and install the O-ring seal.



TIE0015852

3. Connect the power steering hose to the power steering pump.

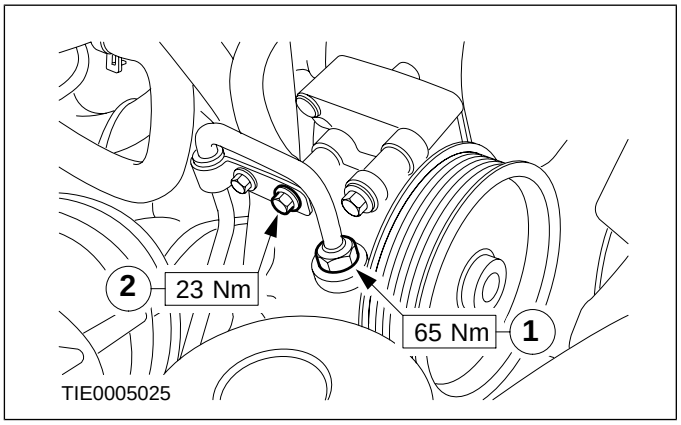

TIE0005018

4. Install the power steering line to the power steering pump.

1. Connect the union.

REMOVAL AND INSTALLATION

2. Install the bolt.

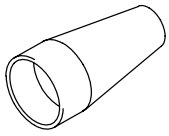


5. **Install the accessory drive belt. For additional information, refer to Section 303-05 [Accessory Drive].**
6. **Fill and bleed the power steering system. For additional information, refer to Section 211-00 [Steering System - General Information].**

REMOVAL AND INSTALLATION

Power Steering Pump — 2.3L Duratec-HE (MI4)

Special Tool(s)

 13015	Expander, Teflon Seal 211-188

Special Tool(s)

Removal

NOTE: Removal steps in this procedure may contain installation details.

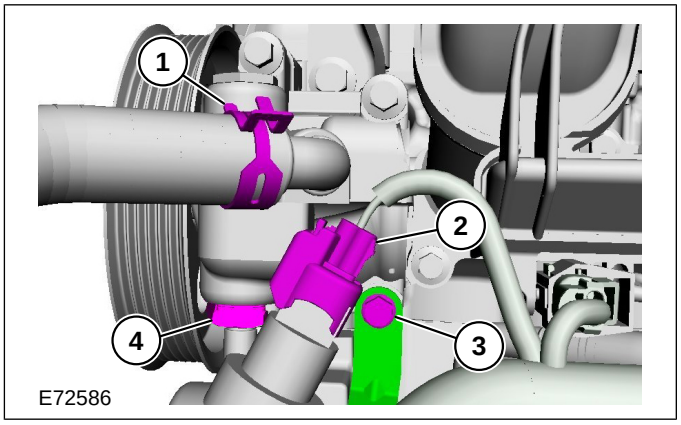
1. Remove the power steering pump drive belt.

   Refer to: Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

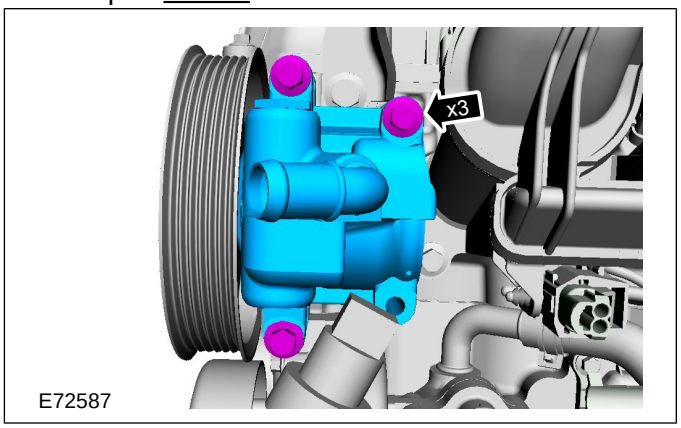
2. **WARNING:Be prepared to collect escaping fluids.**

   CAUTION:Make sure that all openings are sealed.

3. Torque: 23 Nm
4. Torque: 65 Nm

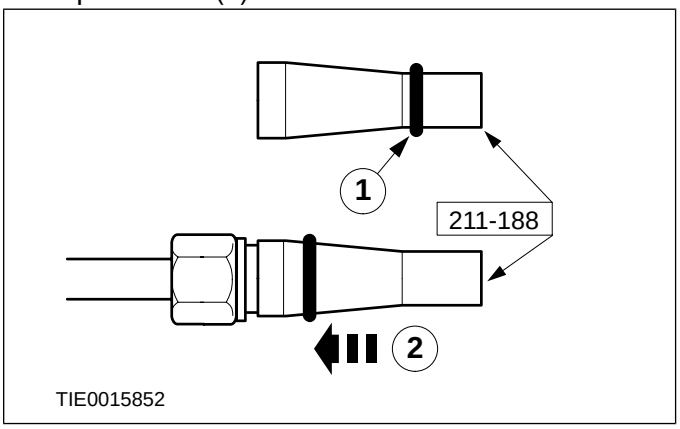


3. Torque: 23 Nm



Installation

1. To install, reverse the removal procedure.
2. Special Tool(s): 211-188



3. Fill the power steering system.

   Refer to:Power Steering System Filling (211-00 Steering System - General Information, General Procedures).

4. Bleed the power steering system.

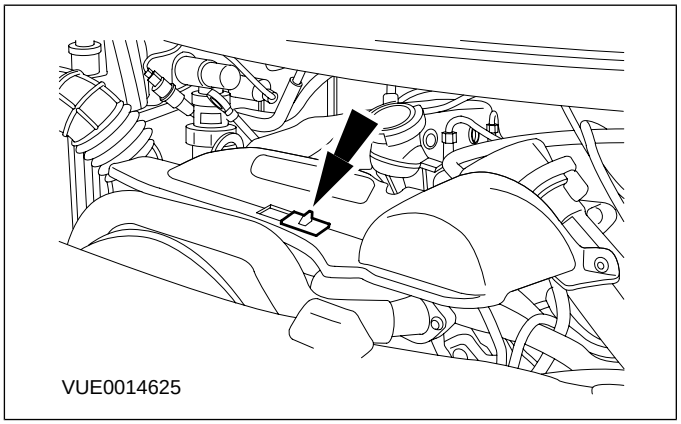
   Refer to:Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).

REMOVAL AND INSTALLATION

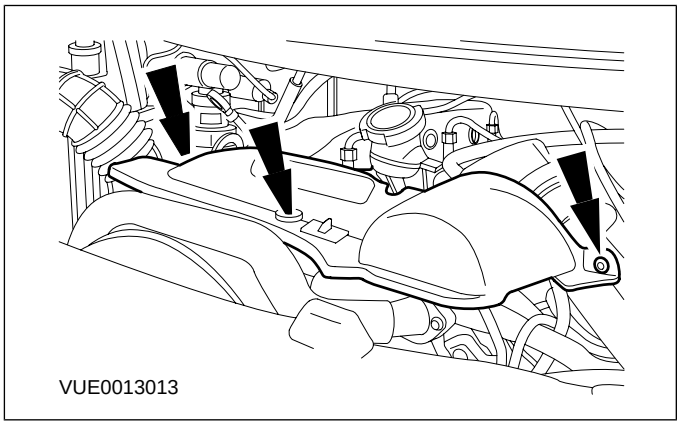
Power Steering Pump to Steering Gear Pressure Line — 2.4L Duratorq-TDCi (Puma) Diesel (13 440 0)

Removal

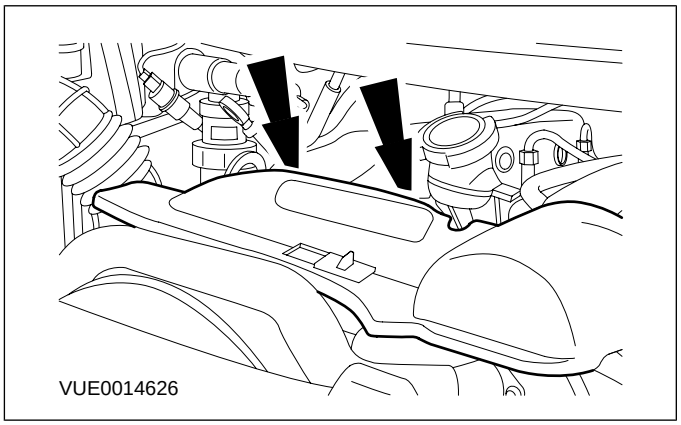
1. Slide open the bolt cover.



2. Remove the accessory drive belt shield retaining bolts.



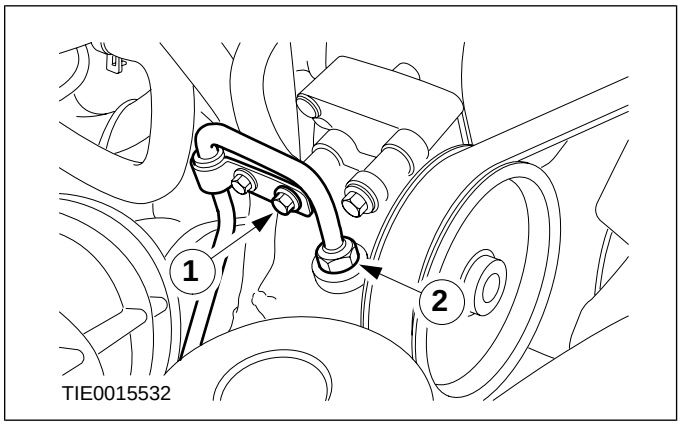
3. Detach the fuel charging wiring harness and remove the accessory drive belt shield.



4. Disconnect the power steering line from the power steering pump.

1. Remove the bolt.
2. Disconnect the union.

- Allow the fluid to drain into a suitable container.

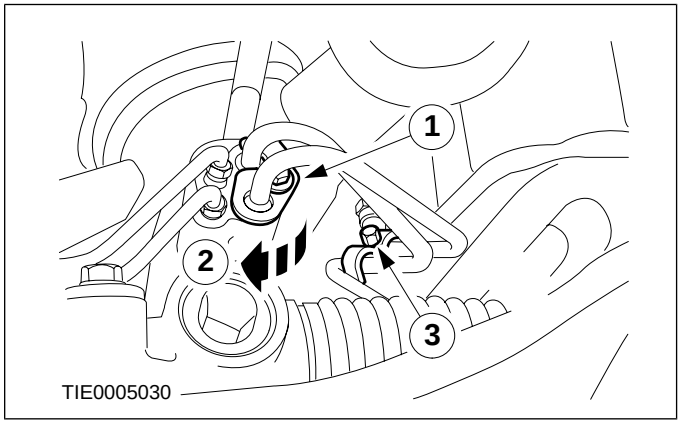


5. Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].

6. Disconnect the power steering line from the power steering gear.

1. Remove the bolt.
2. Rotate the clamp plate.
3. Detach the lines from the front axle crossmember.

- Allow the fluid to drain into a suitable container.

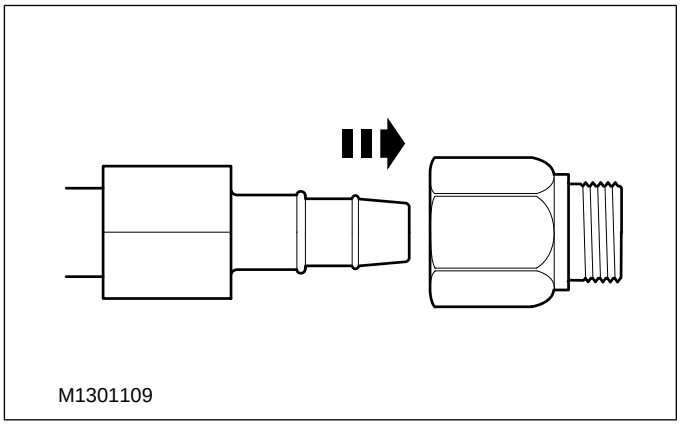


7. Remove the power steering pump to steering gear pressure line.

REMOVAL AND INSTALLATION

Installation

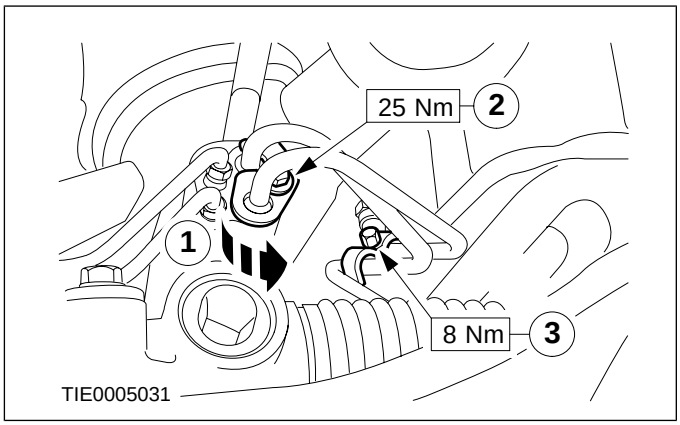
1. **Install a new power steering line to power steering pump union.**



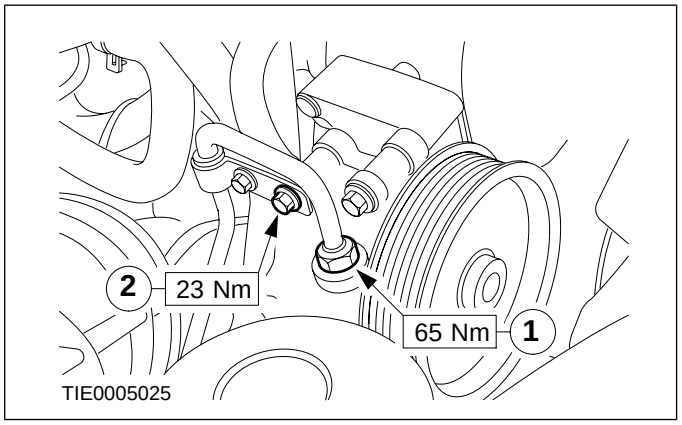
2. **CAUTION:Make sure the power steering line is correctly located in the valve body.**

   Connect the power steering line to the power steering gear.

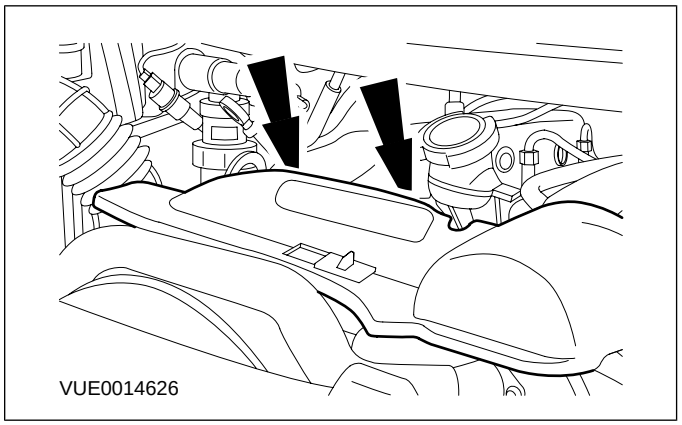
   1. Rotate the clamp plate.
   2. Install the bolt.
   3. Attach the lines to the front axle crossmember.



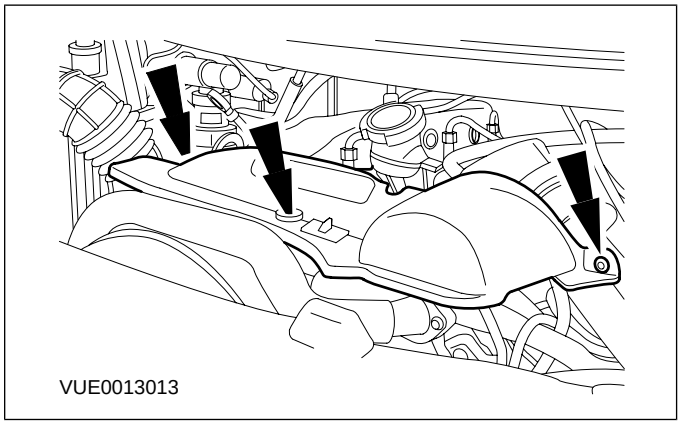
3. **Lower the vehicle.**
4. **Connect the power steering line to the power steering pump.**
   1. Connect the union.
   2. Install the bolt.



5. **Loosely install the accessory drive belt shield and attach the fuel charging wiring harness.**

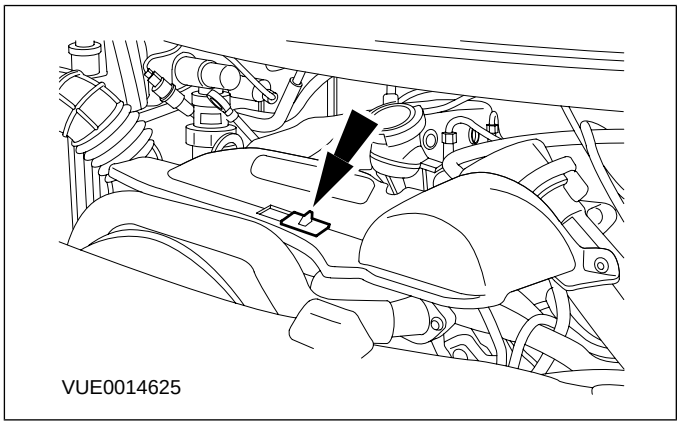


6. **Install the accessory drive belt shield retaining bolts.**



REMOVAL AND INSTALLATION

7. Close the bolt cover.

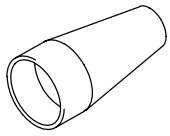


8. Fill and bleed the power steering system. For additional information, refer to Section 211-00 [Steering System - General Information].

REMOVAL AND INSTALLATION

Power Steering Pump to Steering Gear Pressure Line — 2.4L Duratorq-TDCi (Puma) Diesel

Special Tool(s)

 13015	Expander, Teflon Seal 211-188

Special Tool(s)

Removal

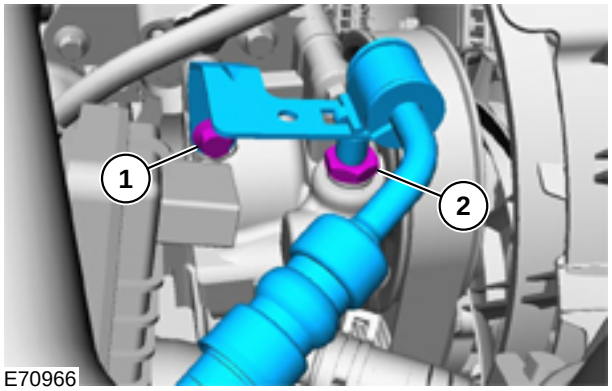
NOTE: Removal steps in this procedure may contain installation details.

All vehicles

1. **WARNING:Be prepared to collect escaping fluids.**

   CAUTION:Make sure that all openings are sealed.

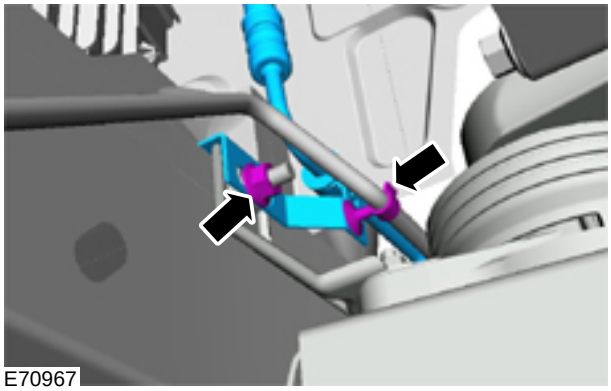
   1. Torque: 23 Nm
   2. Torque: 65 Nm



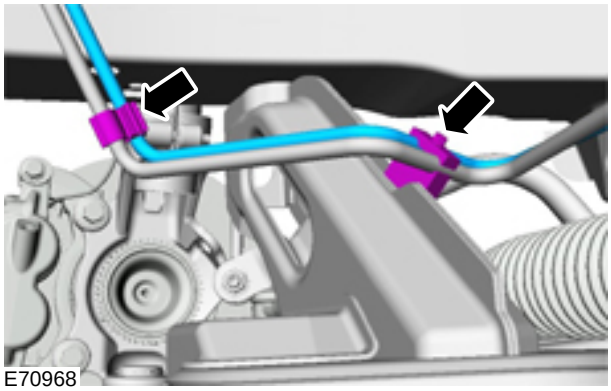
2. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

3. Torque: 30 Nm



4. Torque: 1 Nm



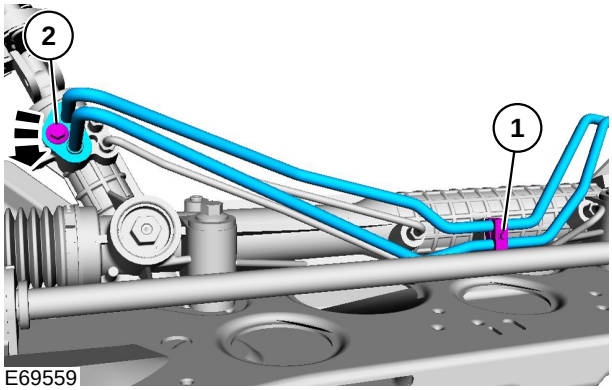
Left-hand drive vehicles

5. **WARNING:Be prepared to collect escaping fluids.**

REMOVAL AND INSTALLATION

CAUTION:Make sure that all openings are sealed.

1. Torque: 3 Nm
2. Torque: 23 Nm

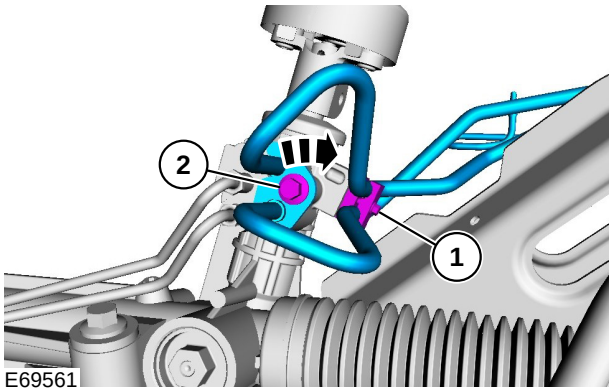


Right-hand drive vehicles

6. **WARNING:Be prepared to collect escaping fluids.**

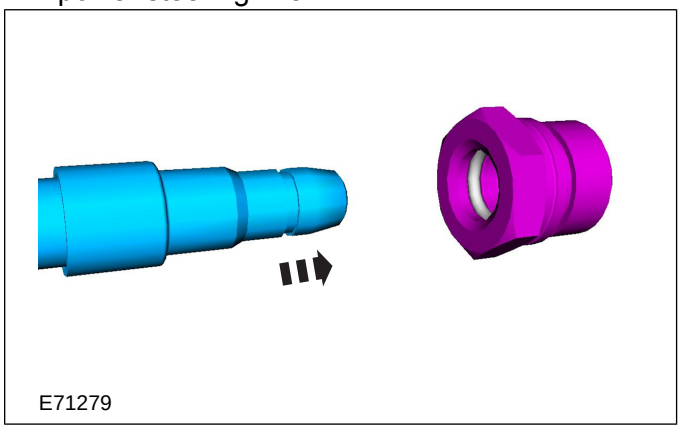
   CAUTION:Make sure that all openings are sealed.

   1. Torque: 3 Nm
   2. Torque: 23 Nm



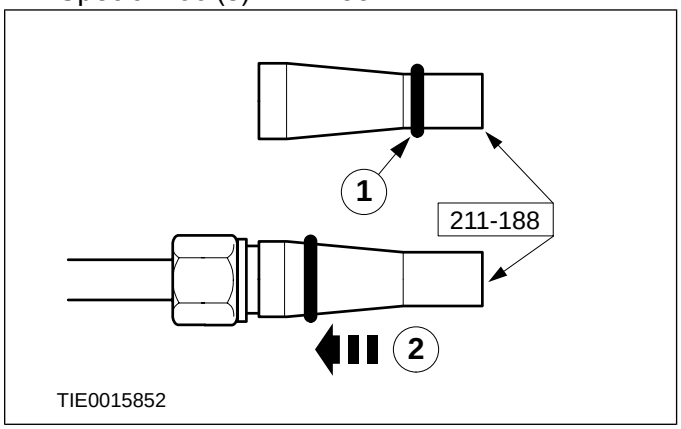
Installation

1. To install, reverse the removal procedure.
2. This step is only required when installing a new power steering line.



3. This step is only required when installing the original power steering pressure line.

   Special Tool(s): 211-188



4. Fill the power steering system.

   Refer to:Power Steering System Filling (211-00 Steering System - General Information, General Procedures).

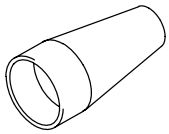
5. Bleed the power steering system.

   Refer to:Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).

REMOVAL AND INSTALLATION

Power Steering Pump to Steering Gear Pressure Line — 2.3L Duratec-HE (MI4)

Special Tool(s)

 13015	Expander, Teflon Seal 211-188

Special Tool(s)

Removal

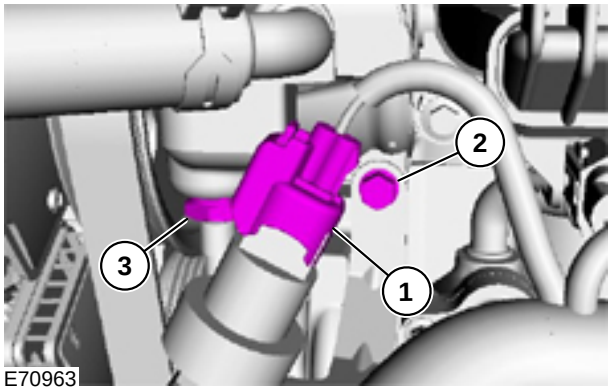
NOTE: Removal steps in this procedure may contain installation details.

All vehicles

1. **WARNING:Be prepared to collect escaping fluids.**

   CAUTION:Make sure that all openings are sealed.

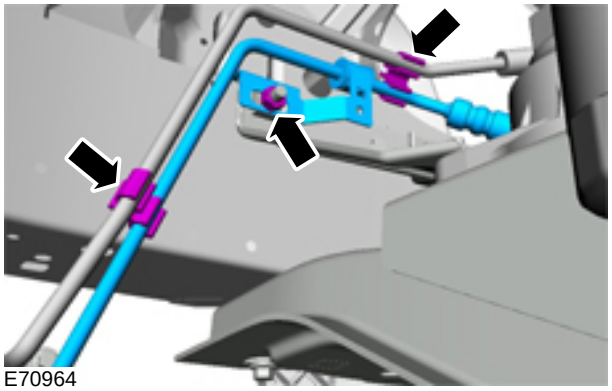
   2. Torque: 23 Nm
   3. Torque: 65 Nm



2. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

3. Torque: 30 Nm

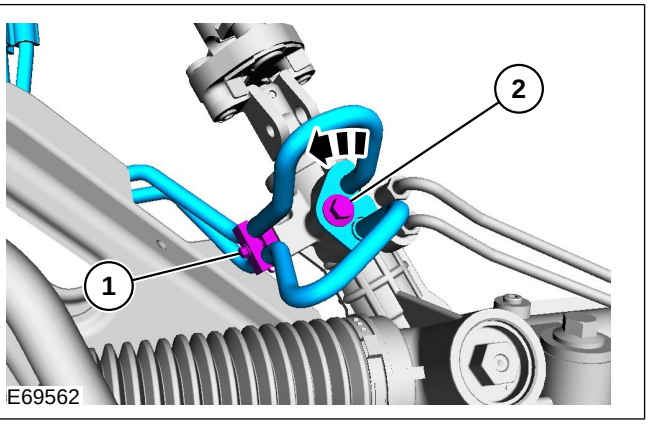


Left-hand drive vehicles

4. **WARNING:Be prepared to collect escaping fluids.**

   CAUTION:Make sure that all openings are sealed.

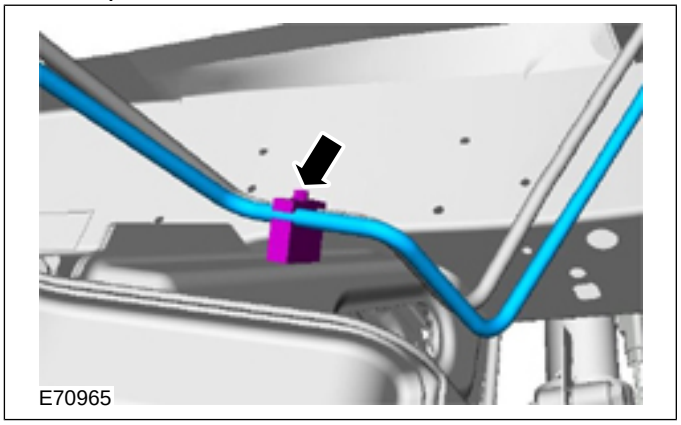
   1. Torque: 3 Nm
   2. Torque: 23 Nm



REMOVAL AND INSTALLATION

Right-hand drive vehicles

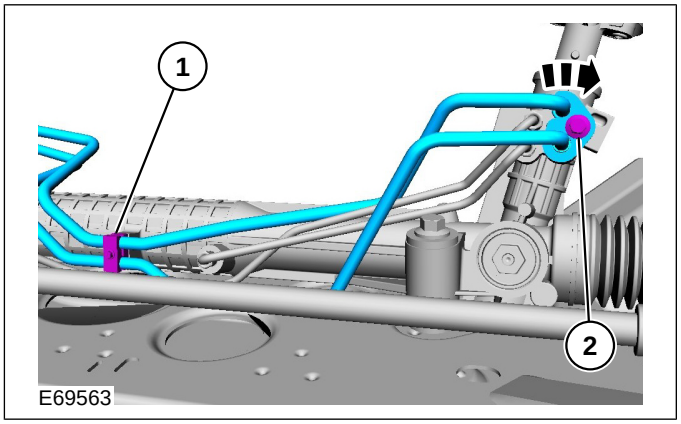
5. Torque: 1 Nm



6. **WARNING:Be prepared to collect escaping fluids.**

CAUTION:Make sure that all openings are sealed.

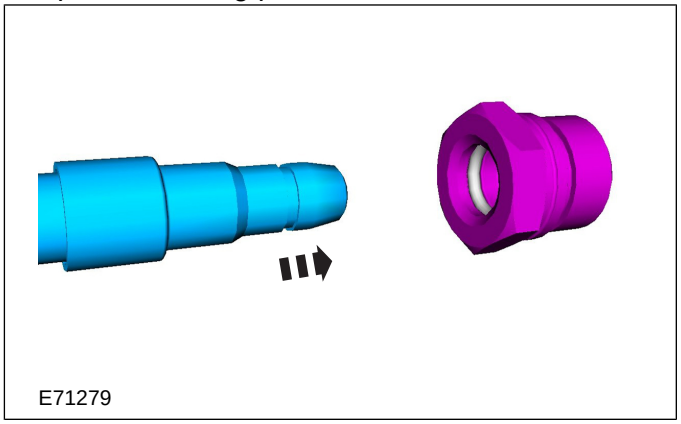
1. Torque: 3 Nm
2. Torque: 23 Nm



Installation

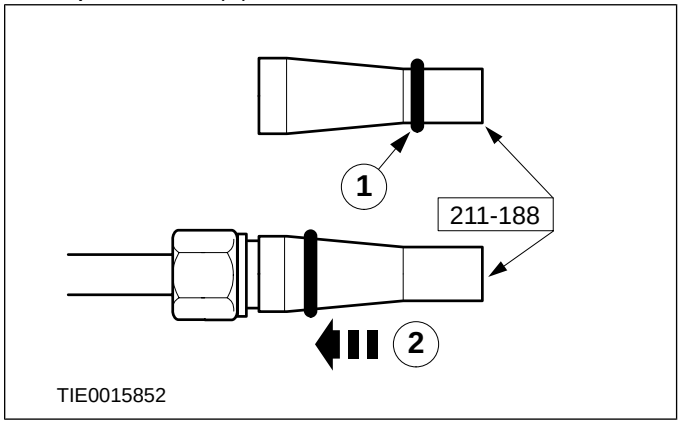
1. To install, reverse the removal procedure.

2. This step is only required when installing a new power steering pressure line.



3. This step is only required when installing the original power steering pressure line.

Special Tool(s): 211-188



4. Fill the power steering system.

Refer to:Power Steering System Filling (211-00 Steering System - General Information, General Procedures).

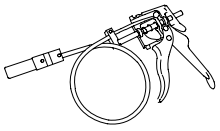
5. Bleed the power steering system.

Refer to:Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).

REMOVAL AND INSTALLATION

Power Steering Fluid Cooler (13 444 0)

Special Tool(s)

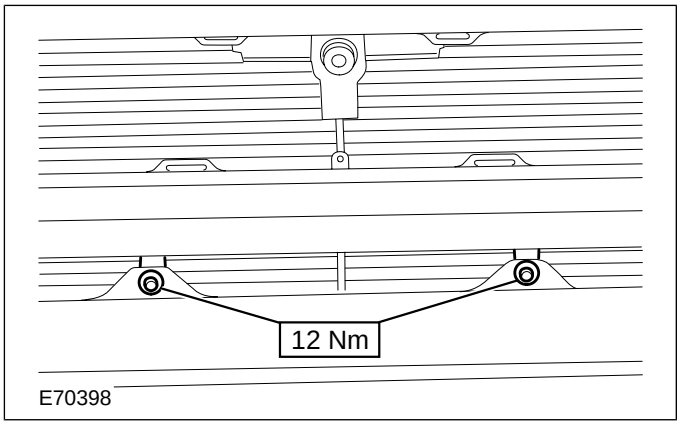
 24003	Remover/Installer, Cooling Hose Clamp 303-397 (24-003)

Removal

1. **Remove the front bumper cover.**

   For additional information, refer to:Front Bumper Cover (501-19 Bumpers, Removal and Installation).

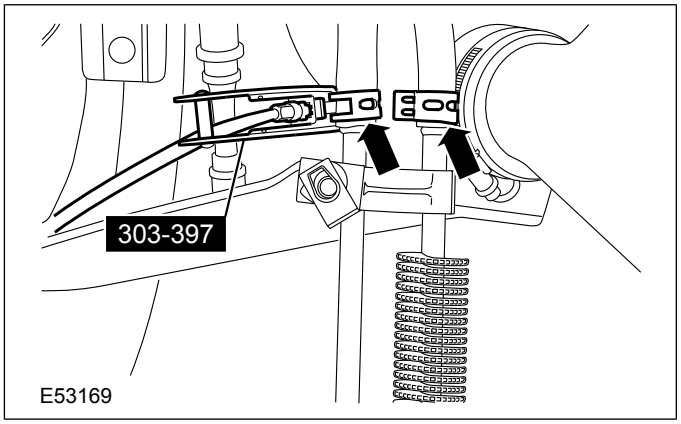
2. **Detach the power steering fluid cooler from the vehicle body.**



3. **WARNING:Be prepared to collect escaping fluids.**

   Remove the power steering fluid cooler.

   - Using the special tool, disconnect the power steering fluid cooler lines from the power steering fluid cooler.



Installation

1. **To install, reverse the removal procedure.**
2. **Fill the power steering system.**

   For additional information, refer to:Power Steering System Filling (211-00 Steering System - General Information, General Procedures).

3. **Bleed the power steering.**

   For additional information, refer to:Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).

REMOVAL AND INSTALLATION

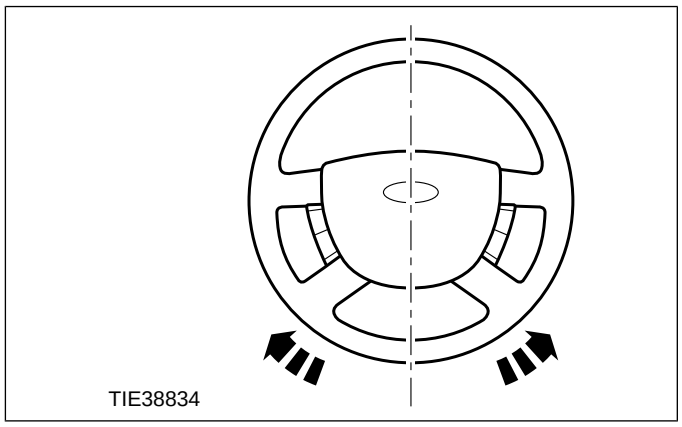
Steering Gear

Removal

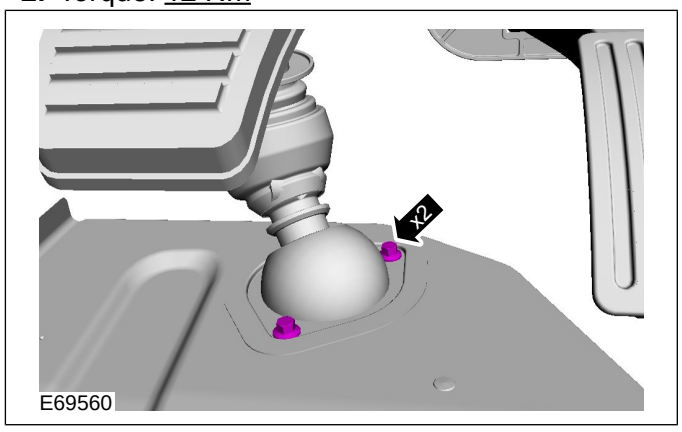
NOTE: Removal steps in this procedure may contain installation details.

All vehicles

1. **NOTE:**Make sure that the road wheels are in the straight ahead position.



2. Torque: 12 Nm

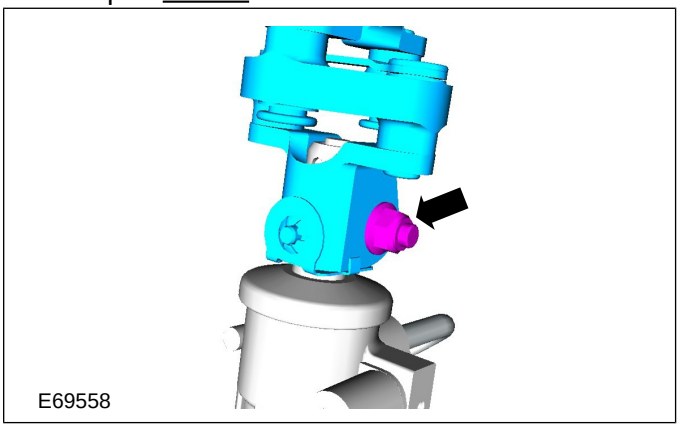


3. Remove the front wheels and tires.

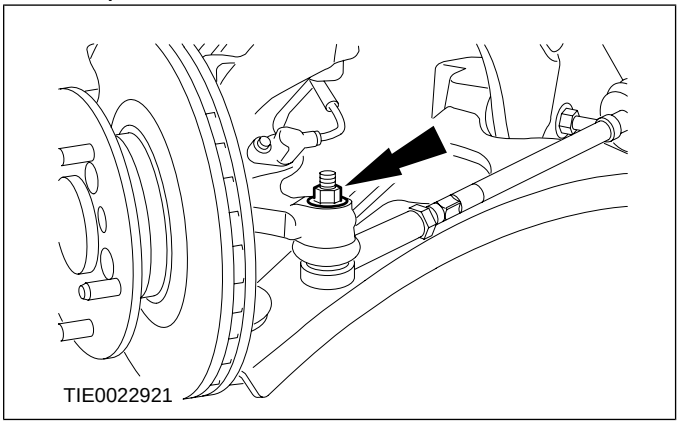
   Refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

4. **WARNING:Make sure a new steering column flexible coupling nut and bolt are installed.**

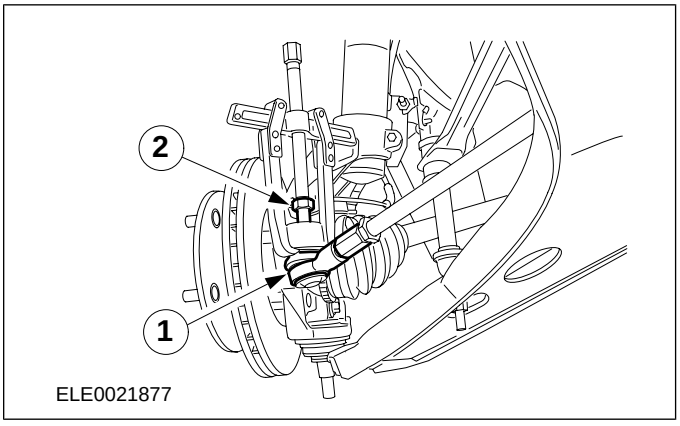
   Torque: 23 Nm



5. Torque: 80 Nm

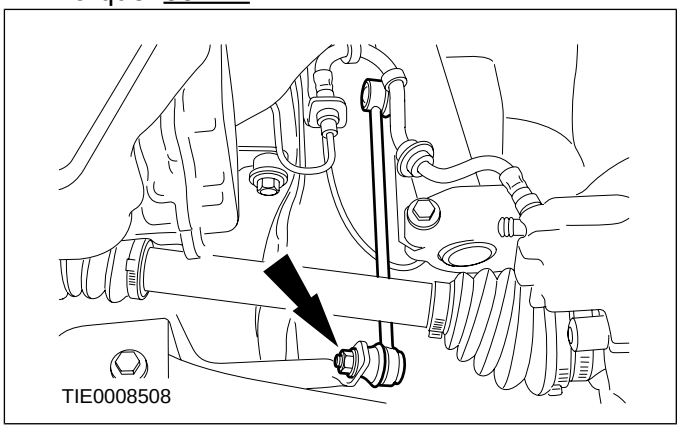


6. **WARNING:Make sure a new tie rod end nut is installed.**



REMOVAL AND INSTALLATION

7. Torque: 55 Nm

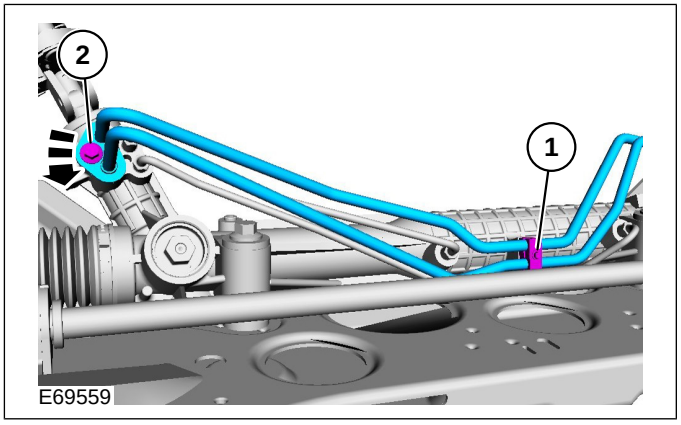


Left-hand drive vehicles with 2.2L diesel engine or 2.4L diesel engine

8. **WARNING:Be prepared to collect escaping fluids.**

   CAUTION:Make sure that all openings are sealed.

   1. Torque: 3 Nm
   2. Torque: 23 Nm

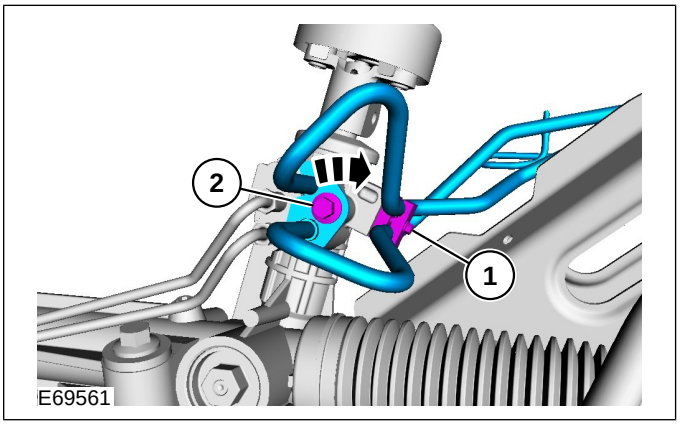


Right-hand drive vehicles with 2.2L diesel engine or 2.4L diesel engine

9. **WARNING:Be prepared to collect escaping fluids.**

   CAUTION:Make sure that all openings are sealed.

   1. Torque: 3 Nm
   2. Torque: 23 Nm

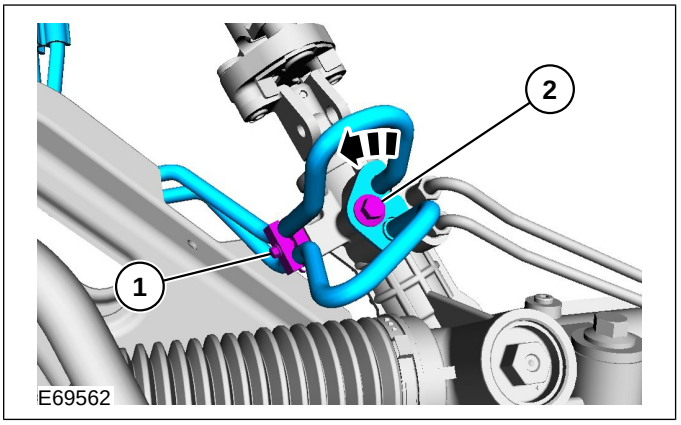


Left-hand drive vehicles with 2.3L engine

10. **WARNING:Be prepared to collect escaping fluids.**

    CAUTION:Make sure that all openings are sealed.

    1. Torque: 3 Nm
    2. Torque: 23 Nm



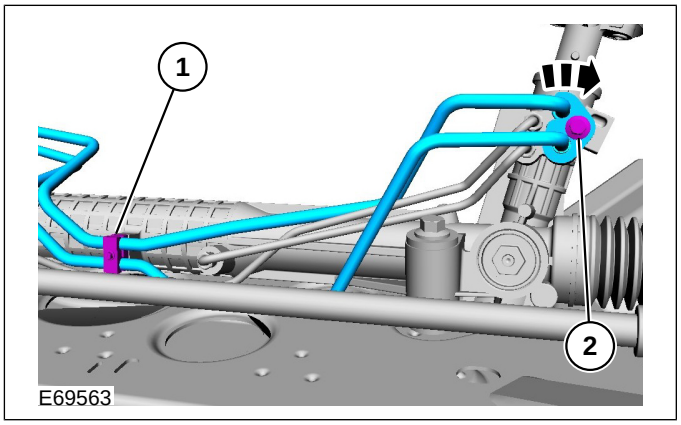
Right-hand drive vehicles with 2.3L engine

11. **WARNING:Be prepared to collect escaping fluids.**

REMOVAL AND INSTALLATION

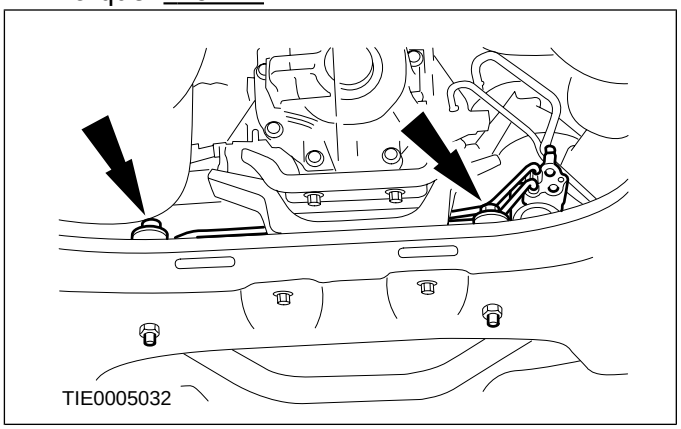
CAUTION:Make sure that all openings are sealed.

1. Torque: 3 Nm
2. Torque: 23 Nm



All vehicles

12 Torque: 115 Nm



Installation

1. To install, reverse the removal procedure.

2. Fill the power steering system.

Refer to:Power Steering System Filling (211-00 Steering System - General Information, General Procedures).

3. Bleed the power steering system.

Refer to:Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).

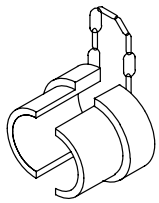
4. Check the toe setting and adjust as necessary.

Refer to:Front Toe Adjustment (204-00 Suspension System - General Information, General Procedures).

REMOVAL AND INSTALLATION

Steering Gear to Fluid Cooler Return Hose

Special Tool(s)

 17049	Remover, Transmission Fluid Cooler 307-242

Special Tool(s)

General Equipment

Coolant hose clamp remover/installer

Removal

NOTE: Removal steps in this procedure may contain installation details.

All vehicles

1. Remove the front bumper cover.

   Refer to:Front Bumper Cover (501-19 Bumpers, Removal and Installation).

2. Raise and support the vehicle.

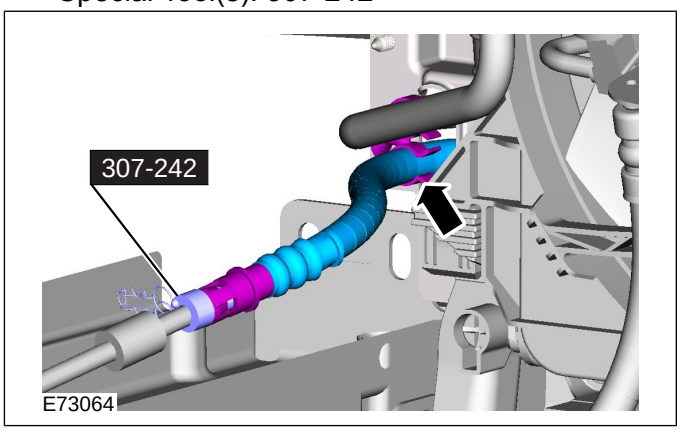
   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

Vehicles with 2.3L engine

3. **WARNING:Be prepared to collect escaping fluids.**

   CAUTION:Make sure that all openings are sealed.

   Special Tool(s): 307-242

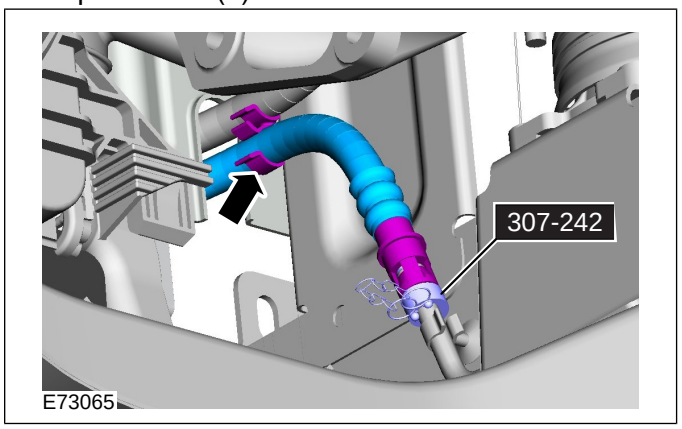


Vehicles with 2.4L diesel engine

4. **WARNING:Be prepared to collect escaping fluids.**

   CAUTION:Make sure that all openings are sealed.

   Special Tool(s): 307-242



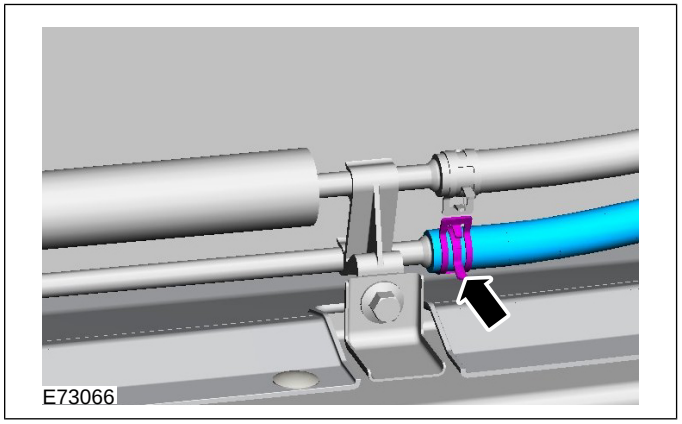
5. Lower the vehicle.

All vehicles

6. **WARNING:Be prepared to collect escaping fluids.**

   CAUTION:Make sure that all openings are sealed.

   General Equipment: Coolant hose clamp remover/installer



REMOVAL AND INSTALLATION

Installation

1. To install, reverse the removal procedure.
2. Fill the power steering system.

   Refer to:Power Steering System Filling (211-00 Steering System - General Information, General Procedures).
3. Bleed the power steering system.

   Refer to:Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).

SECTION 211-03 Steering Linkage

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 211-03-2

DESCRIPTION AND OPERATION

Steering Linkage..... 211-03-3

DIAGNOSIS AND TESTING

Steering Linkage..... 211-03-4

REMOVAL AND INSTALLATION

Tie Rod..... (13 263 0) 211-03-5
Tie Rod End..... (13 273 0) 211-03-8
Steering Gear Boot..... (13 134 0) 211-03-9

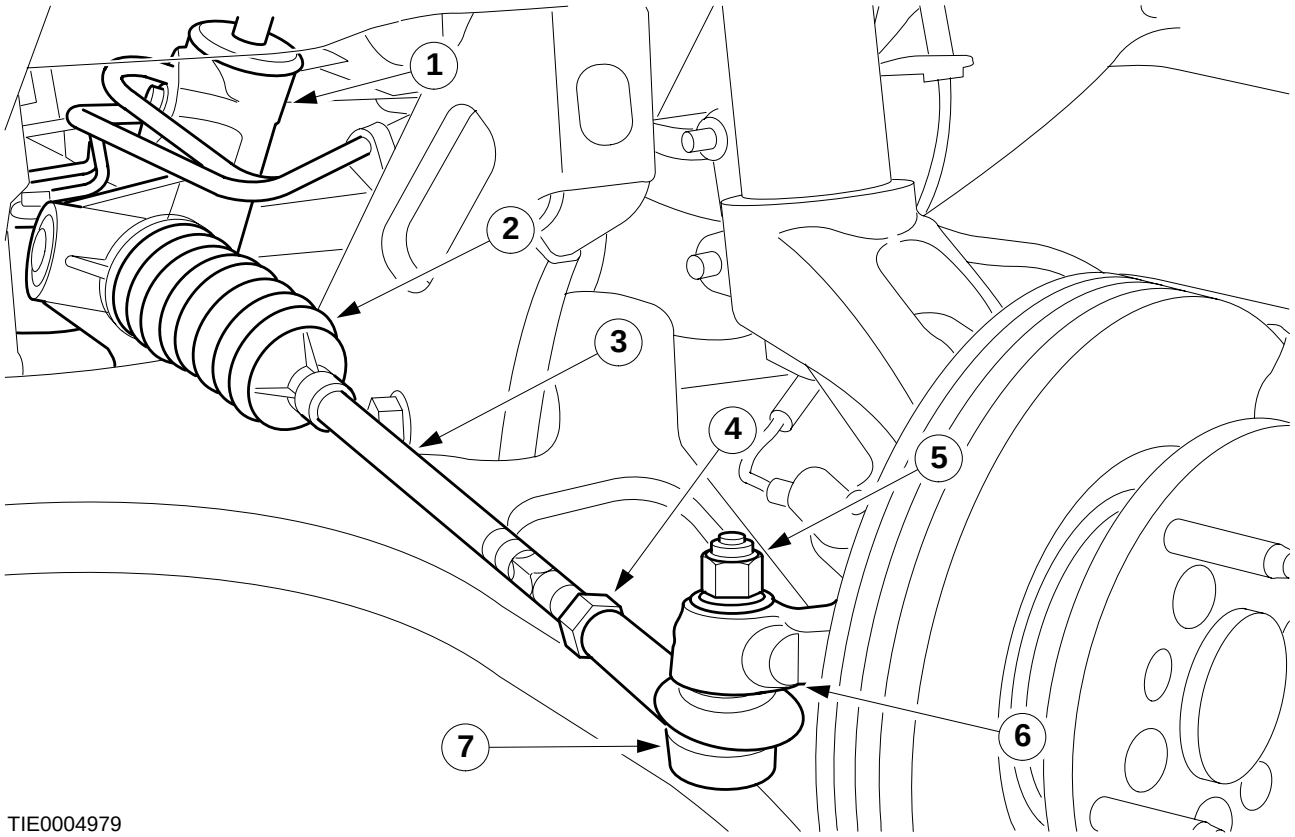
SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Tie-rod end locknut	80	59	-
Tie-rod end retaining nut	80	59	-
Tie-rod to steering gear	120	89	-

DESCRIPTION AND OPERATION

Steering Linkage



Item	Part Number	Description
1		Steering gear
2		Steering gear boot
3		Tie-rod
4		Tie-rod end locknut
5		Tie-rod end retaining nut

Item	Part Number	Description
6		Wheel knuckle
7		Tie-rod end

DIAGNOSIS AND TESTING

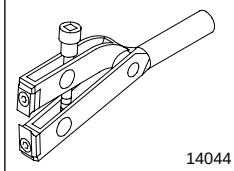
Steering Linkage

REFER to Section 211-00 [Steering System - General Information].

REMOVAL AND INSTALLATION

Tie Rod (13 263 0)

Special Tool(s)

 14044	Clamping Tool, Boot Retaining Clamp 204-169 (14-044)

General Equipment

Pipe wrench

Materials	
Name	**Specification**
Thread-locking compound	WSK-M2G349-A8

Removal

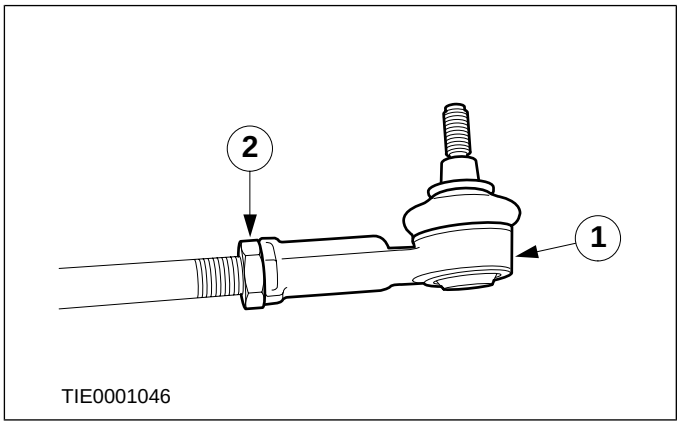
1. **Remove the steering gear.**

   For additional information, refer to:Steering Gear (211-02 Power Steering, Removal and Installation).

2. **NOTE:Make a note of the number of turns used to remove the tie-rod end.**

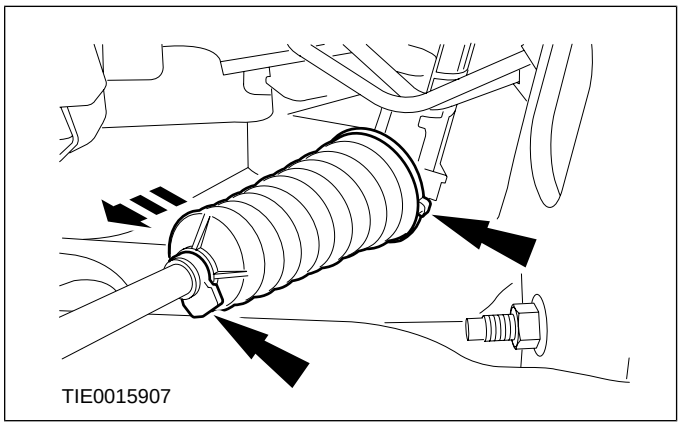
   Remove the tie-rod end and the tie-rod end locknut.

   1. Remove the tie-rod end.
   2. Remove the tie-rod end locknut.

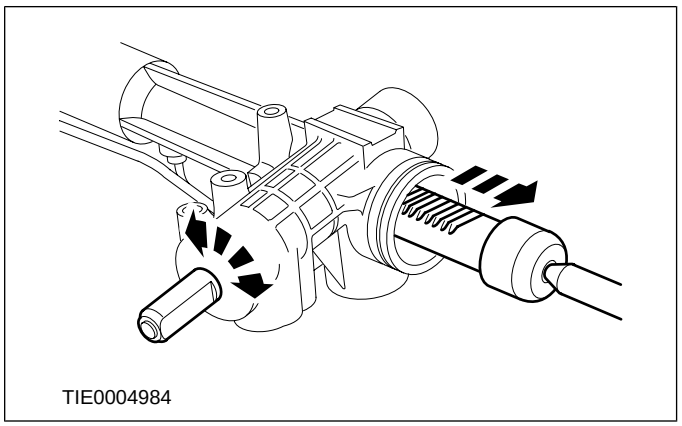


3. **Remove the steering gear boot.**

   - Discard the steering gear boot and retaining clamps.



4. **Rotate the steering gear pinion to expose the steering rack.**



5. **CAUTIONS:**

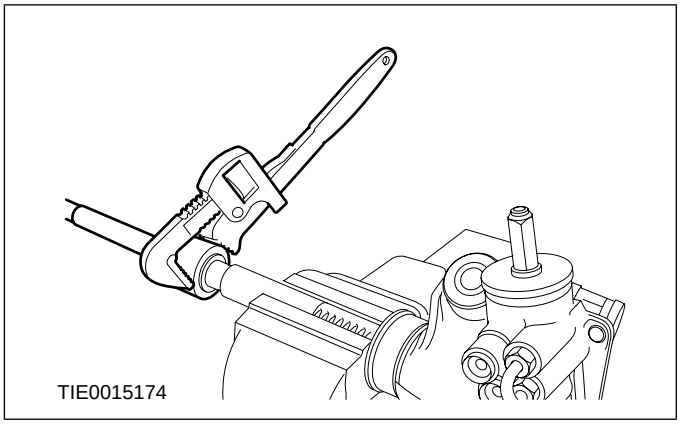
   ⚠Do not clamp the steering rack on exposed hydraulic sealing surfaces.

   ⚠Clamp the steering rack in vise jaws. Do not clamp the steering gear body.

   ⚠Make sure vise jaw protectors are used.

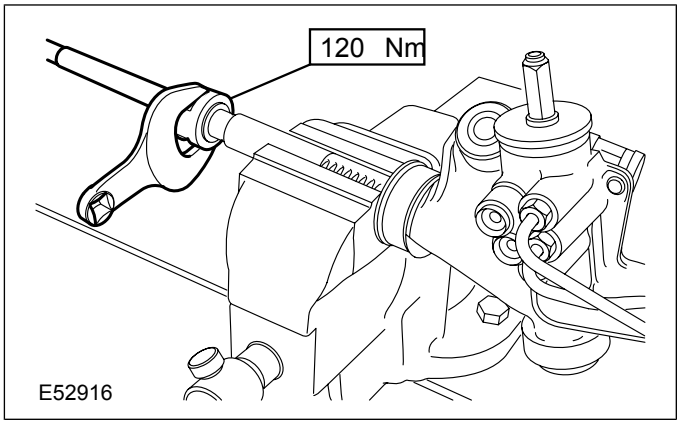
REMOVAL AND INSTALLATION

Secure the steering gear in a vise and, using a suitable pipe wrench, remove the tie-rod.



Installation

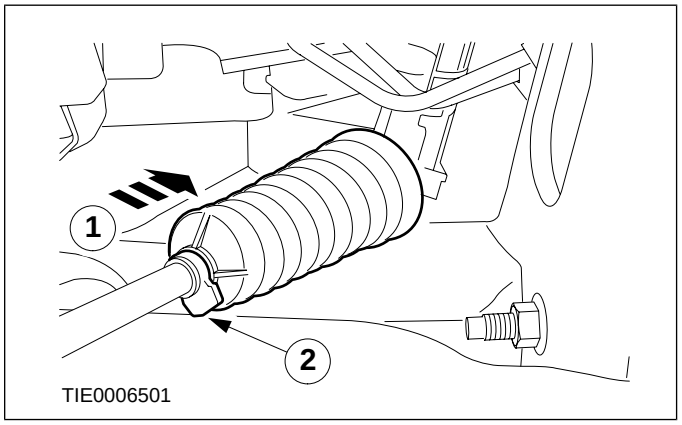
1. **Remove any traces of thread-locking compound from the threaded end of the steering rack.**
2. **Coat the threaded bore in the tie-rod with thread-locking compound.**
3. **Install the tie-rod.**



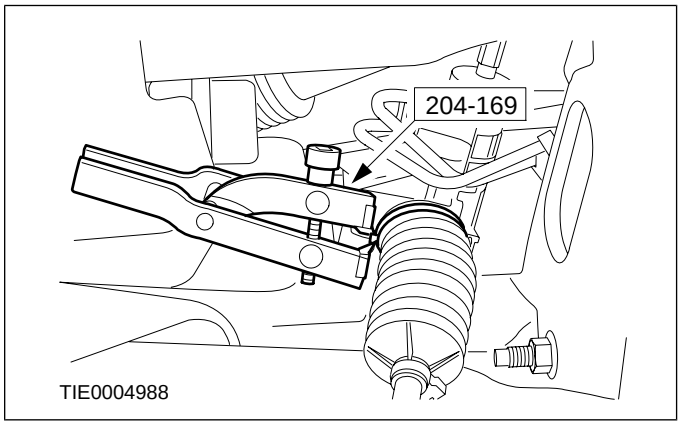
4. **NOTE:Make sure the correct steering gear boot is installed to the correct side of the steering gear.**

   Install a new steering gear boot.

   1. Install the boot.
   2. Install a new steering gear outer boot clamp.

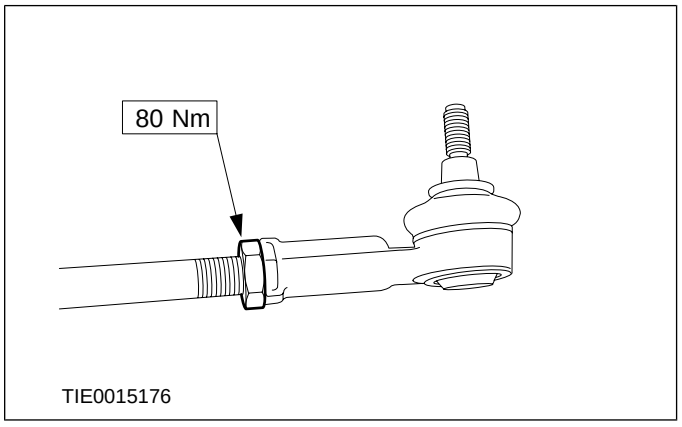


5. **Using the special tool, install a new steering gear boot inner clamp.**



6. **NOTE:Install the tie-rod end using the same number of turns used to remove it.**

   Install the tie-rod end and the tie-rod end locknut.



7. **Install the steering gear.**

   For additional information, refer to:Steering Gear (211-02 Power Steering, Removal and Installation).

REMOVAL AND INSTALLATION

8. Check the front toe setting and adjust as necessary.

   For additional information, refer to:Specifications (204-00 Suspension System - General Information, Specifications)
   / Front Toe Adjustment (204-00 Suspension System - General Information, General Procedures).

REMOVAL AND INSTALLATION

Tie Rod End (13 273 0)

General Equipment

Two leg puller

Removal

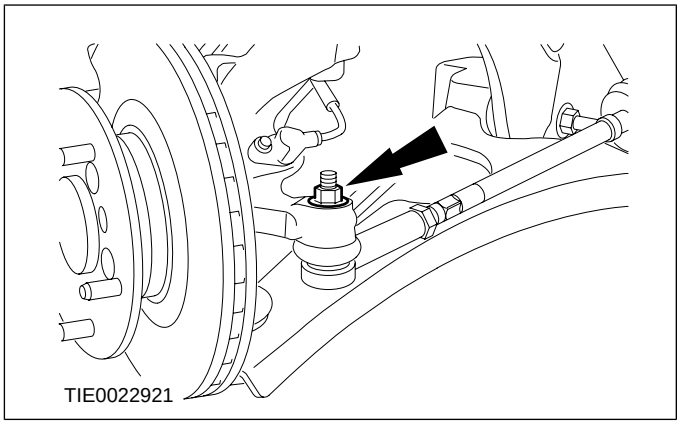
1. **Remove the front wheel and tire.**

   For additional information, refer to:Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

2. **CAUTION:Leave the tie-rod end retaining nut in place to protect the ball joint stud.**

   Loosen the tie-rod end locknut and the tie-rod end retaining nut.

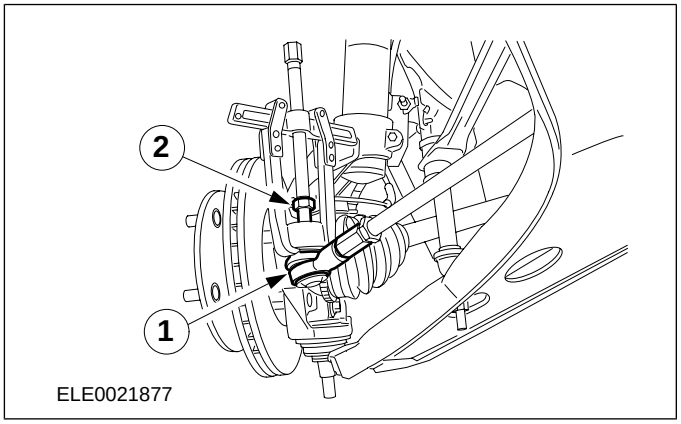
   1. Loosen the locknut.
   2. Loosen the retaining nut.



3. **CAUTION:Protect the ball joint seal using a soft cloth to prevent damage.**

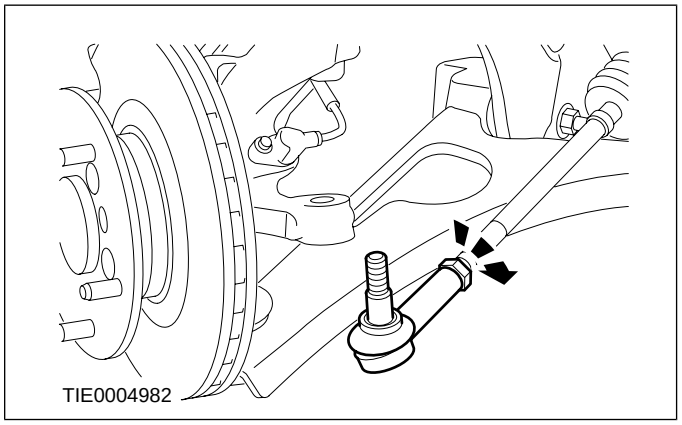
   Using a suitable two leg puller, detach the tie-rod end from the wheel knuckle.

   1. Release the tie-rod end.
   2. Remove and discard the tie-rod end retaining nut.



4. **NOTE:Make a note of the number of turns used to remove the tie-rod end.**

   Remove the tie-rod end.

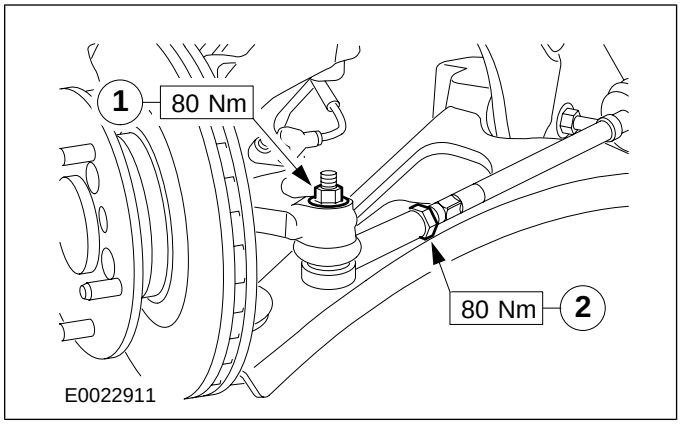


Installation

1. **WARNING:Install a new tie-rod end retaining nut. Failure to follow this instruction may result in personal injury.**

NOTE: Install the tie-rod end using the same number of turns used to remove it.

To install, reverse the removal procedure.



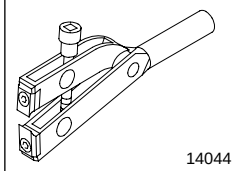
2. **Adjust the front wheel alignment. For additional information, refer to:(204-00 Suspension System - General Information)**

   Specifications (Specifications), Front Toe Adjustment (General Procedures).

REMOVAL AND INSTALLATION

Steering Gear Boot (13 134 0)

Special Tool(s)

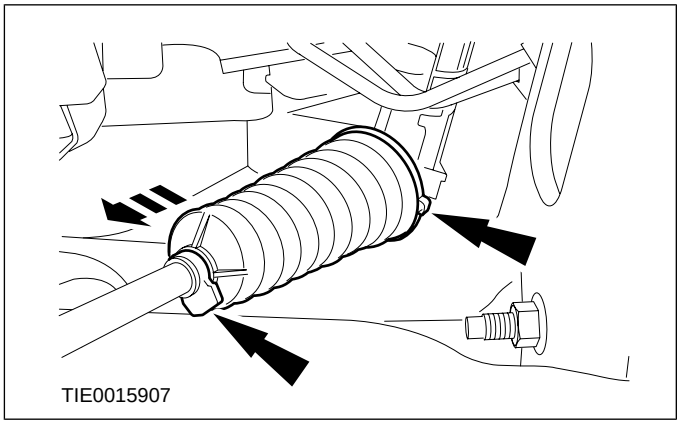
 14044	Clamping Tool, Boot Retaining Clamp 204-169 (14-044)

Removal

1. **Remove the tie-rod end.**

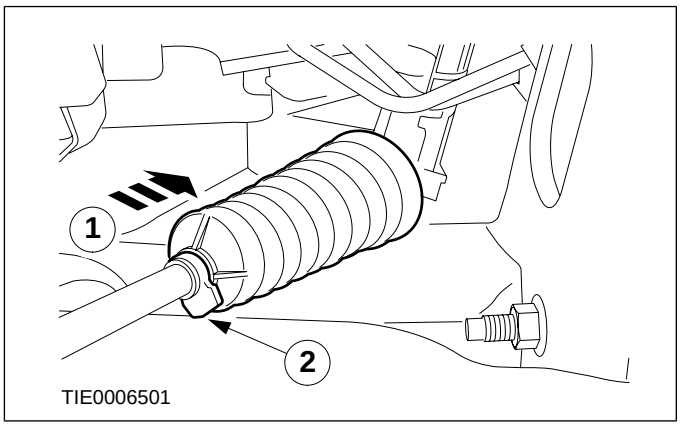
   For additional information, refer to Tie-Rod End in this section.

2. **Remove the steering gear boot.**
   - Discard the inner clamp.


TIE0015907

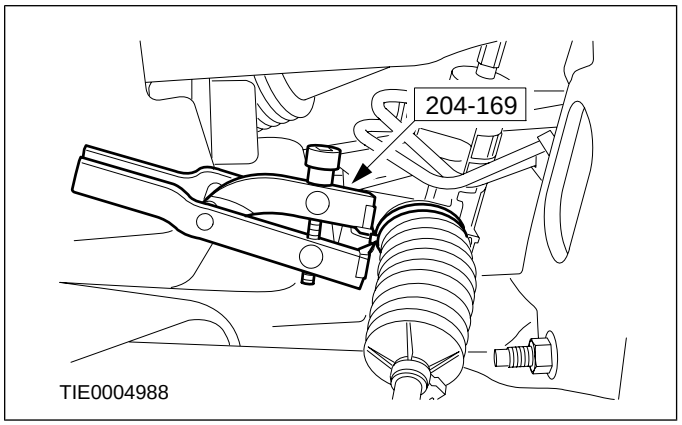
Installation

1. **Install the steering gear boot and outer clamp.**
   1. Install the boot.
   2. Install the outer clamp.



TIE0006501

2. **Using the special tool, install a new inner steering gear boot clamp.**



TIE0004988

3. **Install the tie-rod end.**

   For additional information, refer to Tie-Rod End in this section.

SECTION 211-04 Steering Column

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 211-04-2

DESCRIPTION AND OPERATION

Steering Column..... 211-04-3

DIAGNOSIS AND TESTING

Steering Column..... 211-04-5

REMOVAL AND INSTALLATION

Steering Wheel..... 211-04-6
Steering Column..... 211-04-7
Steering Column Flexible Coupling..... 211-04-9

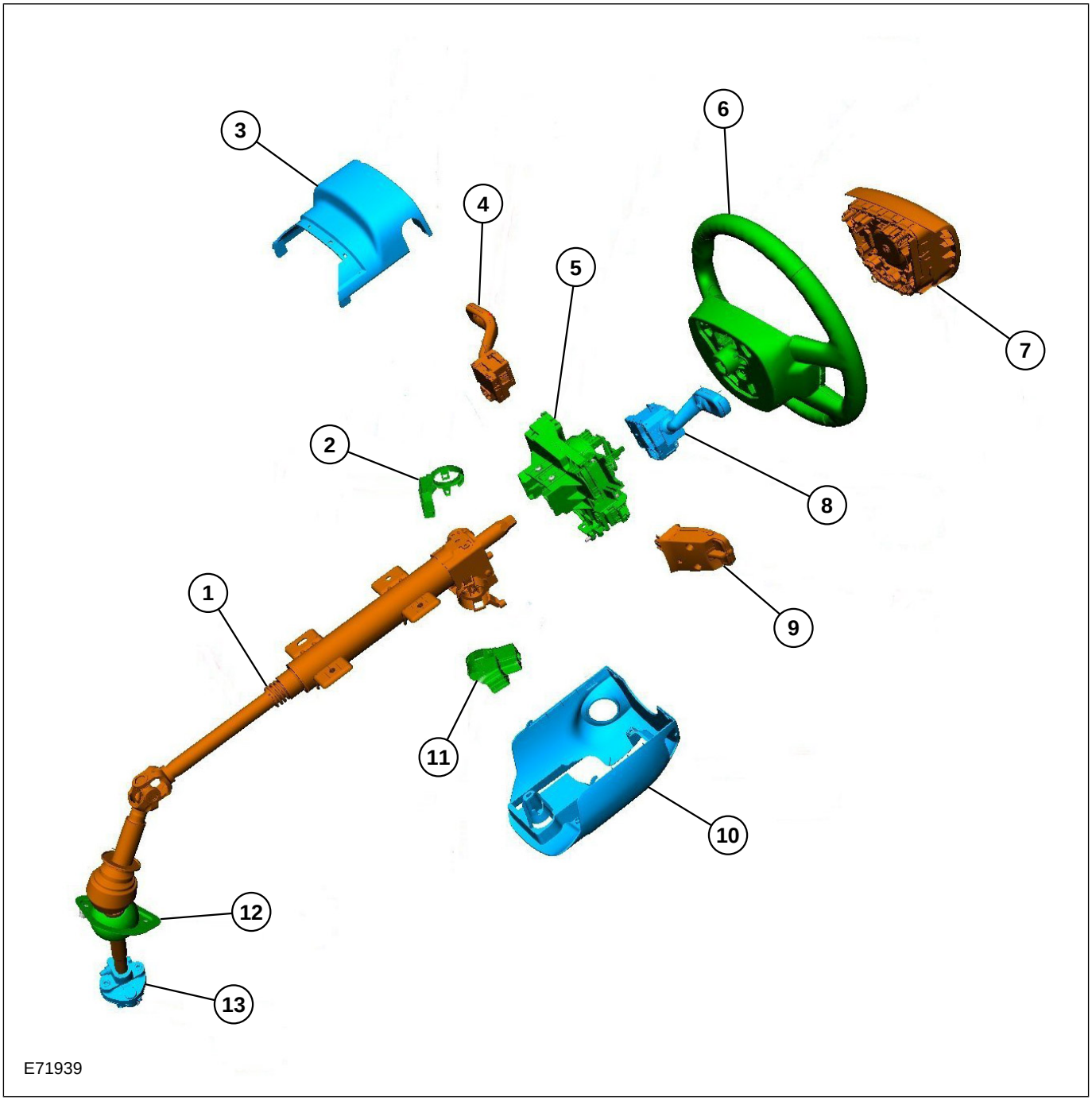
SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Steering wheel retaining bolt	48	35	–
Steering column retaining nuts	20	15	–
Steering column flexible coupling upper pinch bolt	28	21	–
Steering column flexible coupling lower pinch bolt	23	17	–
Steering column lower bearing retaining bolts	12	9	–

DESCRIPTION AND OPERATION

Steering Column



Item	Description
1	Steering column
2	Passive anti-theft system (PATS) transceiver
3	Steering column upper shroud
4	Windshield wiper/washer switch
5	Clockspring and steering wheel rotation sensor assembly

Item	Description
6	Steering wheel
7	Driver air bag module
8	Turn signal lamp switch
9	Audio control switch
10	Steering column lower shroud
11	Ignition switch

DESCRIPTION AND OPERATION

Item	Description
12	Steering column lower bearing
13	Steering column flexible coupling

DIAGNOSIS AND TESTING

Steering Column

REFER to Section 211-00 [Steering System - General Information].

REMOVAL AND INSTALLATION

Steering Wheel

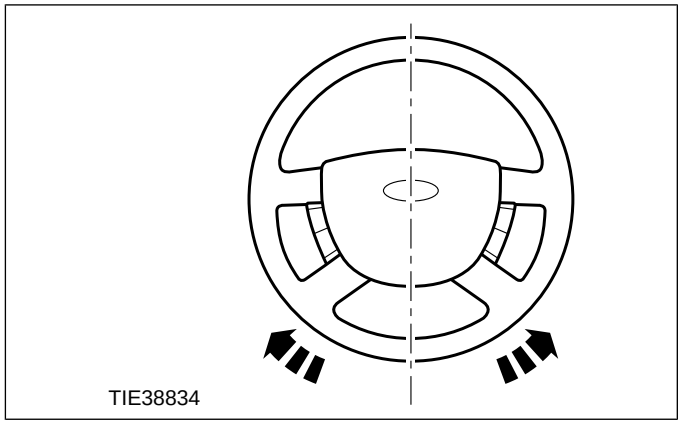
Removal

NOTE: Removal steps in this procedure may contain installation details.

All vehicles

1. **CAUTION:Make sure that the steering wheel lock is engaged.**

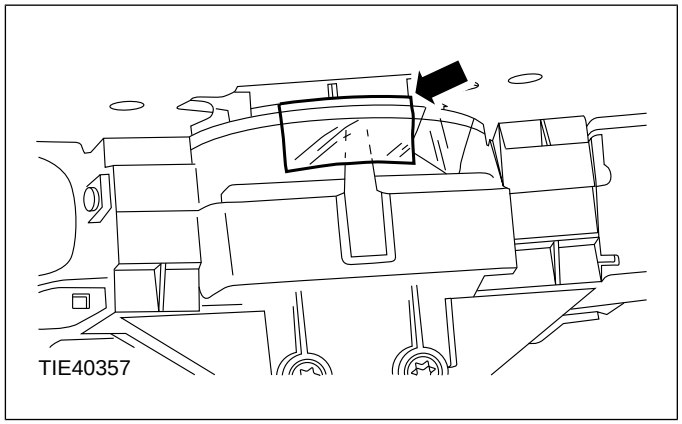
   NOTE: Make sure that the road wheels are in the straight ahead position.



2. Remove the driver air bag module.

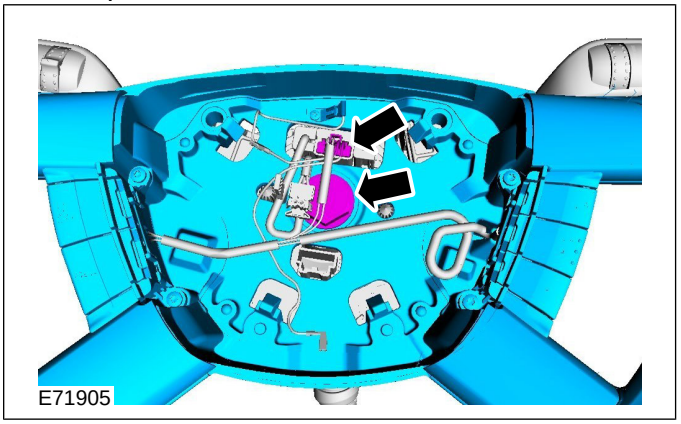
   Refer to:Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).

3. **CAUTION:Make sure that the clockspring rotor does not rotate.**



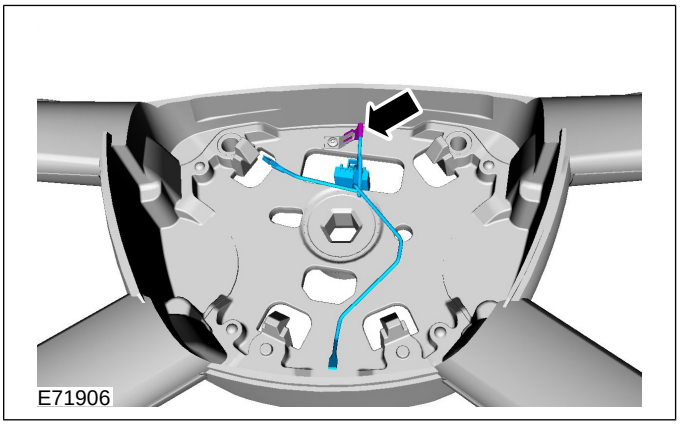
4. **CAUTION:Make sure that the clockspring pins are not bent or damaged.**

   Torque: 48 Nm



Vehicles without speed control

5.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Steering Column

Removal

NOTE: Removal steps in this procedure may contain installation details.

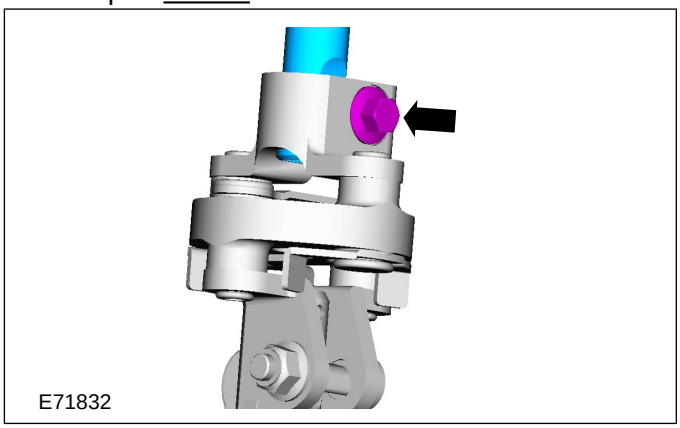
1. Remove the following items:
1. Steering wheel

   Refer to:Steering Wheel (211-04 Steering Column, Removal and Installation).
2. Ignition lock barrel

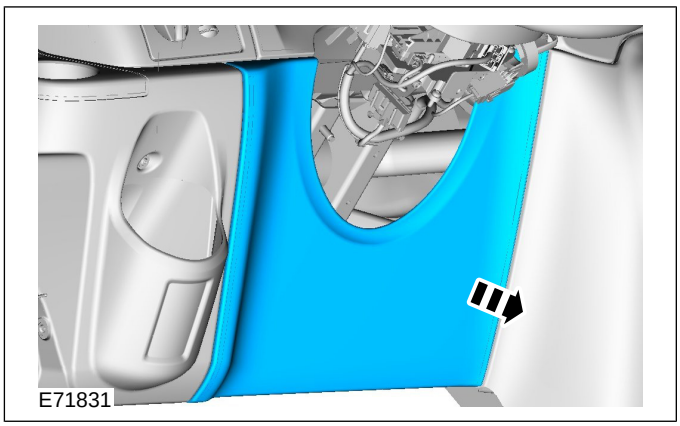
   Refer to:Ignition Lock Cylinder (501-14 Handles, Locks, Latches and Entry Systems, Removal and Installation).

2. **WARNING:Make sure a new steering column flexible coupling bolt is installed.**

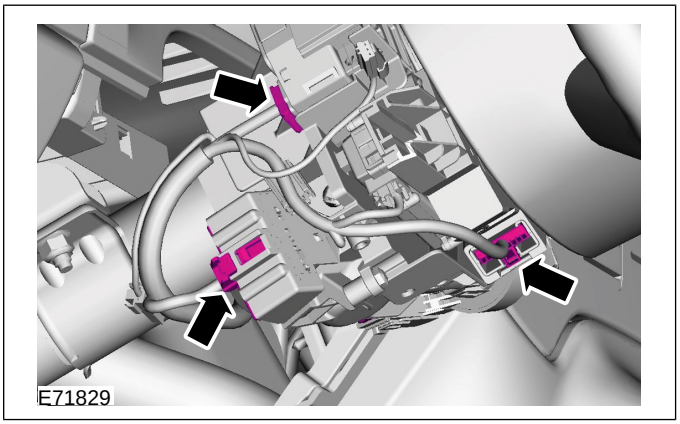
Torque: 28 Nm



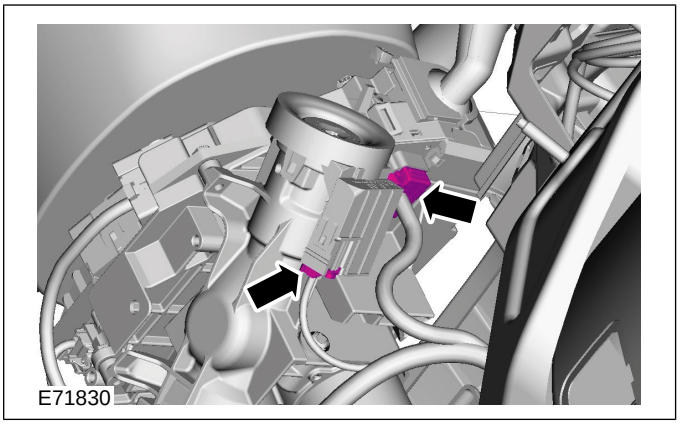
3.



4.

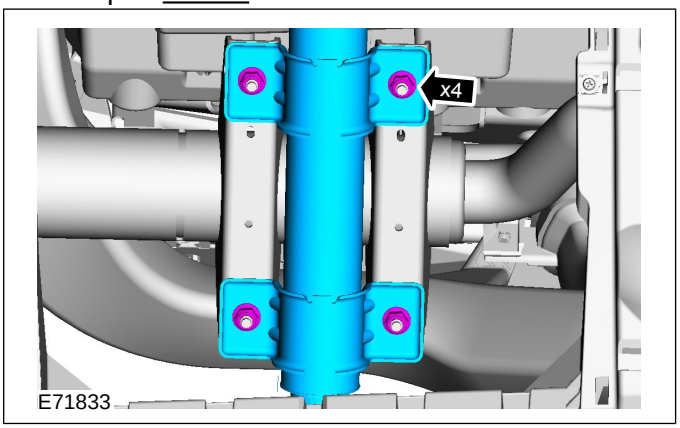


5.



6. **WARNING:Make sure that new steering column locknuts are installed.**

Torque: 20 Nm

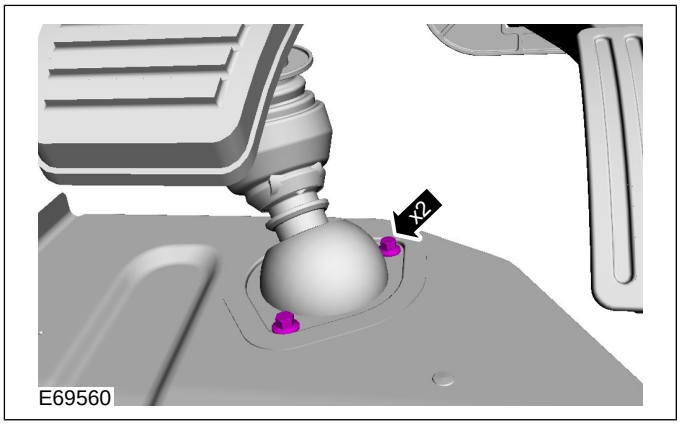


Installation

1. To install, Reverse the removal procedure.

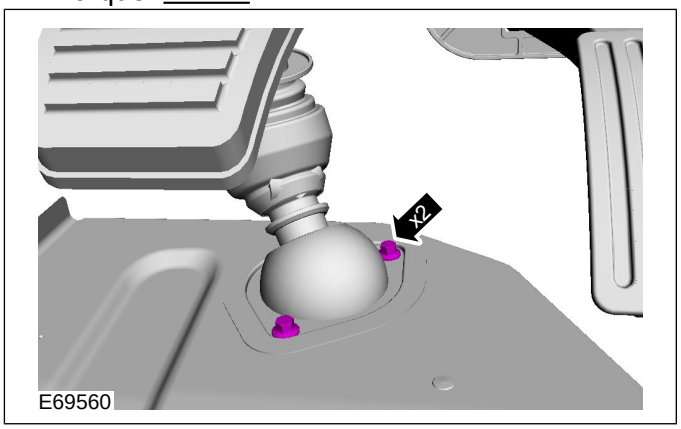
REMOVAL AND INSTALLATION

2. Loosen the bolts four turns.



3. Start the engine and turn the steering from steering lock to steering lock.

4. Torque: 12 Nm



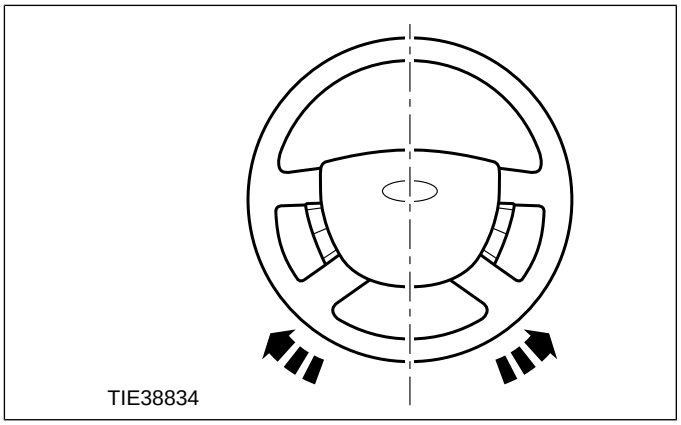
REMOVAL AND INSTALLATION

Steering Column Flexible Coupling

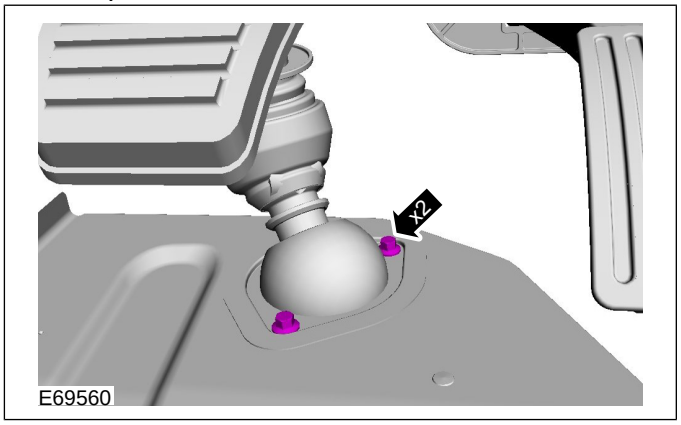
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. **NOTE:**Make sure that the road wheels are in the straight ahead position.



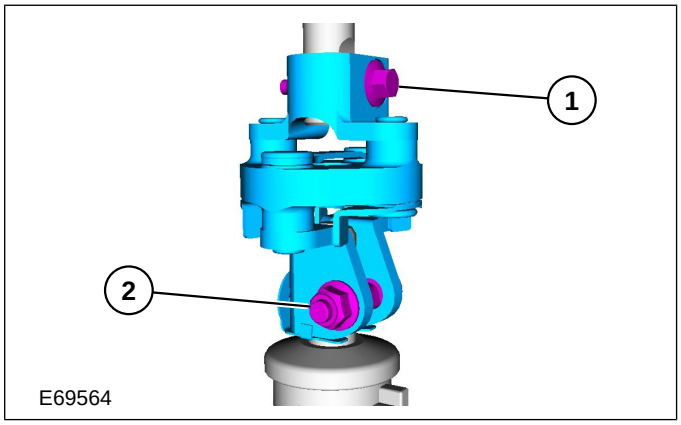
2. Torque: 12 Nm



3. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

4. **WARNING:Make sure a new steering column flexible coupling nut and bolts are installed.**
   1. Torque: 28 Nm
   2. Torque: 23 Nm



Installation

1. To install, reverse the removal procedure.

SECTION 211-05 Steering Column Switches

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Steering Column Switches 211-05-2
Inspection and Verification 211-05-2
Pinpoint Test 211-05-3

REMOVAL AND INSTALLATION

Ignition Switch ..... (36 424 0) 211-05-6
Steering Column Multifunction Switch 211-05-8

DIAGNOSIS AND TESTING

Steering Column Switches

Refer to Wiring Diagrams Cell700,for schematic and connector information.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Electrical
– Fuse(s) – Wiring harness – Electrical connector(s) – Switch(es) – Battery

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Sympton Chart.

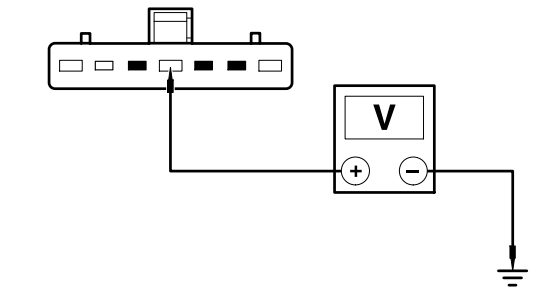
Symptom Chart

Symptom	Possible Sources	Action
• The ignition switch is inoperative	• Ignition switch.	• CARRY OUT the Ignition Switch Component Test. REFER to the Wiring Diagrams.
	• Circuit(s).	• GO to Pinpoint Test A.
• No power in ACC	• Ignition switch.	• CARRY OUT the Ignition Switch Component Test. REFER to the Wiring Diagrams.
	• Circuit(s).	• GO to Pinpoint Test B.
• No power in RUN	• Ignition switch.	• CARRY OUT the Ignition Switch Component Test. REFER to the Wiring Diagrams.
	• Circuit(s).	• GO to Pinpoint Test C.
• No power in START	• Ignition switch.	• CARRY OUT the Ignition Switch Component Test. REFER to the Wiring Diagrams
	• Circuit(s).	• GO to Pinpoint Test D.
• The multifunction switch does not operate correctly	• Switch(es). • Circuit(s).	• REFER to: Battery (414-01 Battery, Mounting and Cables, Diagnosis and Testing), Wipers and Washers (501-16 Wipers and Washers, Diagnosis and Testing).

DIAGNOSIS AND TESTING

Pinpoint Test

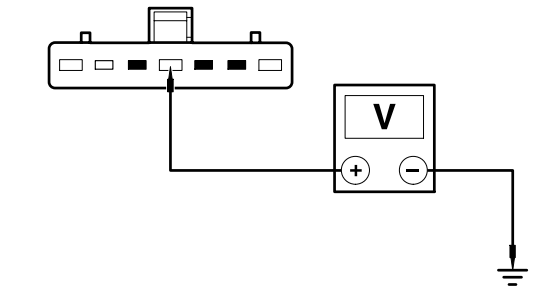
PINPOINT TEST A : THE IGNITION SWITCH IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
A1: CHECK THE IGNITION SWITCH ELECTRICAL CONNECTOR	
	1 Remove the steering column shrouds.
	2 Check the ignition switch electrical connector. • Is the ignition switch electrical connector clean and secure? → **Yes** GO to A2. → **No** CLEAN and SECURE the ignition switch electrical connector. TEST the system for normal operation.
A2: CHECK FOR VOLTAGE ON CIRCUIT SBP77B (RD/GY)	
	1 DisconnectIgnition Switch CDC32.
 TIE0013056	2 Measure the voltage between the ignition switch CDC32 Pin 4, circuit SBP77B (RD/GY), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** VERIFY the customers concern. → **No** REPAIR the circuit SBP77B (RD/GY). TEST the system for normal operation.

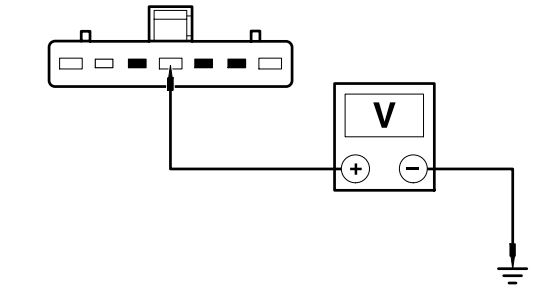
PINPOINT TEST B : NO POWER IN ACC

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
B1: CHECK FOR VOLTAGE ON CIRCUIT SBP77B (RD/GY)	
	1 DisconnectIgnition Switch CDC32.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0013056	2 Measure the voltage between the ignition switch CDC32 Pin 4, circuit SBP77B (RD/GY) harness side and ground. • Is the voltage greater than 10 volts? → **Yes** REPAIR circuit CDC31A (GN/OG). TEST the system for normal operation. → **No** REPAIR circuit SBP77B (RD/GY). TEST the system for normal operation.

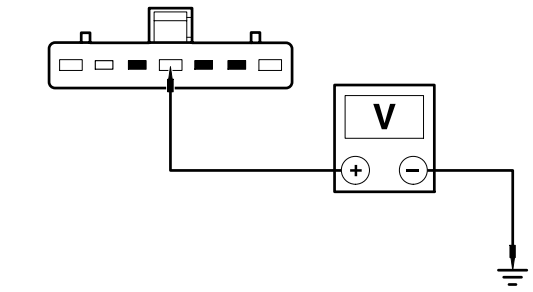
PINPOINT TEST C : NO POWER IN RUN

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
C1: CHECK FOR VOLTAGE ON CIRCUIT SBP77B (RD/GY)	
	1 DisconnectIgnition Switch CDC32.
 TIE0013056	2 Measure the voltage between the ignition switch CDC32 Pin 4, circuit SBP77B (RD/GY) harness side and ground. • Is the voltage greater than 10 volts? → **Yes** REPAIR the circuit CDC32A (GY/RD). TEST the system for normal operation. → **No** REPAIR the circuit SBP77B (RD/GY). TEST the system for normal operation.

PINPOINT TEST D : NO POWER IN START

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
D1: CHECK FOR VOLTAGE ON CIRCUIT SBP77B (RD/GY)	
	1 DisconnectIgnition Switch CDC32.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0013056	2 Measure the voltage between the ignition switch CDC32 Pin 4, circuit SBP77B (RD/GY) harness side and ground. • Is the voltage greater than 10 volts? → **Yes** REPAIR circuit CDC35A (BU/WH). TEST the system for normal operation. → **No** REPAIR circuit SBP77B (RD/GY). TEST the system for normal operation.

REMOVAL AND INSTALLATION

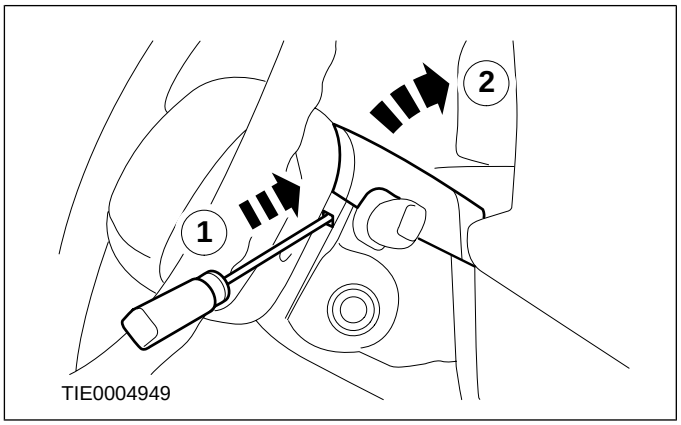
Ignition Switch (36 424 0)

Removal

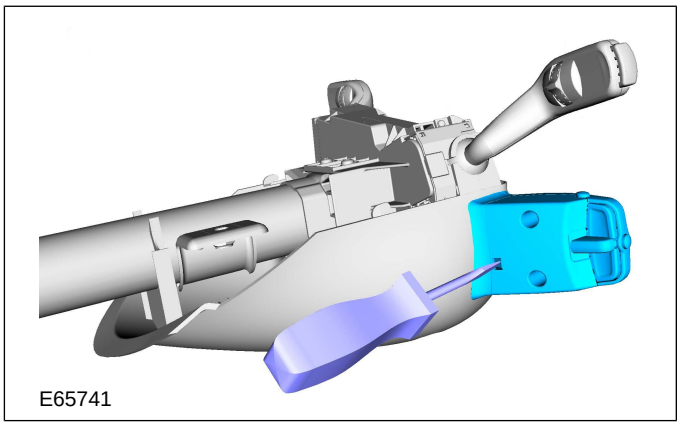
1. **Disconnect the battery ground cable.**

   For additional information, refer to: Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

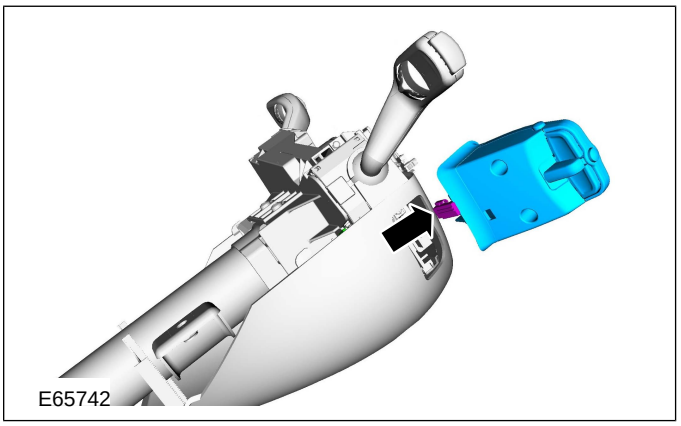
2. **Remove the steering column upper shroud.**
   1. Using a thin bladed screwdriver, release the two clips (one each side).
   2. Remove the shroud.



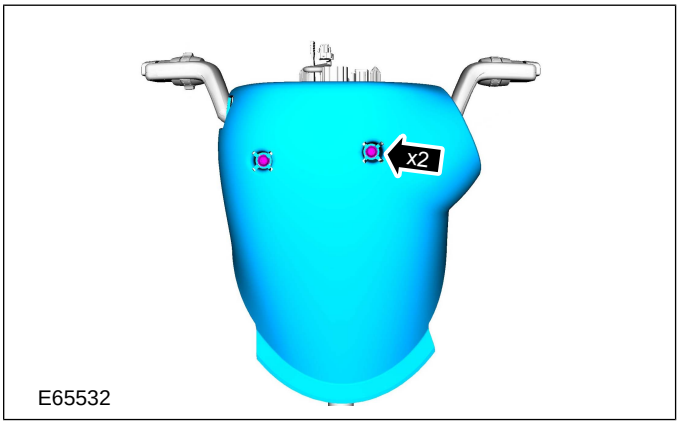
3. **Using a thin bladed screwdriver, detach the audio remote control switch from the lower shroud.**



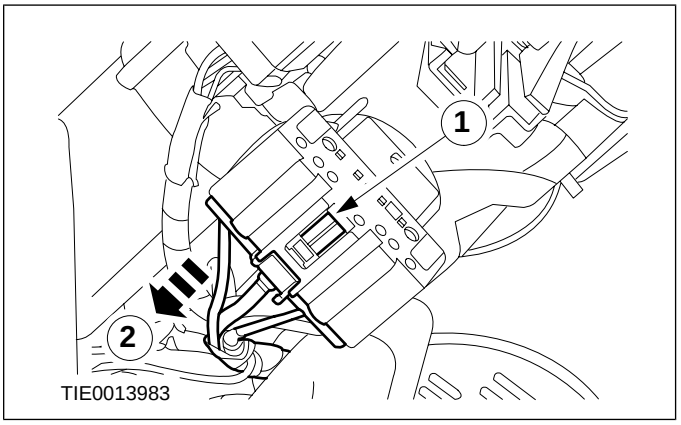
4. **Remove the audio remote control switch.**



5. **Remove the steering column lower shroud.**



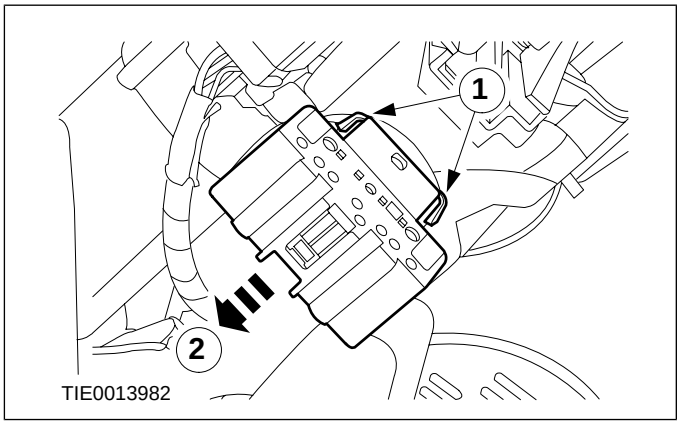
6. **Disconnect the ignition switch electrical connector.**
   1. Depress the locking tang.
   2. Disconnect the ignition switch electrical connector.



7. **Remove the ignition switch.**
   1. Depress the locking tangs.

REMOVAL AND INSTALLATION

2. Remove the ignition switch.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Steering Column Multifunction Switch

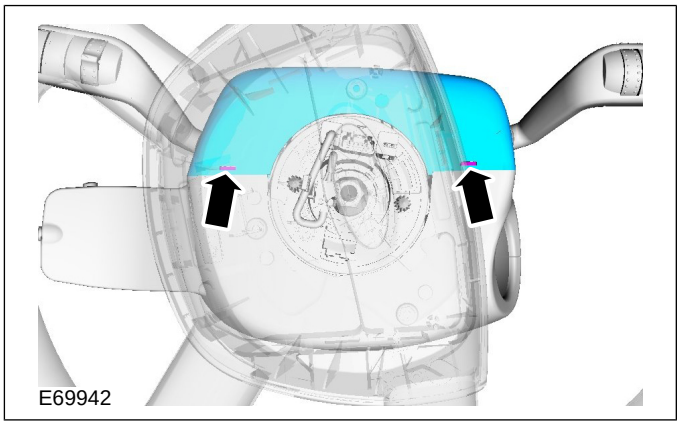
Removal

NOTE: Removal steps in this procedure may contain installation details.

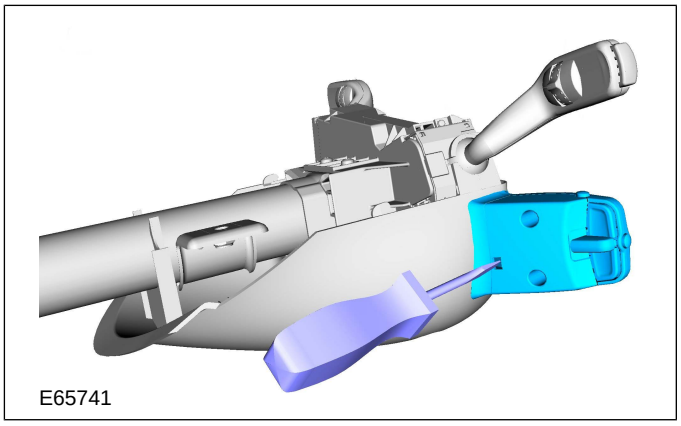
1. Disconnect the battery ground cable.

   Refer to: Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

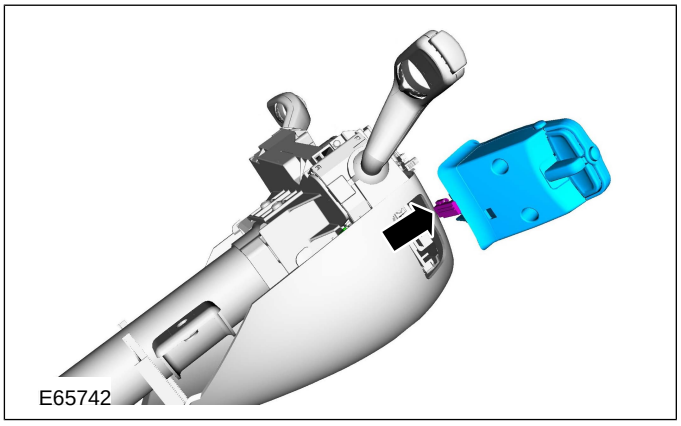
2.



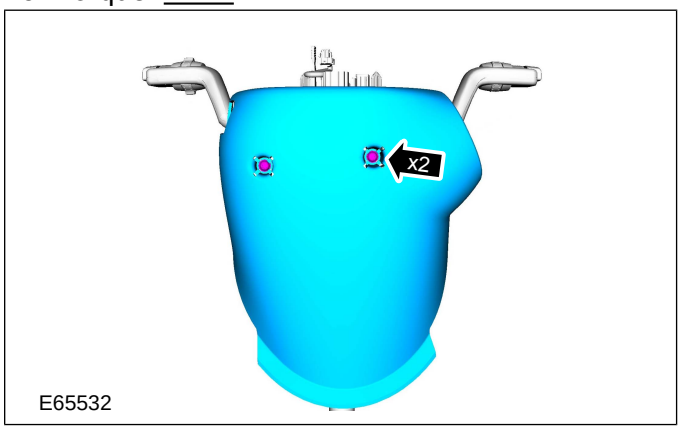
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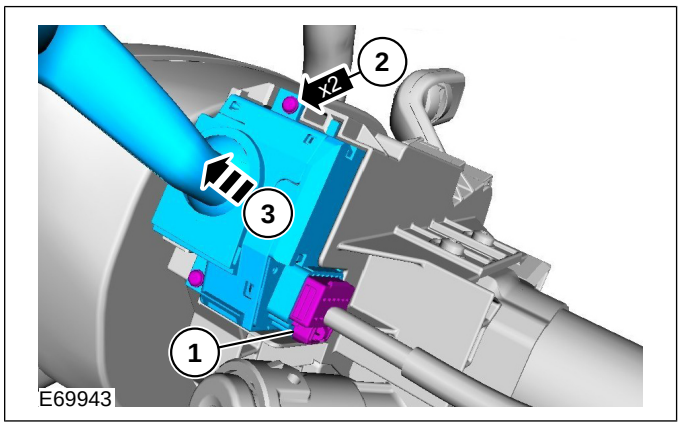
4.



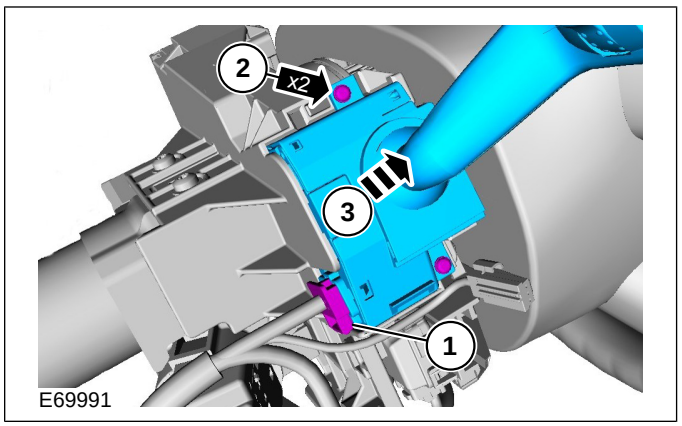
5. Torque: 2 Nm



6. 2. Torque: 1 Nm



7. 2. Torque: 1 Nm



Installation

1. To install, reverse the removal procedure.

SECTION 303-00 Engine System - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Engine 303-00-2
Inspection and Verification 303-00-2
Engine Oil Leaks 303-00-13
Ultraviolet (UV) Testing 303-00-13
Measure the compression pressure (21 111 0) 303-00-13
Measure the compression (Engine - 2.4L Diesel with EGR) 303-00-14
Measure the compression (Engine - 2.4L Diesel without EGR) 303-00-15
Measure the compression (Engine - 2.0L Diesel) 303-00-17
Measure the compression (Engine - 2.3L) 303-00-18
Oil Pressure - Measure (21 113 0) 303-00-20
Measure the oil pressure (Engine - 2.4L Diesel) 303-00-20
Measure the oil pressure (Engine - 2.0L Diesel) 303-00-22
Measure the oil pressure (Engine - 2.3L) 303-00-23
Valve train analysis - static (engine off) 303-00-24

GENERAL PROCEDURES

Camshaft Bearing Journal Diameter 303-00-25
Camshaft Bearing Journal Clearance 303-00-26
Camshaft End Play 303-00-27
Camshaft Surface Inspection 303-00-28
Camshaft Lobe Lift 303-00-29
Crankshaft Main Bearing Journal Diameter 303-00-30
Crankshaft End Play 303-00-31
Cylinder Bore Taper 303-00-32
Piston Inspection 303-00-33
Piston Pin to Bore Diameter 303-00-34
Piston Diameter 303-00-35
Piston Ring End Gap 303-00-36
Piston Ring-to-Groove Clearance 303-00-37
Piston Pin Diameter 303-00-38
Connecting Rod Large End Bore 303-00-39
Valve Stem Diameter 303-00-40
Valve Seat Inspection 303-00-41
Flywheel Inspection 303-00-42
Flywheel Inspection — Vehicles With: Dual Mass Flywheel 303-00-43
Flywheel Clutch Surface Inspection 303-00-44
Cylinder Head Distortion 303-00-45
Cylinder Block Distortion 303-00-46
Exhaust Manifold Cleaning and Inspection 303-00-47
Bearing Inspection 303-00-48

DIAGNOSIS AND TESTING

Engine

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Visual Inspection Chart

Mechanical	Electrical
– Coolant leaks – Oil leaks – Fuel system leaks – Visibly damaged or worn parts – Loose or missing nuts or bolts	– Fuse(s) – Loose or corroded connector(s) – Control module – Damaged or worn switch(es)

Symptom Chart

Symptom	Possible Sources	Action
• Loss of oil	• Oil leaks from the engine or auxiliary components.	• Look for evidence of oil leaks on components. Use an ultraviolet (UV) leak tester if oil leak is not evident. Install new gaskets or components as required.
	• Internal or external leak at the oil cooler.	• Check the coolant expansion tank for oil film on the coolant surface. Install a new oil cooler or oil cooler gasket.
	• Leak at the crankshaft front or rear oil seal.	• Install a new oil seal. • Align the front cover.
• Oil consumption	• Use of the wrong type of engine oil.	• Determine the last type of engine oil used (refer to the latest invoice or oil receipt) and compare with the specification. Change the engine oil.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Faulty positive crankcase ventilation system. - Hoses or ventilation/breather valves are blocked. This causes excessive pressure in the crankcase which causes oil to enter the combustion chamber. - Crankcase ventilation oil separator is faulty and engine oil can enter the combustion chamber through the intake manifold.	• Check that the crankcase ventilation system is operating correctly and repair as necessary. REFER to Section 303-08 [Engine Emission Control].
	• Turbocharger seals.	• Install a new turbocharger. Engine - 2.4L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel]. Engine - 2.0L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
	• Damaged gaskets or mating surfaces. - Cylinder head gasket is damaged or mating faces are warped. - Valve stem oil seals are worn causing engine oil to enter the combustion chamber between the valve stem and the valve stem guide.	• Check the gaskets and mating surfaces for damage. Remove the cylinder head. Check the mating faces, cylinder head gaskets and the flatness of the cylinder head and engine block mating faces. Install new valve stem oil seals.
	• Piston ring or cylinder liner wear.	• Install new components as necessary.
• Coolant consumption	• Cooling system components.	• REFER to Section 303-03 [Engine Cooling].

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Exhaust gas recirculation (EGR) cooler (if equipped).	• Install a new EGR cooler.
	• Oil cooler.	• Install a new oil cooler.
	• Damaged gaskets or warped mating faces.	• Check the cylinder head gasket for damage. Check the cylinder head and cylinder block for distortion. REFER to Cylinder Head Distortion / Cylinder Block Distortion in this section.
	• Cracks or fractures in engine components surrounded by coolant, such as cylinder liners and cylinder head combustion chamber.	• Determine the damaged engine component and install a new component.
• Engine will not crank	• Battery or cables.	• Check the battery, bracket and cables. REFER to Section 414-00 [Charging System - General Information].
	• Starter motor or cables.	• Check the starting system. REFER to Section 303-06 [Starting System].
• Engine cranks but will not start	• Fuel tank is empty.	• Check the fluid level.
	• Water in fuel.	• Drain the water from the fuel system. REFER to Section 310-00 [Fuel System - General Information].
	• Fuel filter blocked (only vehicles with diesel engine).	• Install a new fuel filter. REFER to Section 310-01 [Fuel Tank and Lines].
	• Air in fuel lines (only vehicles with diesel engine).	• Bleed the fuel system. Check the fuel system for leaks. REFER to Section 310-00 [Fuel System - General Information].
	• Engine intake air system.	• Check the intake air system. REFER to Section 303-12 [Intake Air Distribution and Filtering].

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Glow plug faulty (only vehicles with diesel engine).	• Check the glow plugs. Install new glow plugs as necessary. Engine - 2.4L Diesel - REFER to Section 303-07A [Glow Plug System -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-07B [Engine Ignition -- 2.3L Duratec-HE (MI4)] / 303-07C [Glow Plug System -- 2.2L Duratorq-TDCi (Puma) Diesel]. Engine - 2.0L Diesel - REFER to Section 303-07A [Glow Plug System -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-07B [Engine Ignition -- 2.3L Duratec-HE (MI4)] / 303-07C [Glow Plug System -- 2.2L Duratorq-TDCi (Puma) Diesel].
	• Engine management system.	• Check the engine management system. REFER to Section 303-14 [Electronic Engine Controls].
	• Fuel injection pump faulty or incorrect timing (only vehicles with diesel engine).	• Check the fuel injection pump for correct timing and performance. Engine - 2.4L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel]. Engine - 2.0L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Incorrect valve timing.	• Check and adjust the valve timing. Engine - 2.4L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.0L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.3L REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].
	• Broken or damaged timing chain or sprocket.	• Check the timing chain and sprockets. Install new components as necessary.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Very poor power output/fuel consumption too high/engine running rough	• Fuel system.	• Check the fuel system components. REFER to Section 310-00 [Fuel System - General Information]. • REFER to Section 310-01 [Fuel Tank and Lines]. • Engine - 2.4L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel]. Engine - 2.0L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel]. Engine - 2.3L REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
	• Engine intake air system.	• Check the intake air system. REFER to Section 303-12 [Intake Air Distribution and Filtering].
	• Exhaust system blocked.	• Check the exhaust system. REFER to Section 309-00 [Exhaust System].
	• Engine management system.	• Check the engine management system. REFER to Section 303-14 [Electronic Engine Controls].

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Turbocharger (only vehicles with diesel engine).	• Check the turbocharger. Engine - 2.4L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel]. Engine - 2.0L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
	• Fuel injection pump faulty or incorrect timing (only vehicles with diesel engine).	• Check and adjust fuel injection pump timing. Engine - 2.4L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel]. Engine - 2.0L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Incorrect valve timing, timing chain or timing sprocket damaged.	• Check and adjust valve timing. Install new components as necessary. Engine - 2.4L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.0L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.3L REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].
• Noisy running	• Engine auxiliary components loose or damaged.	• Check engine auxiliary components for damage/looseness.
• Noisy running, misfiring/back-firing	• Incorrect fuel	• Determine which type of fuel was the last put in the tank (note the country specific fuel specifications).
	• Water in fuel or fuel contaminated.	• Check the fuel system for water or other contamination.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Fuel injection pump faulty or incorrect timing (only vehicles with diesel engine).	• Check and adjust fuel injection pump timing. Engine - 2.4L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel]. Engine - 2.0L Diesel - REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
	• Valve timing incorrect, timing chain or timing sprocket damaged.	• Check and adjust valve timing. Install new components as necessary. Engine - 2.4L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.0L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.3L REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Noisy running/valve train noise	• Excessive valve clearance due to faulty hydraulic valve tappets.	• Install new hydraulic valve tappets. Engine - 2.4L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.0L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.3L REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].
	• Timing chain damaged.	• Install a new timing chain. Engine - 2.4L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.0L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.3L REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Timing chain incorrectly tensioned.	• Check the timing chain tension. Install a new tensioner, as necessary. Engine - 2.4L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.0L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.3L REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].
	• Timing chain guides worn or damaged.	• Check the timing chain guides. Install new guides as necessary. Engine - 2.4L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.0L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.3L REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Noisy running/engine block	• Engine components - Pistons - Piston rings - Connecting rod large end, main bearing or thrust bearing journals - Connecting rods bent or damaged.	• Check the engine components for wear or damage. Make sure all components are within specification. Install new components as necessary. Engine - 2.4L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.0L Diesel - REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)]. Engine - 2.3L REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].

Engine Oil Leaks

NOTE: Before installing new gaskets or oil seals, make sure that the fault is clearly established.

If the oil leak cannot be identified clearly by a visual inspection, carry out a UV test:

Ultraviolet (UV) Testing

1. Clean the engine and transmission with a suitable cleaning fluid such as brake cleaner.
2. Pour test fluid GV-2911-3090A in accordance with the quantity specified by the manufacturer through the oil filler neck into the engine and install the oil filler cap.

WARNING:On manual transmissions put the transmission into NEUTRAL. Failure to follow these instructions may result in personal injury.

3. Start the engine and let it run for about five minutes.
4. Switch off the engine.

NOTE: If no leak can be found, road test the vehicle under various loads and again check the engine for leaks.

5. Check the engine for oil leaks using a UV leak tester GV-2929 or UV leak tester GV-2911 B11.
6. Rectify any leaks found and recheck the engine for oil leaks.

Measure the compression pressure (21 111 0)

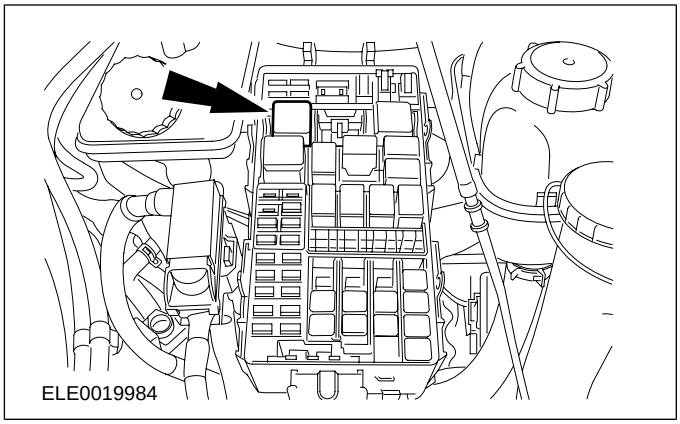
NOTE: The powertrain control module (PCM) receives an error message when the relay is removed or electrical components are disconnected. This error message must be deleted from the fault memory by connecting Worldwide Diagnostic System (WDS) after completing the measurement.

NOTE: Valve clearance must be set correctly before performing a compression test. Make sure engine is at the normal operating temperature.

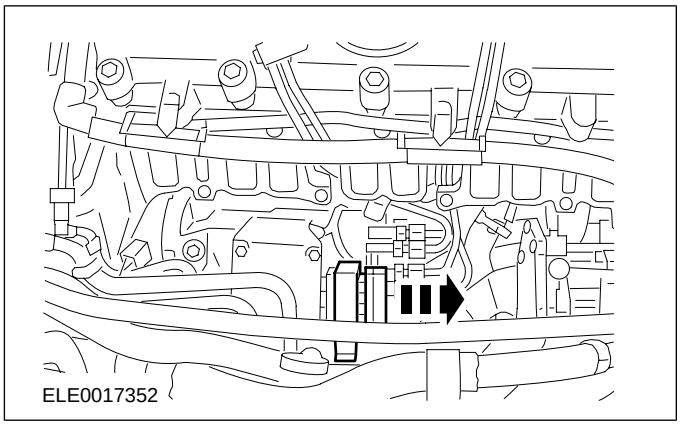
NOTE: The varying design of compression checking devices and fluctuating starter motor speeds normally only allows to check if the compression is even in all cylinders.

DIAGNOSIS AND TESTING

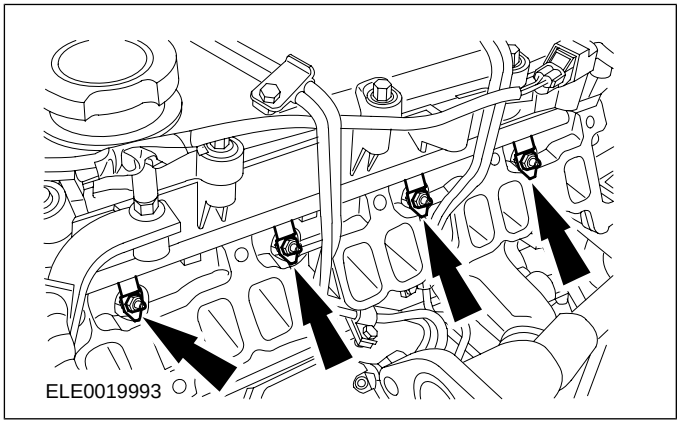
Measure the compression (Engine - 2.4L Diesel with EGR)



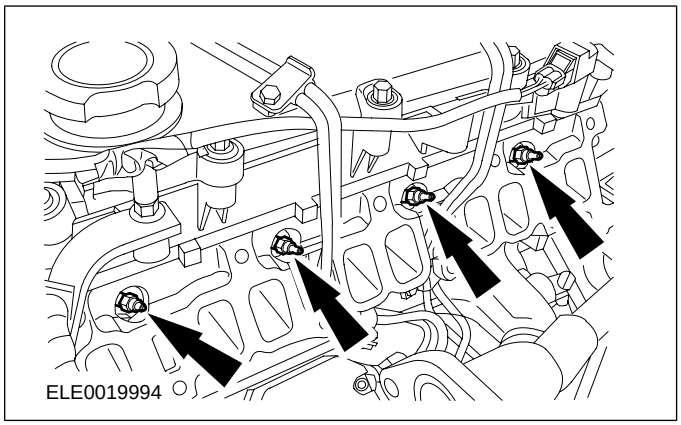
1. Open the Battery Junction Box (BJB) and remove the glow plug relay.
2. Remove the Intake Manifold. REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].



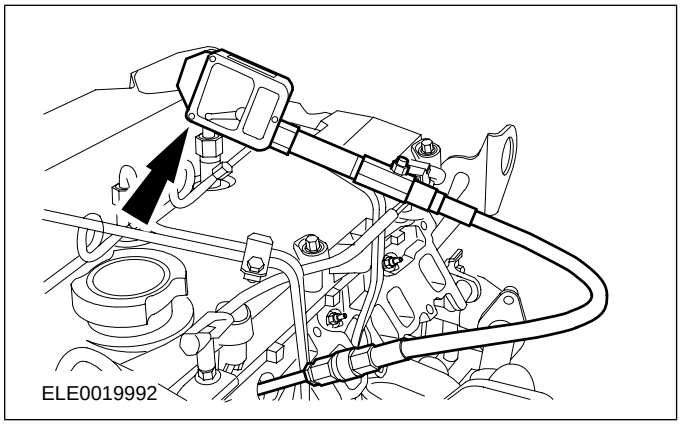
3. Disconnect the fuel injection pump electrical connector.



4. Remove the glow plug power supply.



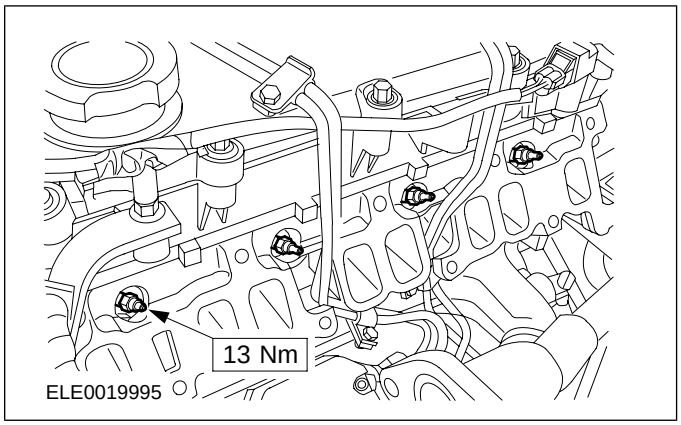
5. Remove the glow plugs.



6. Install compression tester 623.002.1101 with adapter GV-2186 into the glow plug bore.

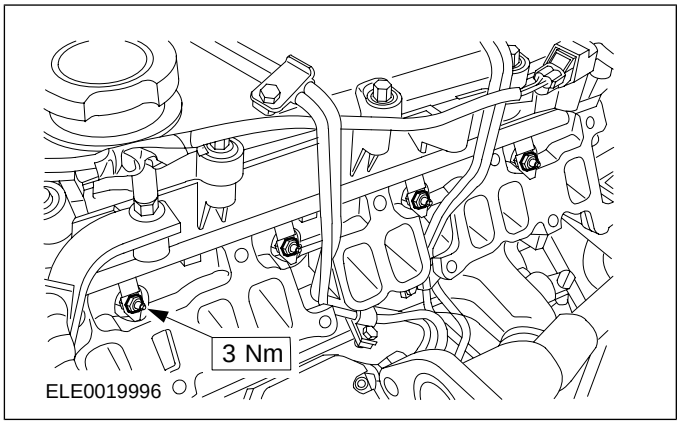
NOTE: Crank the engine with the starter motor until the reading on the compression tester stops rising.

7. Carry out the measurement on all cylinders, following the measuring equipment manufacturer's instructions.
8. Detach the compression tester and adapter.

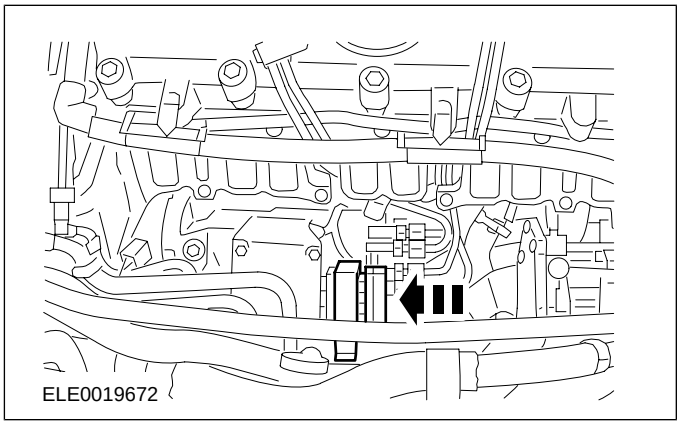


9. Install the glow plugs.

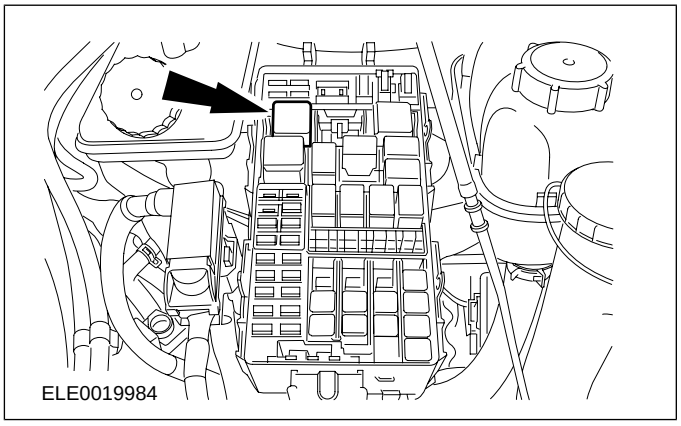
DIAGNOSIS AND TESTING



10. Install the glow plug power supply.

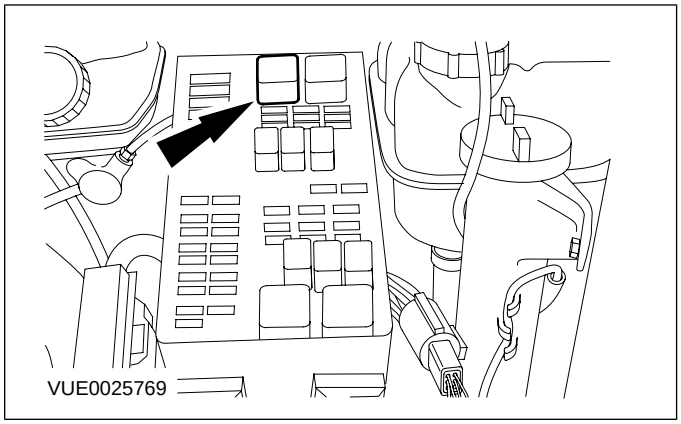


11. Connect the fuel injection pump electrical connector.
12. Install the Intake Manifold. REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].

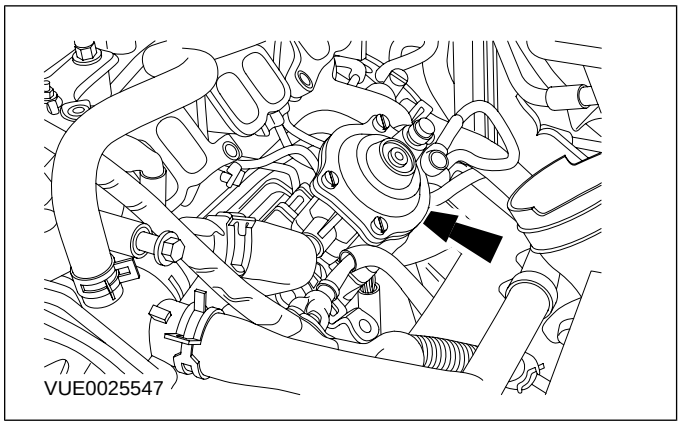


13. Install the glow plug relay.
14. Reset the PCM fault memory.

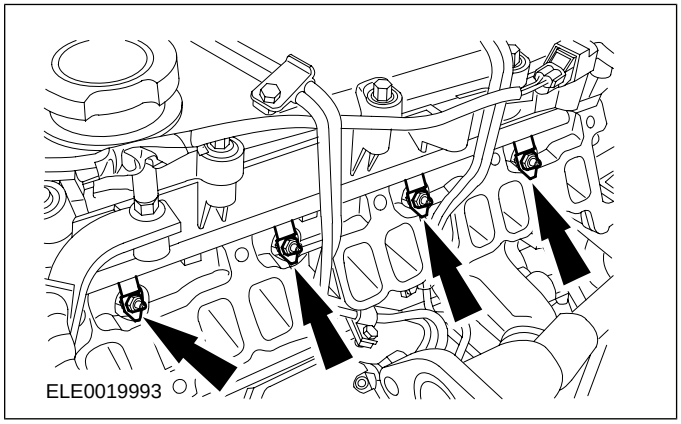
Measure the compression (Engine - 2.4L Diesel without EGR)



1. Open the Battery Junction Box (BJB) and remove the glow plug relay.
2. Remove the Intake Manifold. REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].

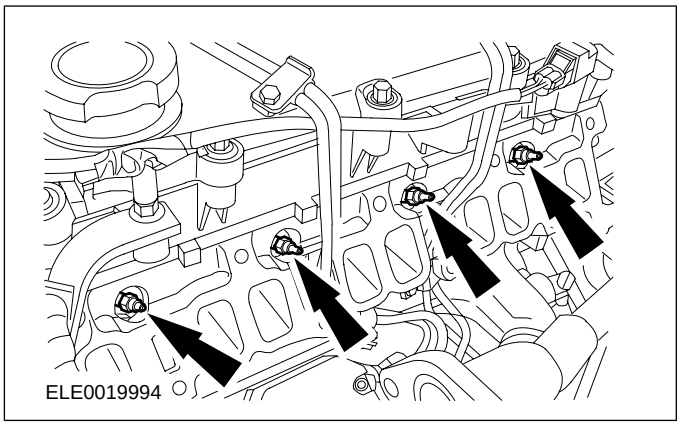


3. Disconnect the fuel shutoff solenoid valve electrical connector.

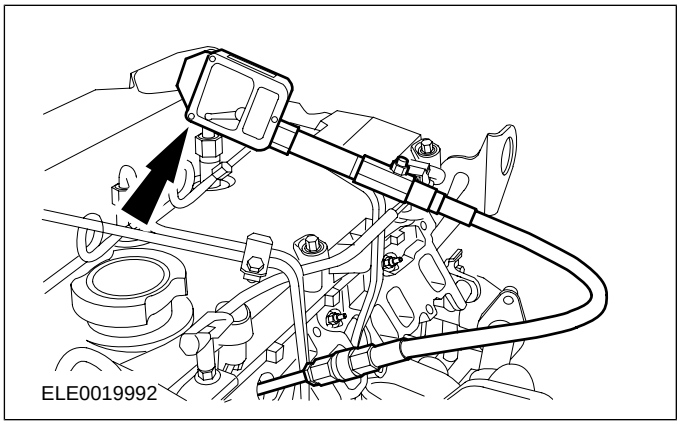


4. Remove the glow plug power supply.

DIAGNOSIS AND TESTING



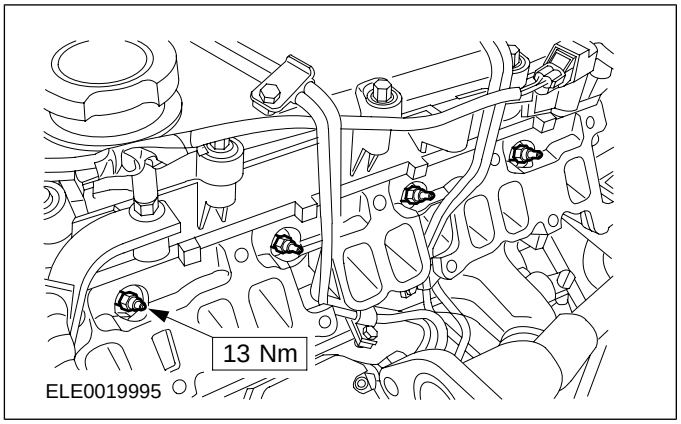
5. Remove the glow plugs.



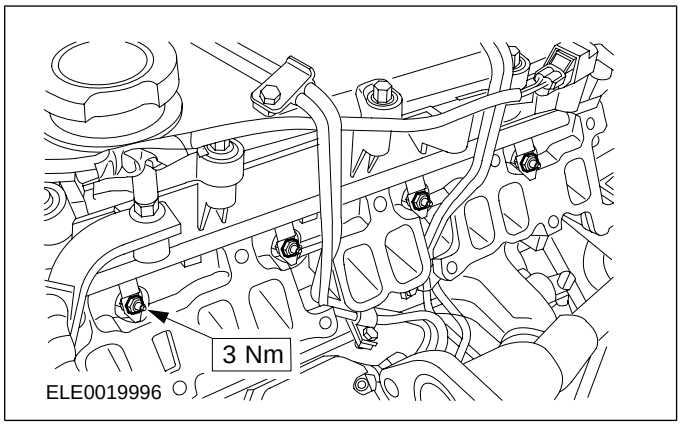
6. Install compression tester 623.002.1101 with adapter GV-2186 into the glow plug bore.

NOTE: Crank the engine with the starter motor until the reading on the compression tester stops rising.

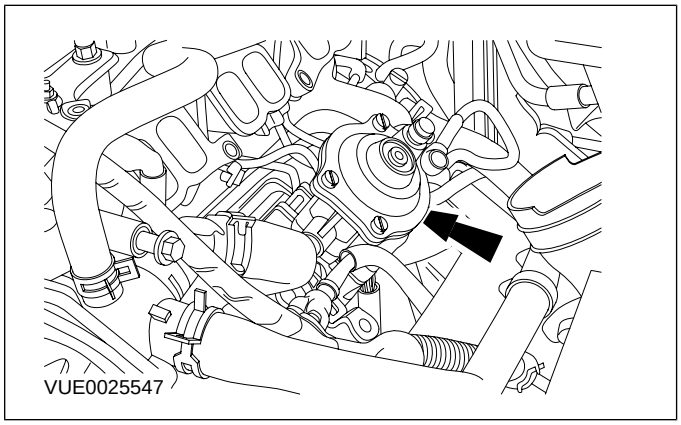
7. Carry out the measurement on all cylinders, following the measuring equipment manufacturer's instructions.
8. Detach the compression tester and adapter.



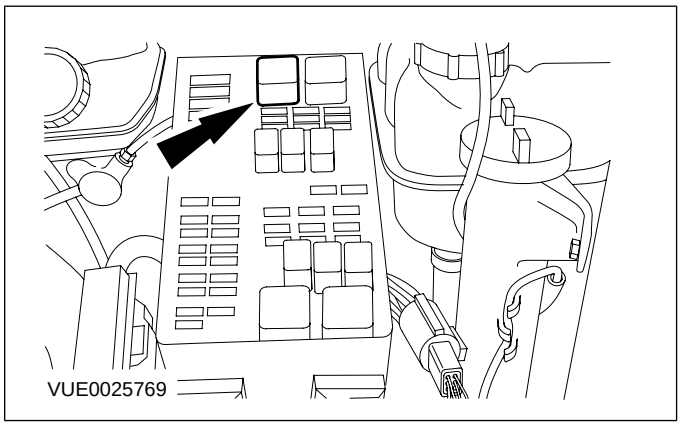
9. Install the glow plugs.



10. Install the glow plug power supply.



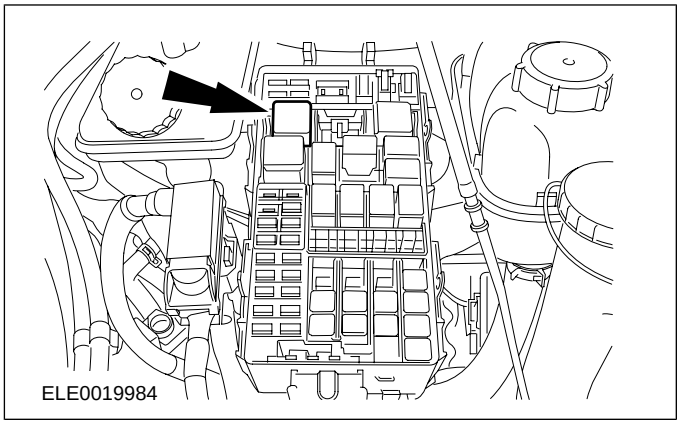
11. Connect the fuel shutoff solenoid valve electrical connector.
12. Install the Intake Manifold. REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].



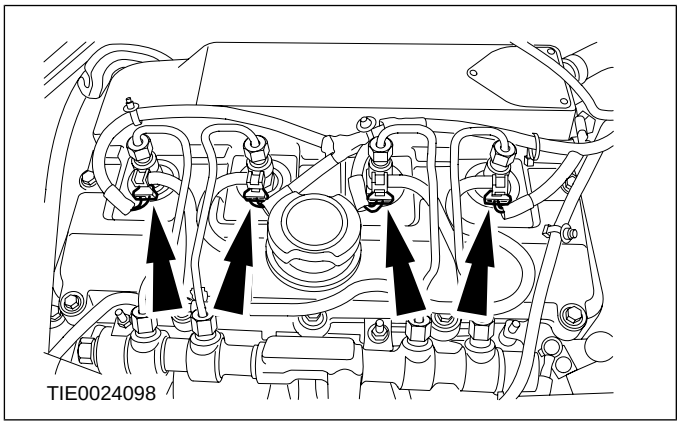
13. Install the glow plug relay.
14. Reset the PCM fault memory.

DIAGNOSIS AND TESTING

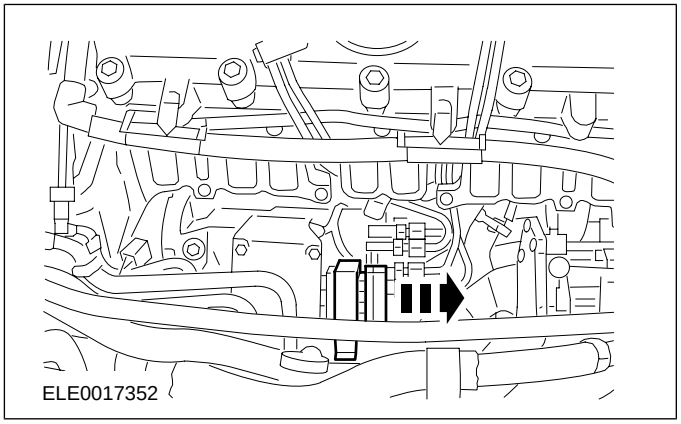
Measure the compression (Engine - 2.0L Diesel)


ELE0019984

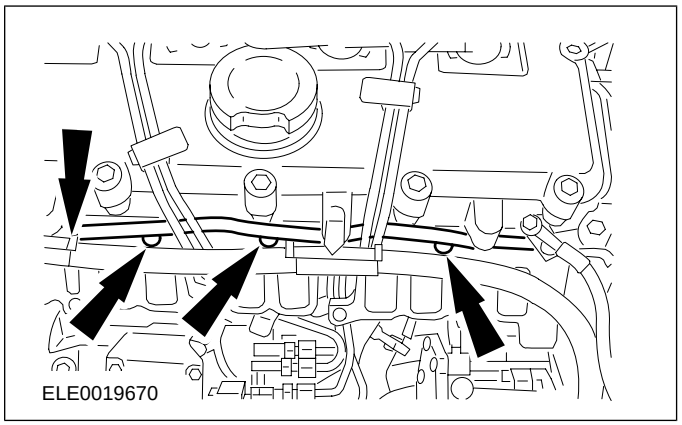
1. Open the BJB and remove the glow plug relay.
2. Remove the Intake Manifold. REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].


TIE0024098

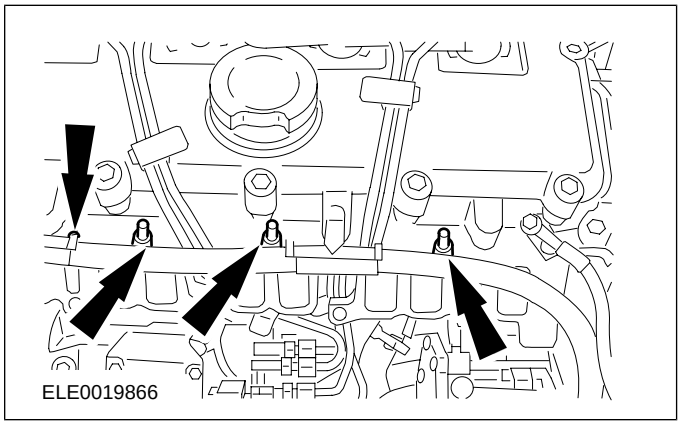
3. Disconnect the fuel injector electrical connectors from the fuel injectors (vehicles with common rail fuel injection).


ELE0017352

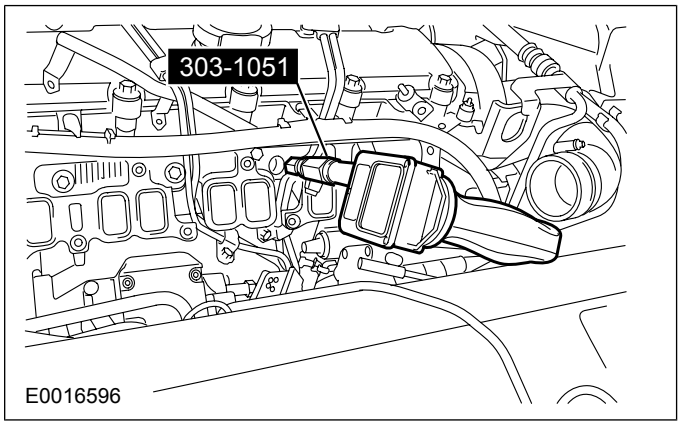
4. Disconnect the injection pump electrical connector (vehicles without common rail fuel injection).


ELE0019670

5. Remove the glow plug power supply.


ELE0019866

6. Remove the glow plugs.



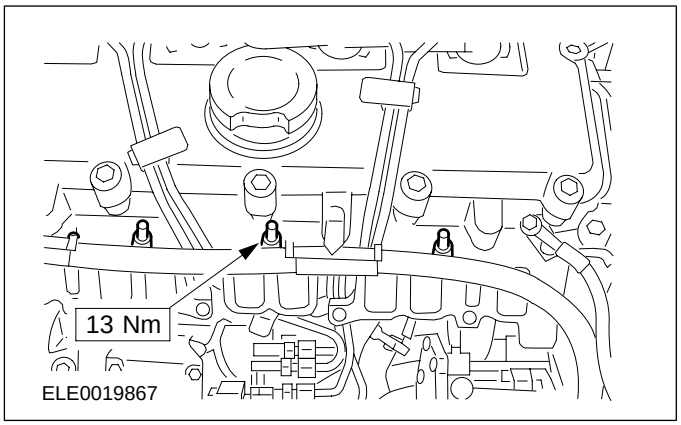
E0016596

7. Install compression tester 623.002.1101 with adapter GV-2186 into the glow plug bore.

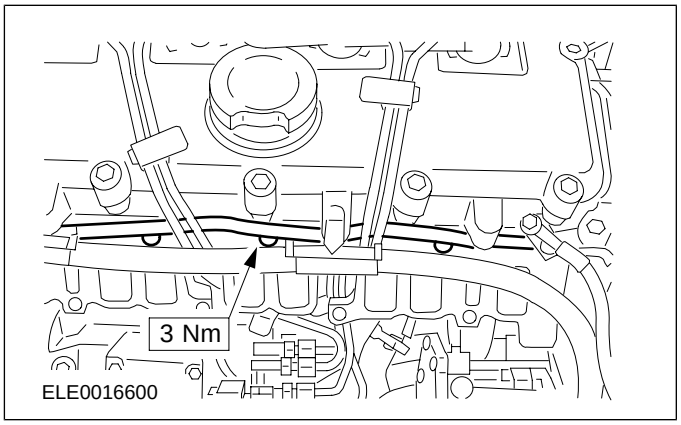
NOTE: Crank the engine with the starter motor until the reading on the compression tester stops rising.

8. Carry out the measurement on all cylinders, following the measuring equipment manufacturer's instructions.
9. Detach the compression tester and adapter.

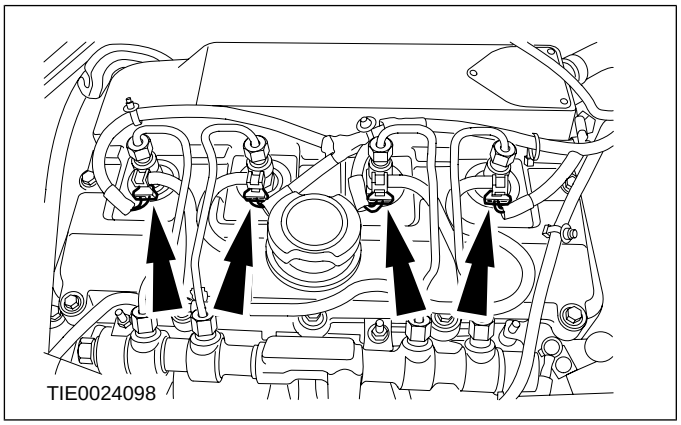
DIAGNOSIS AND TESTING



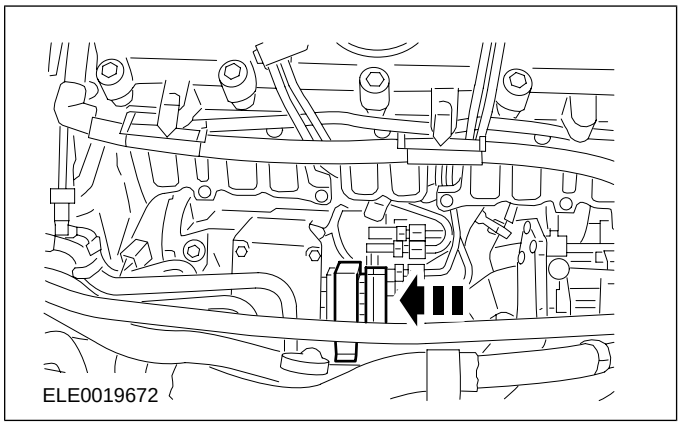
10. Install the glow plugs.



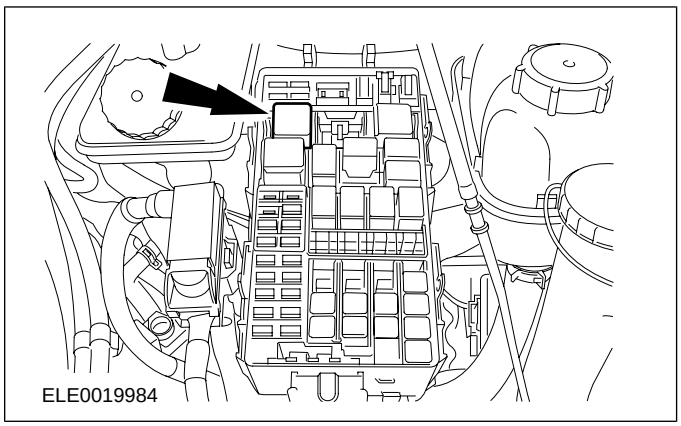
11. Install the glow plug power supply.



12. Connect the fuel injector electrical connectors to the fuel injectors (vehicles with common rail fuel injection).

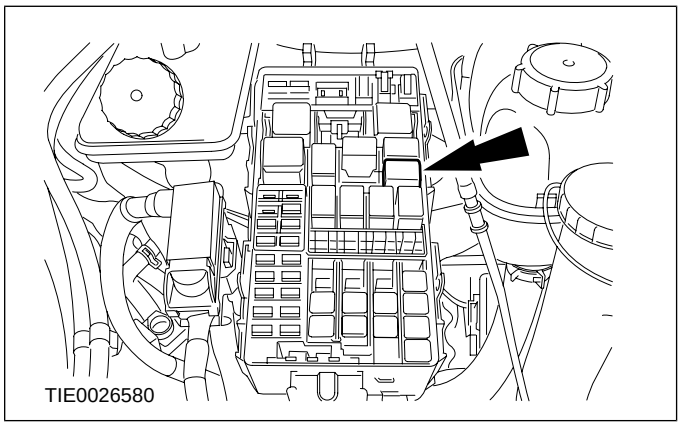


13. Connect the injection pump electrical connector (vehicles without common rail fuel injection).
14. Install the Intake Manifold. REFER to Section 303-01A [Engine -- 2.4L Duratorq-TDCi (Puma) Diesel] / 303-01B [Engine -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-01C [Engine -- 2.3L Duratec-HE (MI4)].



15. Install the glow plug relay.
16. Reset the PCM fault memory.

Measure the compression (Engine - 2.3L)

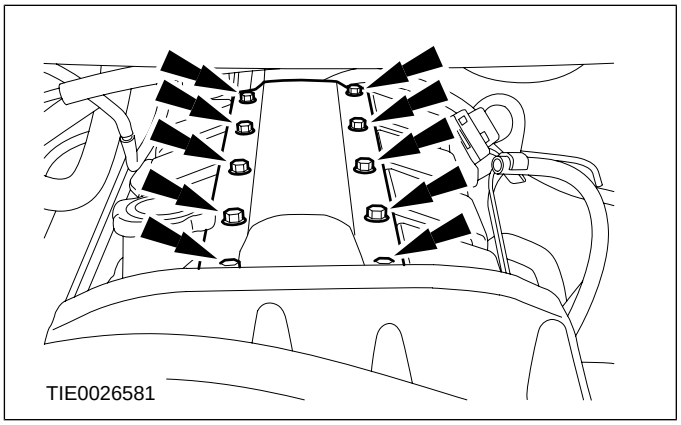


1. Open the Battery Junction Box (BJB) and remove the fuel pump relay.

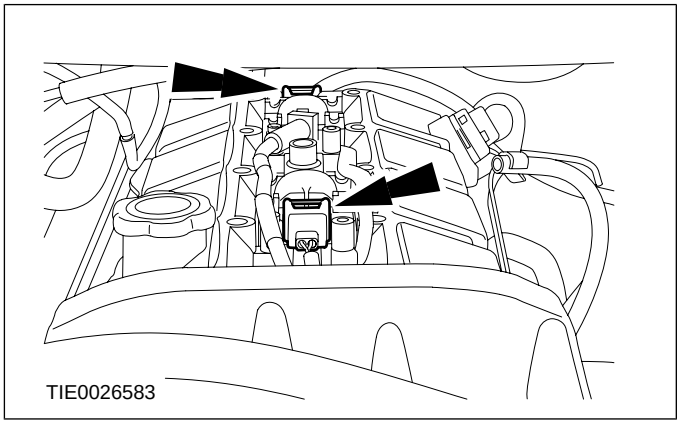
DIAGNOSIS AND TESTING

NOTE: The engine will start, run for a few seconds and then stop.

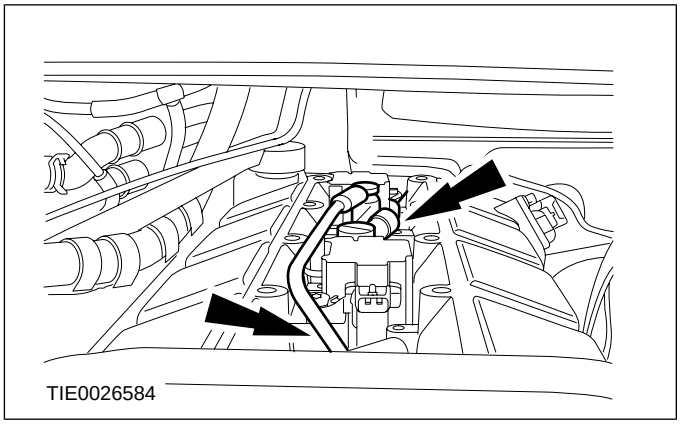
2. Start the engine.



3. Remove the spark plug cover.

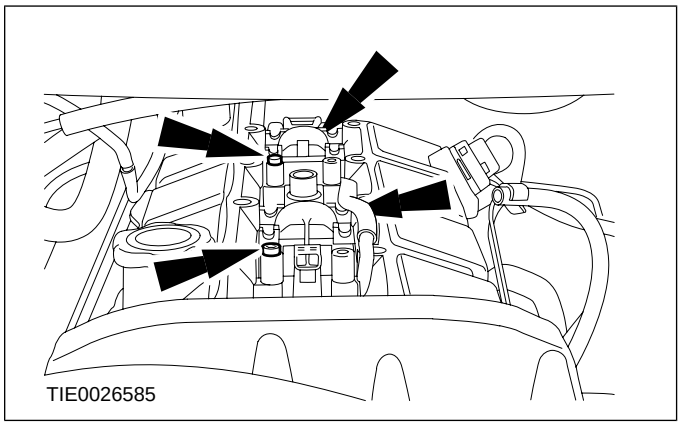


4. Disconnect the ignition coil electrical connectors.

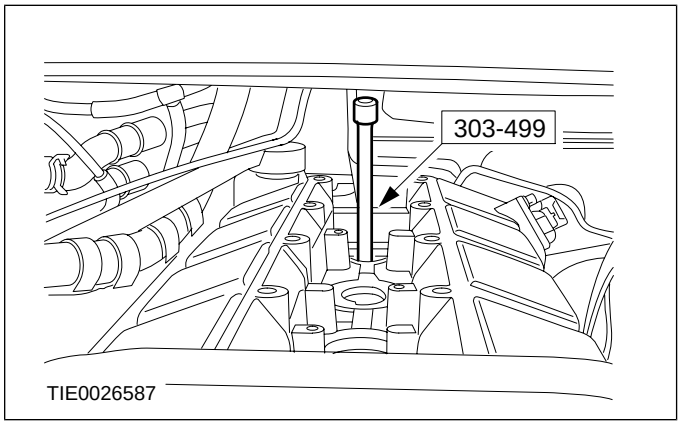


NOTE: Twist the spark plug connectors slightly before disconnecting them. Pull on the connector and not on the cable.

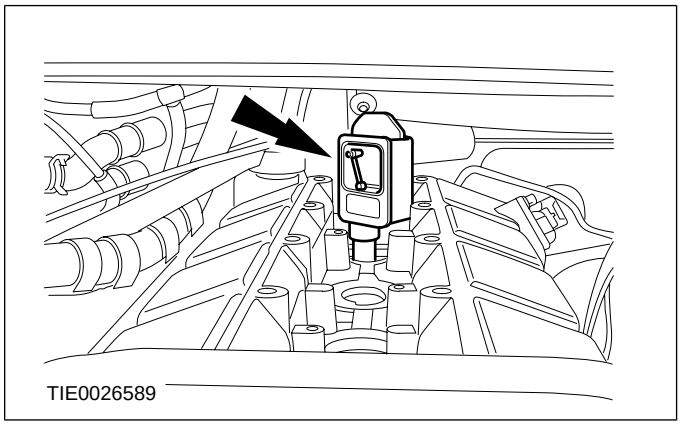
5. Remove the spark plug connectors of cylinder one and three.



6. Remove the ignition coils.



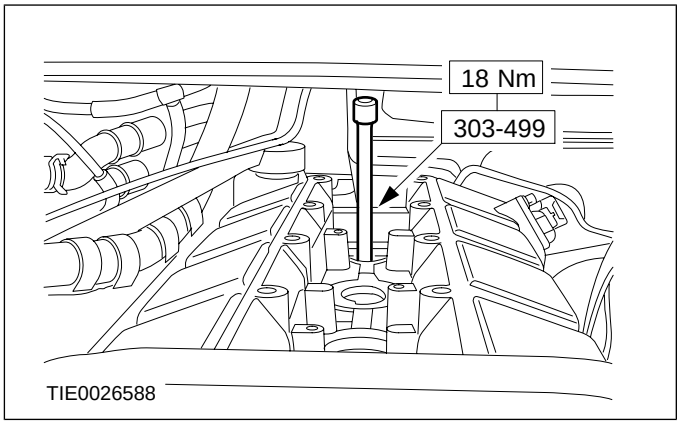
7. Using the special tool, remove the spark plugs.



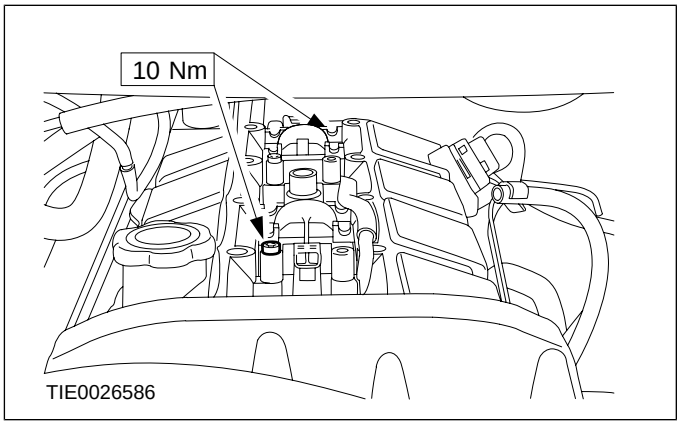
NOTE: Crank the engine with the starter motor and with wide open throttle, until the reading on the compression tester stops rising.

8. Carry out the measurement on all cylinders, following the measuring equipment manufacturer's instructions.

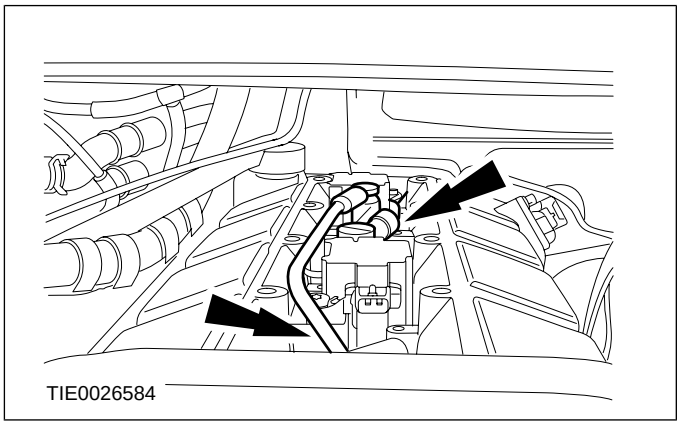
DIAGNOSIS AND TESTING



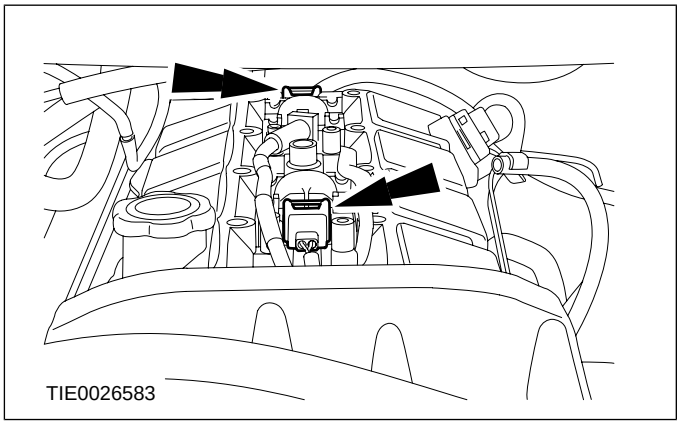
9. Using the special tool, install the spark plugs.



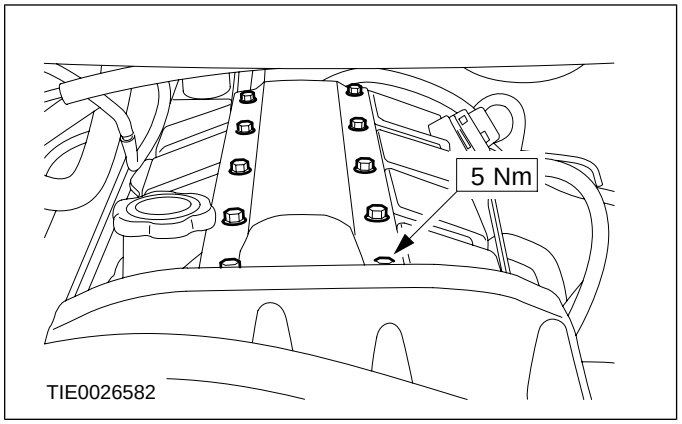
10. Install the ignition coils.



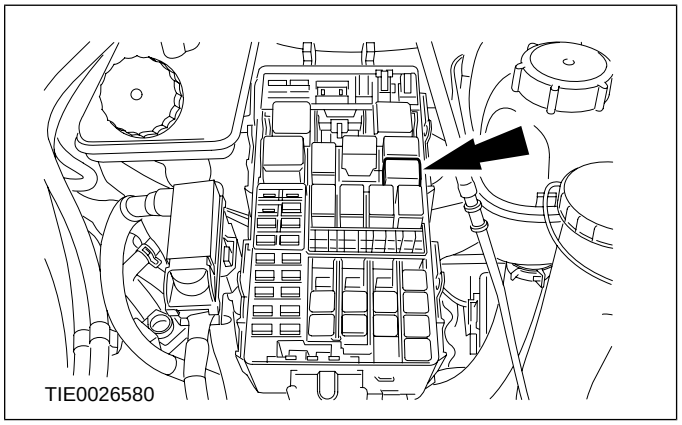
11. Install the spark plug connectors of cylinder one and three.



12. Connect the ignition coil electrical connectors.



13. Install the spark plug cover.



14. Install the fuel pump relay.
15. Reset the PCM fault memory.

Oil Pressure - Measure (21 113 0)

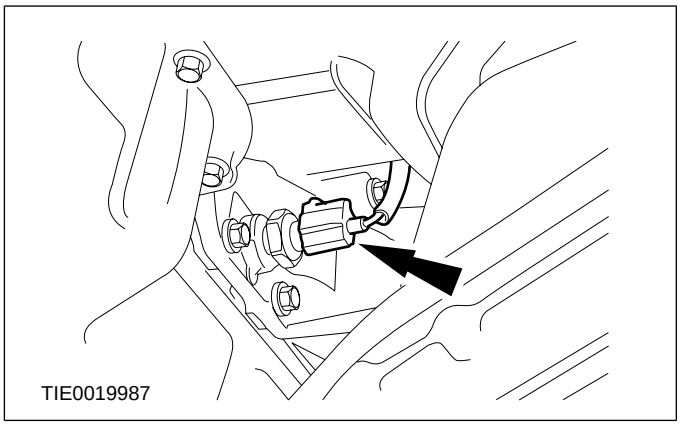
The oil pressure depends on various factors (engine speed, oil temperature, oil viscosity, amount of oil filter contamination etc.).

NOTE: Measure the oil pressure at the specified engine speed. Measure the oil pressure at an oil temperature of 80°C.

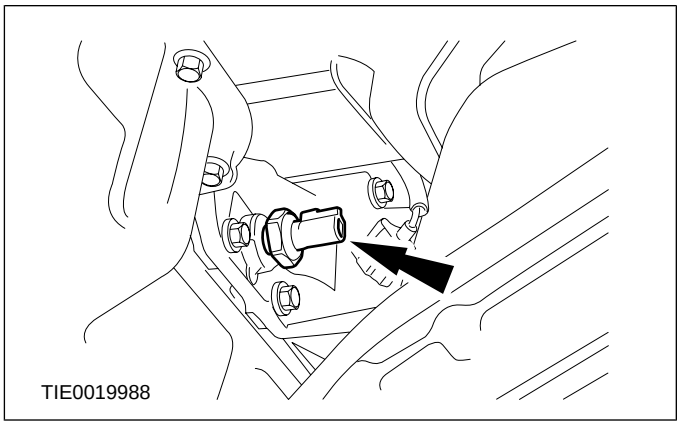
Measure the oil pressure (Engine - 2.4L Diesel)

1. Raise and support the vehicle. REFER to Section 100-02 [Jacking and Lifting].

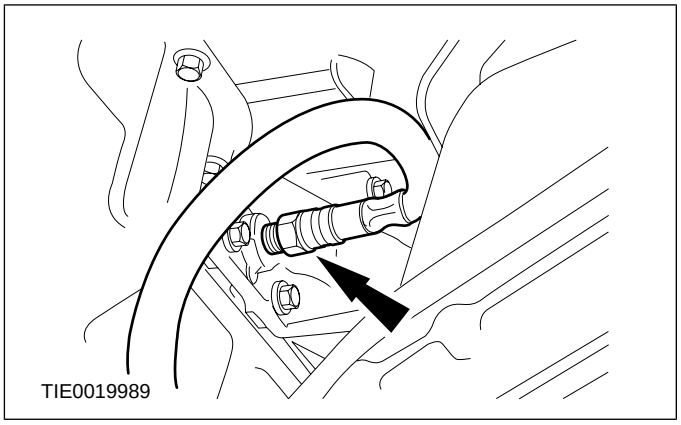
DIAGNOSIS AND TESTING



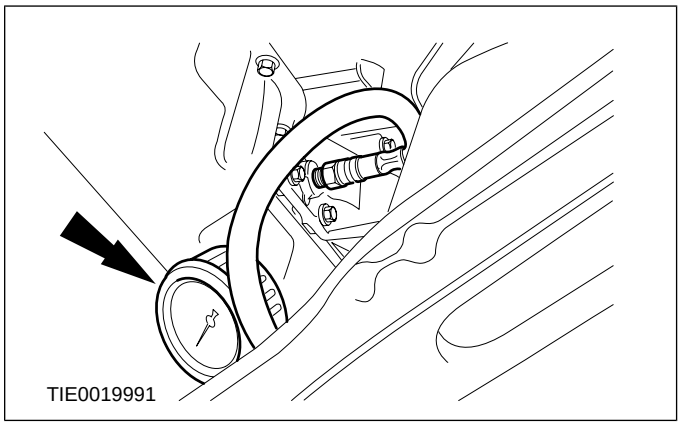
2. Disconnect the oil pressure switch electrical connector.



3. Remove the oil pressure switch.



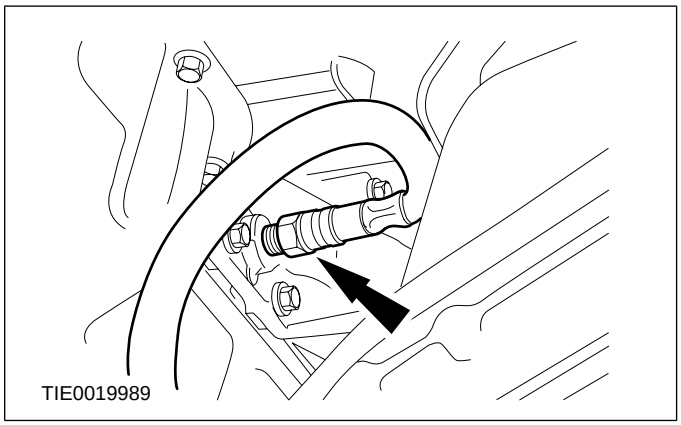
4. Attach the oil pressure gauge (GV 2134) with the oil pressure gauge connector.
5. Lower the vehicle.
6. Start the engine
7. Raise and support the vehicle. REFER to Section 100-02 [Jacking and Lifting].



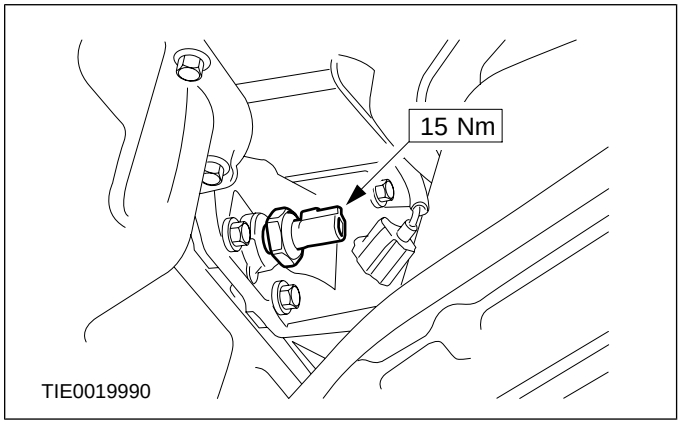
NOTE: Oil pressure at 2000 rpm must be 2.0 bar minimum.

NOTE: Oil pressure at idle must be 1.25 bar minimum.

8. Measure the oil pressure.
9. Lower the vehicle.
10. Stop the engine.
11. Raise and support the vehicle. REFER to Section 100-02 [Jacking and Lifting].

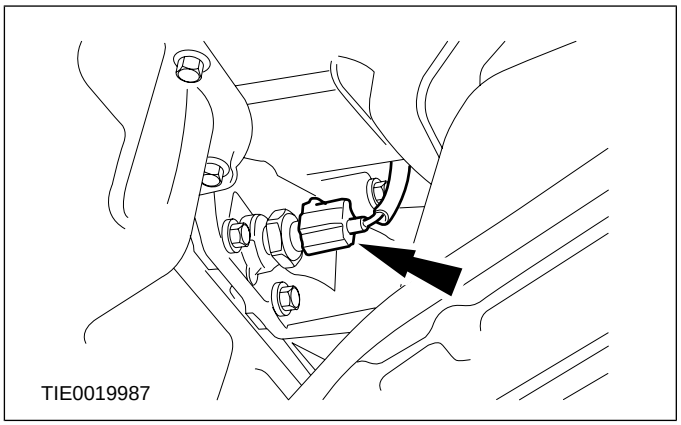


12. Remove the oil pressure gauge and the oil pressure gauge connector.



13. Install the oil pressure switch.

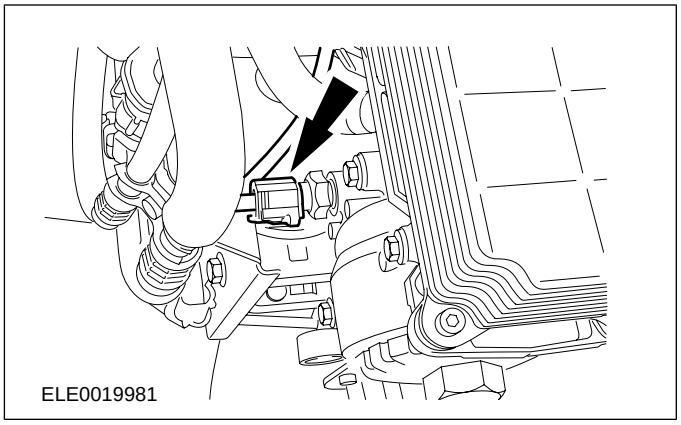
DIAGNOSIS AND TESTING



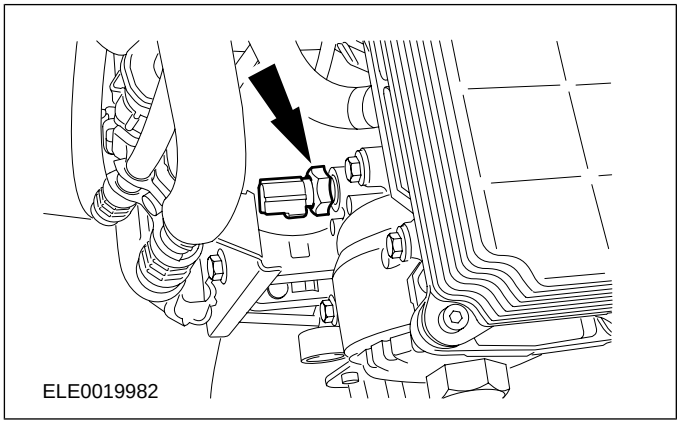
14. Connect the oil pressure switch electrical connector.
15. Lower the vehicle.

Measure the oil pressure (Engine - 2.0L Diesel)

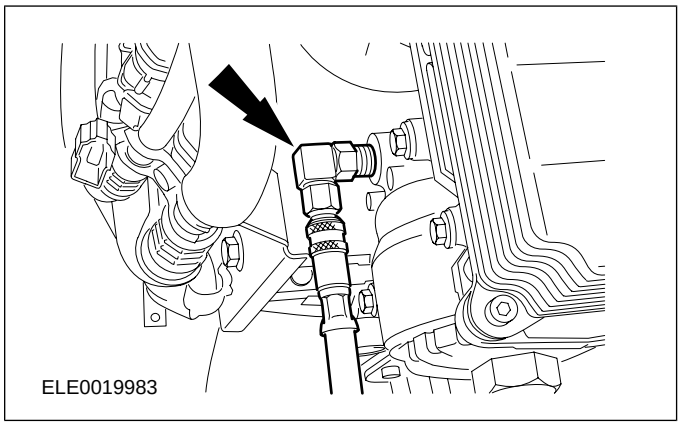
1. Raise and support the vehicle. REFER to Section 100-02 [Jacking and Lifting].



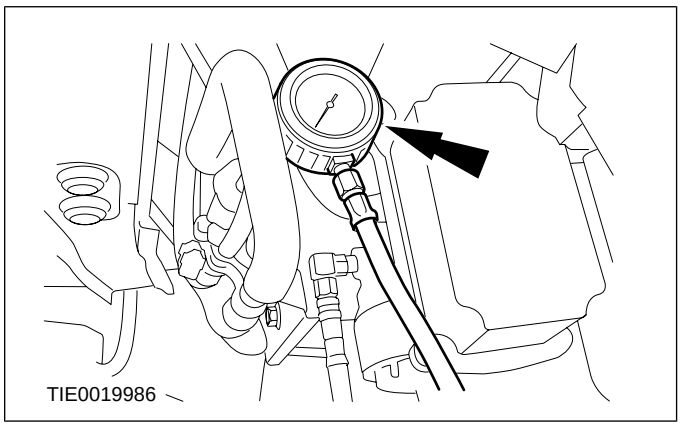
2. Disconnect the oil pressure switch electrical connector.



3. Remove the oil pressure switch.



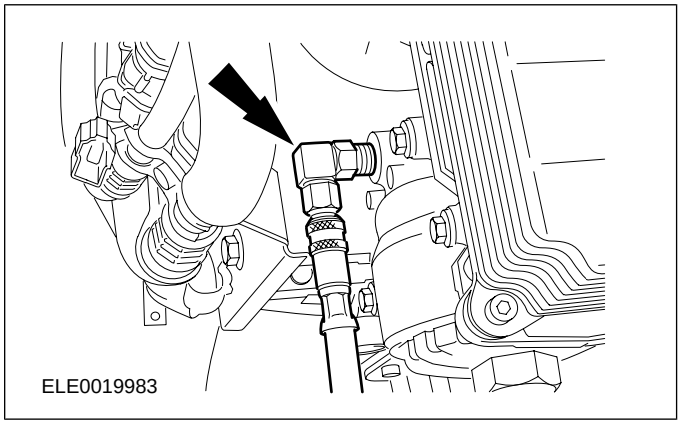
4. Attach the oil pressure gauge (GV 2134) with the oil pressure gauge connector.
5. Lower the vehicle.
6. Start the engine.
7. Raise and support the vehicle. REFER to Section 100-02 [Jacking and Lifting].



NOTE: Oil pressure at 2000 rpm must be 2.0 bar minimum.

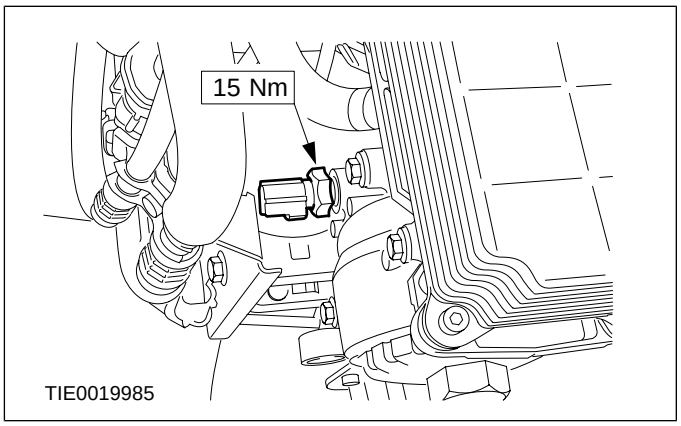
NOTE: Oil pressure at idle must be 1.25 bar minimum.

8. Measure the oil pressure.
9. Lower the vehicle.
10. Stop the engine.
11. Raise and support the vehicle. REFER to Section 100-02 [Jacking and Lifting].

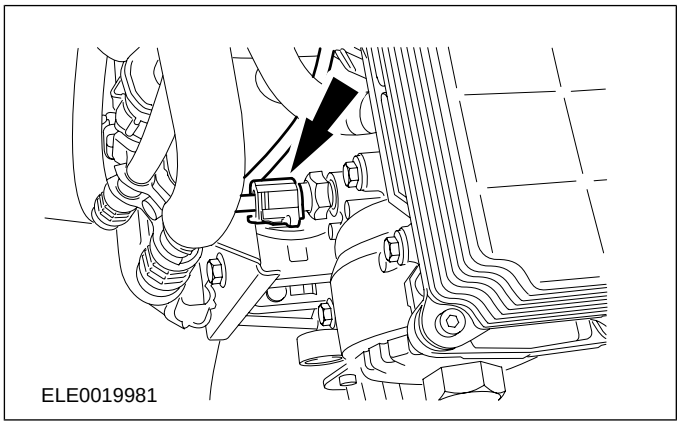


DIAGNOSIS AND TESTING

12. Remove the oil pressure gauge and the oil pressure gauge connector.



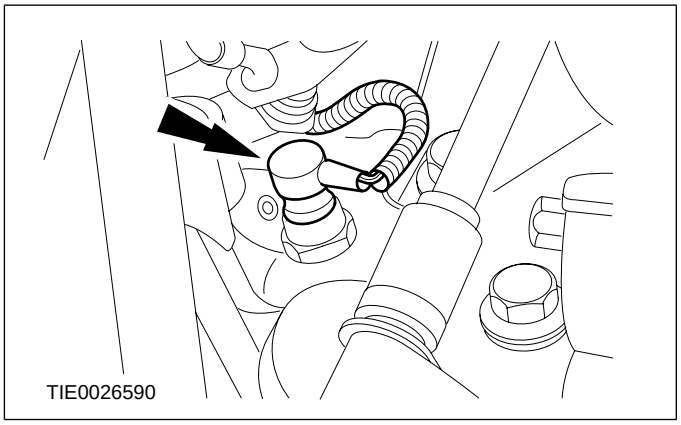
13. Install the oil pressure switch.



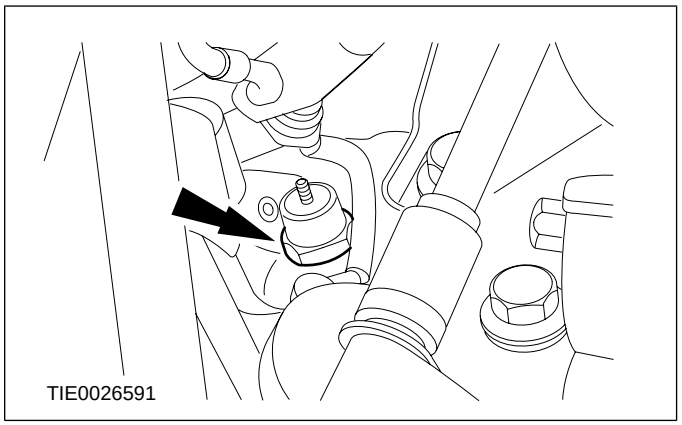
14. Connect the oil pressure switch electrical connector.
15. Lower the vehicle.

Measure the oil pressure (Engine - 2.3L)

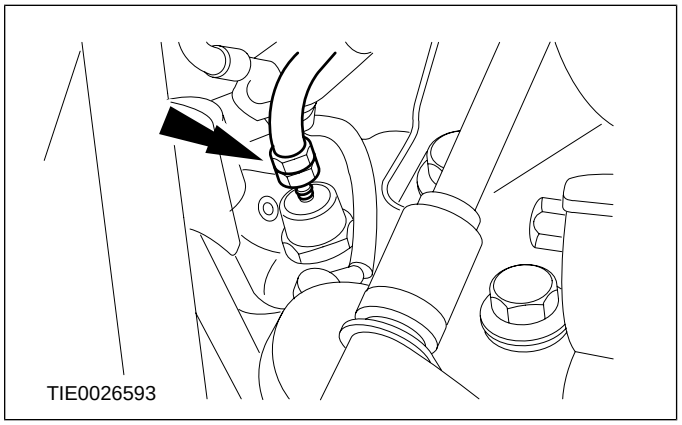
1. Raise and support the vehicle. REFER to Section 100-02 [Jacking and Lifting].



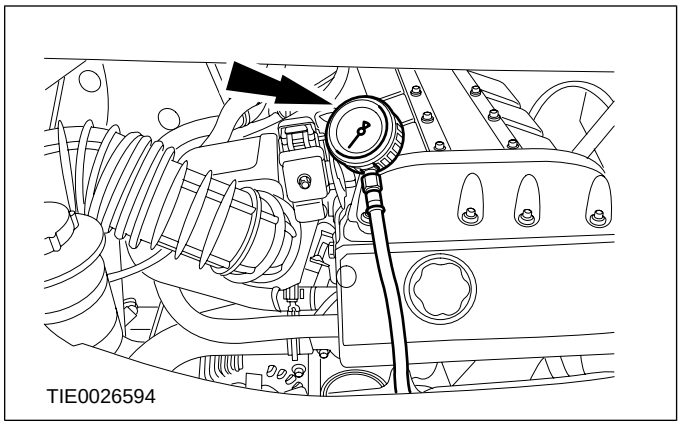
2. Disconnect the oil pressure switch electrical connector.



3. Remove the oil pressure switch.



4. Attach the oil pressure gauge (GV 2134) with the oil pressure gauge connector.
5. Lower the vehicle.
6. Start the engine.
7. Raise and support the vehicle. REFER to Section 100-02 [Jacking and Lifting].

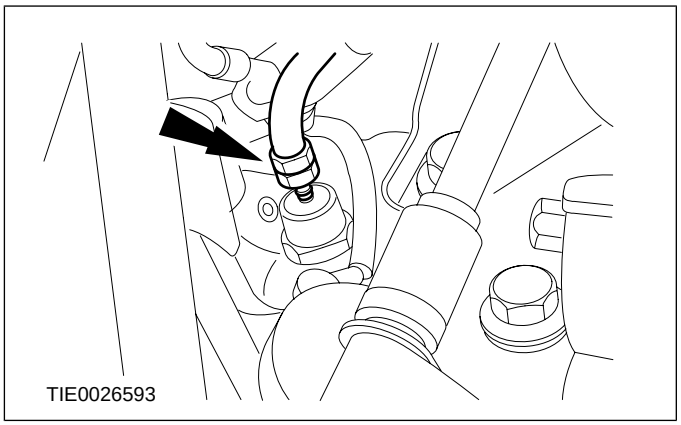


NOTE: Oil pressure a idle: 1.6 bar.

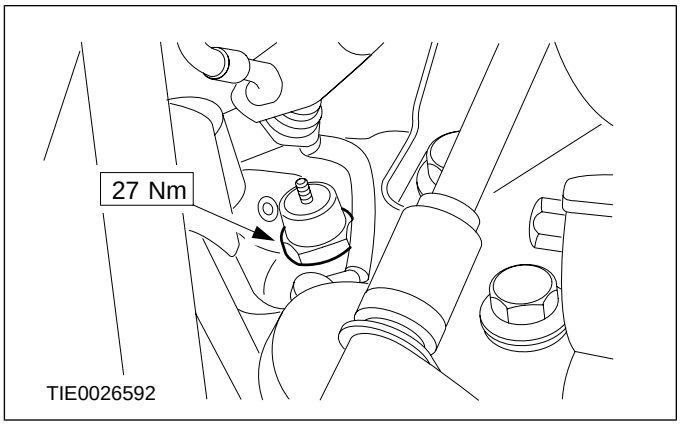
NOTE: Maximum oil pressure: 6.5 bar.

8. Measure the oil pressure.
9. Lower the vehicle.
10. Stop the engine.
11. Raise and support the vehicle. REFER to Section 100-02 [Jacking and Lifting].

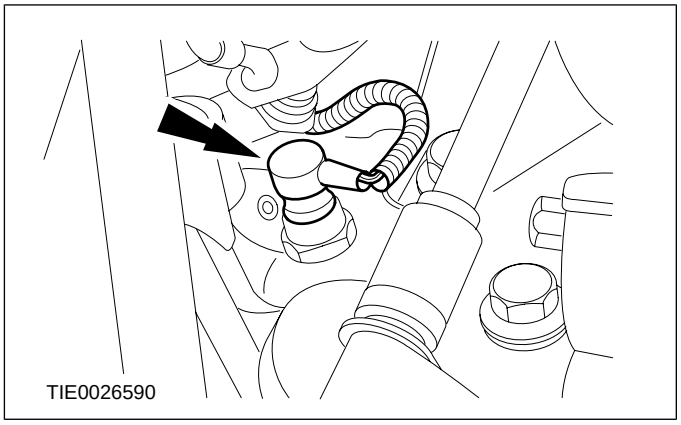
DIAGNOSIS AND TESTING



12. Remove the oil pressure gauge and the oil pressure gauge connector.



13. Install the oil pressure switch.



14. Connect the oil pressure switch electrical connector.
15. Lower the vehicle.

Valve train analysis - static (engine off)

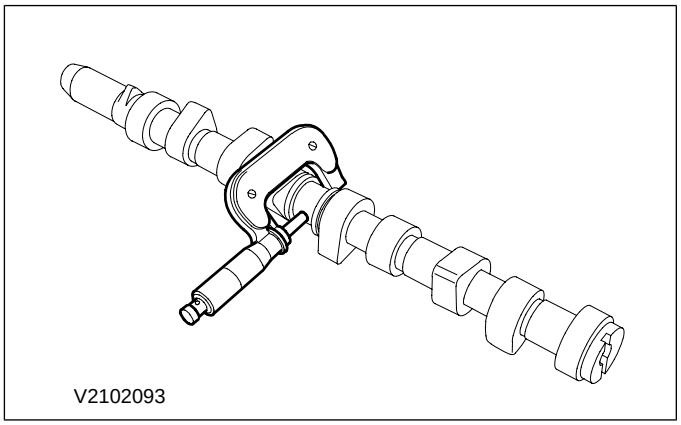
1. Remove the valve cover.

Check all components of the valve train for damage and wear. Make sure that only original components are installed and that all nuts and bolts are tightened to the specified torque.

GENERAL PROCEDURES

Camshaft Bearing Journal Diameter

1. **Determine the diameter of the camshaft journals.**
   - Using a micrometer measure the diameter at 90 degrees intervals to determine if the journals are out-of-round.
   - Measure at two different points on the journal to determine if there is any tapering.
   - If the measurements are out of the specified range, install a new camshaft.


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GENERAL PROCEDURES

Camshaft Bearing Journal Clearance

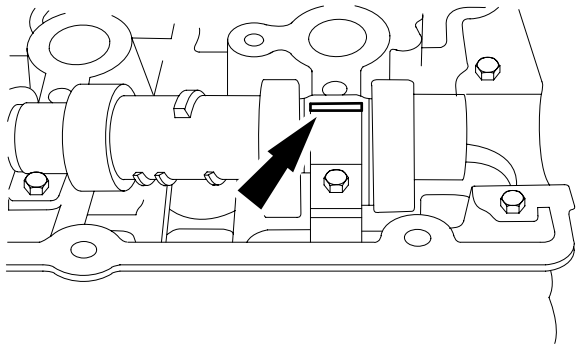
1. **NOTE:Make sure that the following stages are followed exactly. The tappets or followers must be removed to carry out this measurement.**

NOTE: Make sure that the camshaft is to specification.

NOTE: The bearing caps and journals should be free from engine oil and dirt.

Position on a width of plastigage on the bearing cap.

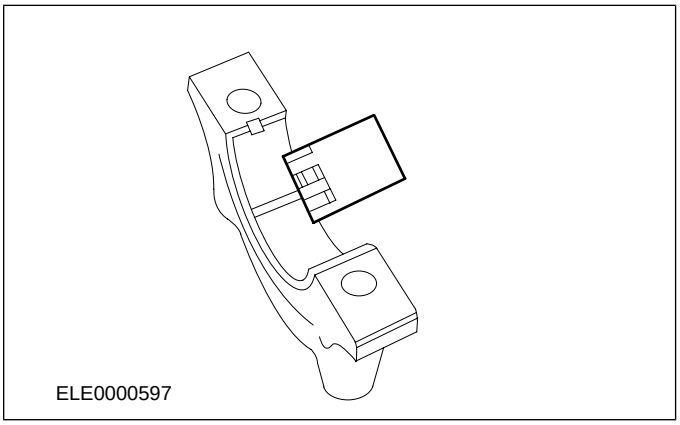
- Insert the camshaft, without lubrication, into the cylinder head.
- Position a plastigage strip, which should be equal to the width of the bearing cap, on the bearing journal.



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2. **Following the tightening specification, install the camshaft bearing caps. Refer to the corresponding Section 303-01.**
3. **NOTE:Do not strike the bearing caps.**

   Remove the camshaft bearing caps, refer to the corresponding Section 303-01.
4. **Using the Plastigage, read off the measurement.**
   - Compare the width of plastigage with the plastigage scale.
   - The value that is read off is the bearing clearance.



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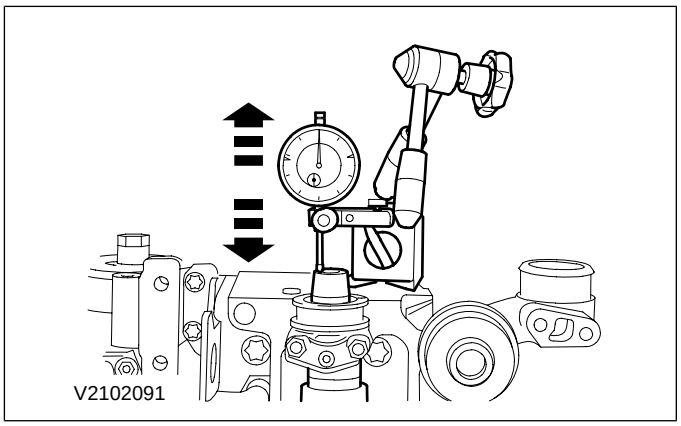
GENERAL PROCEDURES

Camshaft End Play

1. **NOTE:Make sure that the camshaft is to specification.**

   Using a Dial Indicator Gauge, measure the end play.

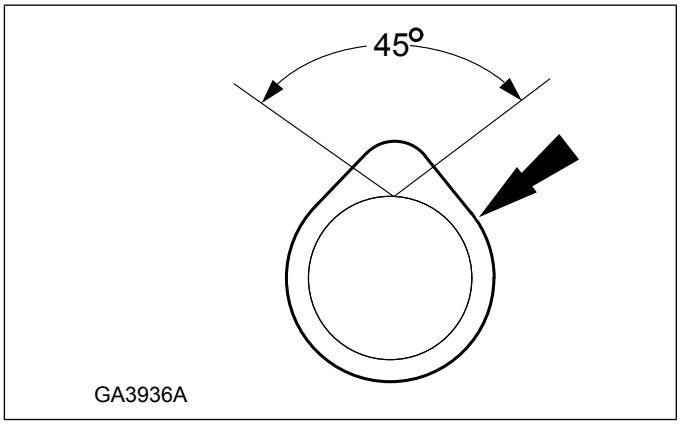
   - Slide the camshaft in both directions. Read and note the maximum and minimum values on the Dial Indicator Gauge.
     - End play = maximum value minus minimum value
   - If the measurement is out of specification, install new components.



GENERAL PROCEDURES

Camshaft Surface Inspection

1. **Inspect the camshaft lobes for pitting or damage in the active area. Minor pitting is acceptable outside the active area.**

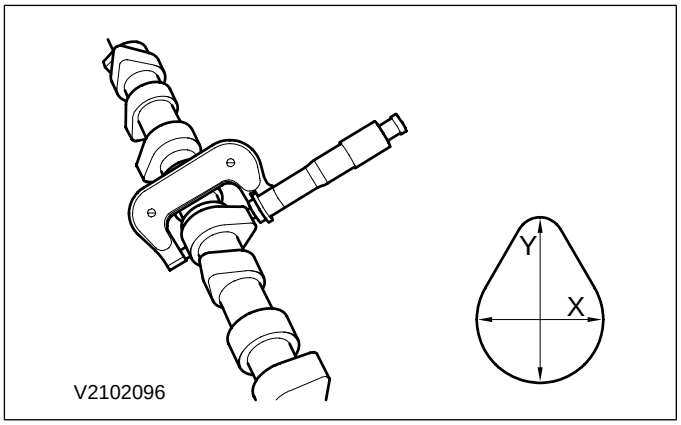


GENERAL PROCEDURES

Camshaft Lobe Lift

1. Determine the cam lift.

- Using a micrometer measure the cam in two directions.
- The difference between the two measurements is the cam lift.



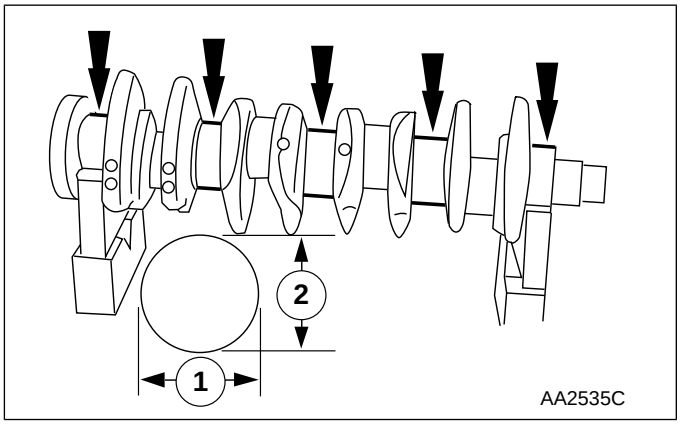
GENERAL PROCEDURES

Crankshaft Main Bearing Journal Diameter

General Equipment

Micrometer

1. **Measure the diameter of the main bearing journals and the big-end bearing journals.**
   - Repeat the measurement with the micrometer offset by 90°, in order to determine any eccentricity which may be present.
   - Measure the journal at two different positions to determine any conicity which may be present.



GENERAL PROCEDURES

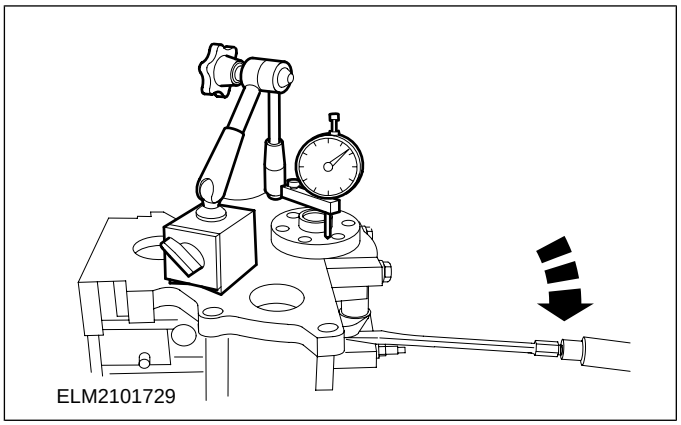
Crankshaft End Play

General Equipment

Dial indicator
Dial indicator fixture

1. Determine the end float

- Place on the dial indicator and bracket .
- Determine the end float by raising the crankshaft with the aid of a screwdriver.
- If necessary, correct the end float by using new thrust half washers.



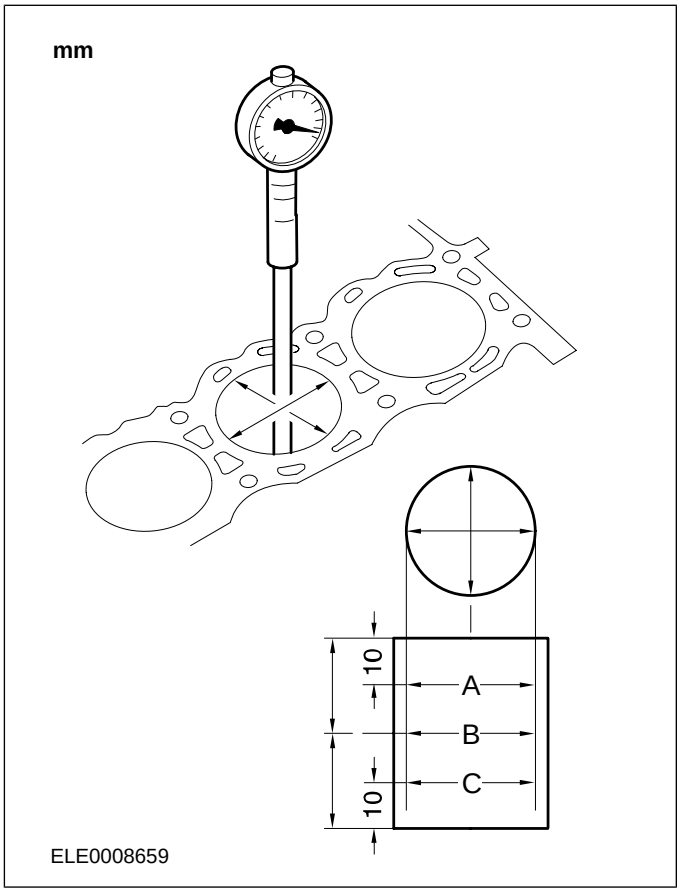
GENERAL PROCEDURES

Cylinder Bore Taper

1. **NOTE:The main bearing caps or lower crankcase must be in place and tightened to the specified torque; however, the bearing shells should not be installed.**

   Measure the cylinder bore with an internal micrometer.

   - Carry out the measurements in different directions and at different heights to determine if there is any out-of-roundness or tapering.
   - If the measurement is out of the specified range, install a new block or hone out the cylinder block (if aplicable/allowed).



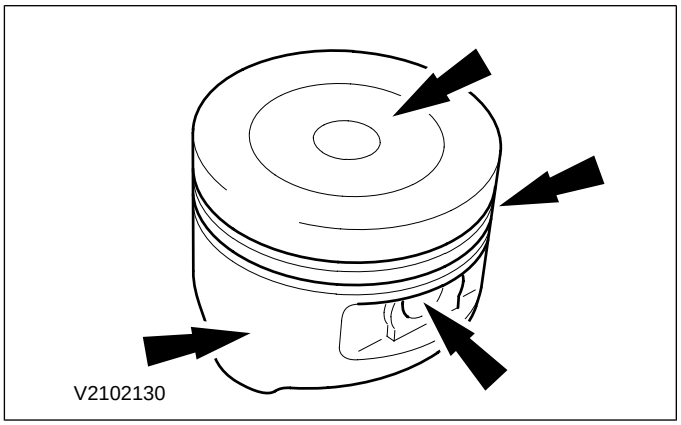
GENERAL PROCEDURES

Piston Inspection

1. **⚠CAUTION:Do not use any aggressive cleaning fluid or a wire brush to clean the piston.**

   Carry out a visual inspection.

   - Clean the piston skirt, pin bush, ring grooves and crown and check for wear or cracks.
   - If there are signs of wear on the piston skirt, check whether the connecting rod is twisted or bent.



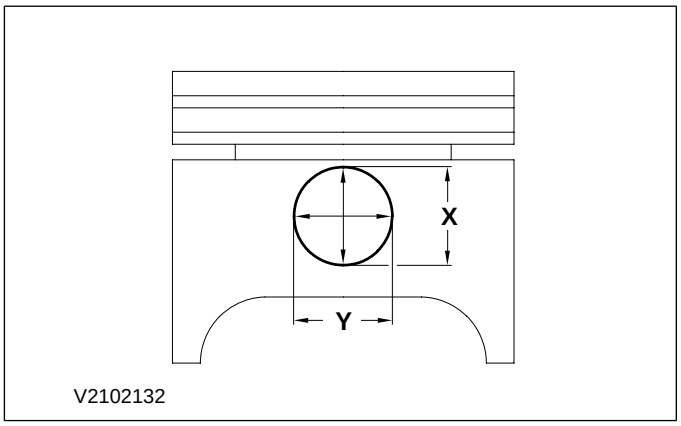
GENERAL PROCEDURES

Piston Pin to Bore Diameter

1. **NOTE:The piston and piston pin form a matched pair. Do not mix up the components.**

   Measure the diameter of the piston pin bore.

   - Measure the diameter in two directions.
   - If the values are not to specification, install both a new piston and a new piston pin.



GENERAL PROCEDURES

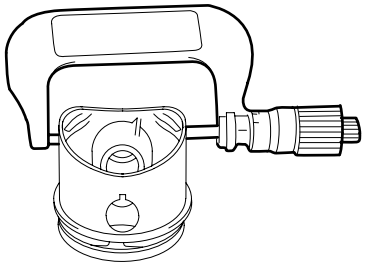
Piston Diameter

General Equipment

Micrometer

1. **NOTE:Mark the piston to make sure the piston is installed correctly.**

   Using a Micrometer measure the piston diameter.



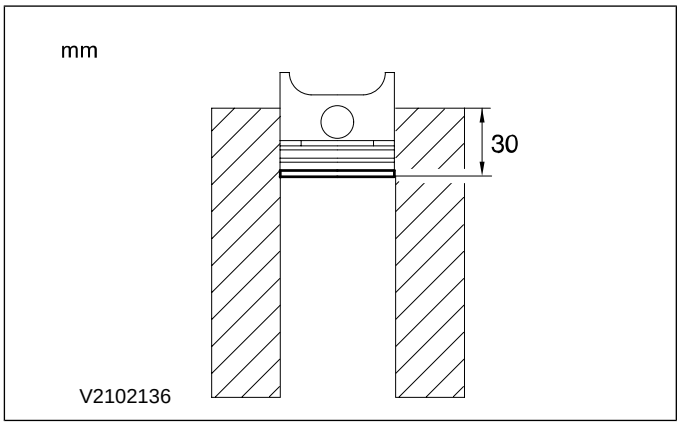
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GENERAL PROCEDURES

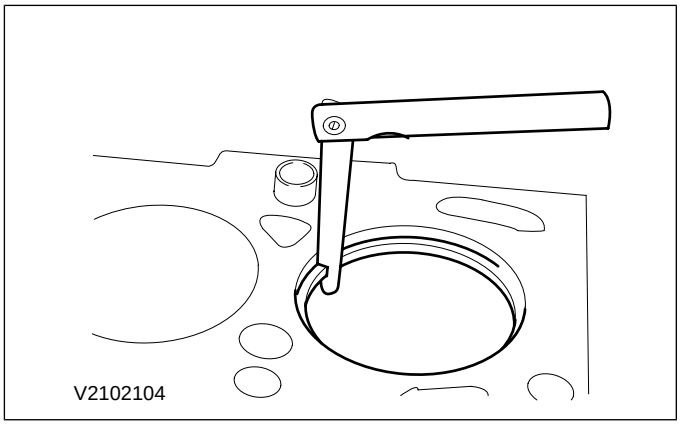
Piston Ring End Gap

1. **CAUTION:Do not mix up the piston rings. Install the piston rings in the same position and location.**

   Take the piston ring and use a piston without rings to push the piston ring about 30 mm into the cylinder bore.



2. **Using the Feeler Gauge, measure the piston ring gap.**



GENERAL PROCEDURES

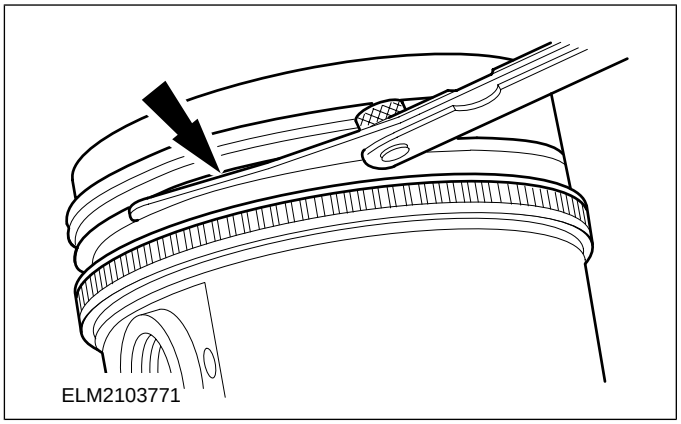
Piston Ring-to-Groove Clearance

General Equipment

Feeler Gauge

1. **NOTE:The piston ring must protrude from the piston groove. To determine the piston ring clearance, insert the Feeler Gauge right to the back of the groove, behind the wear ridge.**

   Using the Feeler Gauge , measure the piston ring clearance.



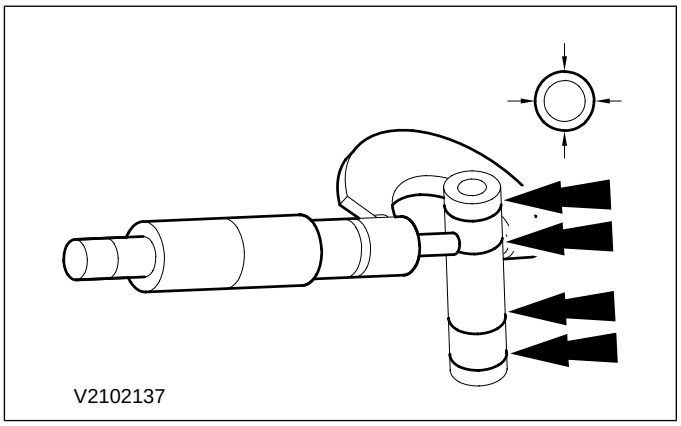
GENERAL PROCEDURES

Piston Pin Diameter

1. **NOTE:The piston and piston pin are a matched pair. Do not mix up the components.**

   Measure the piston pin diameter.

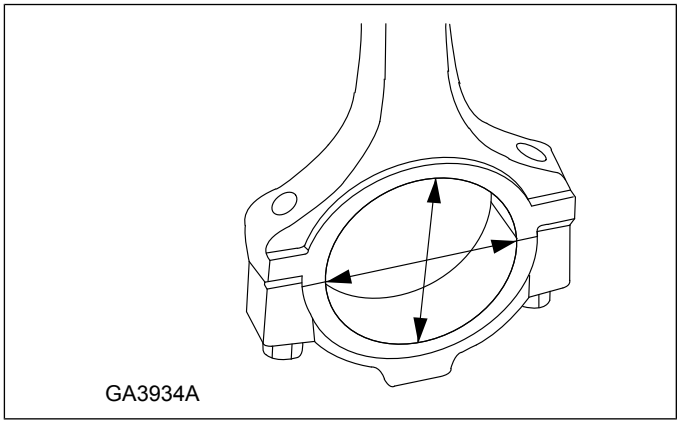
   - Measure the diameter in two directions.
   - If the values are not to specification, install a new piston and a new piston pin.



GENERAL PROCEDURES

Connecting Rod Large End Bore

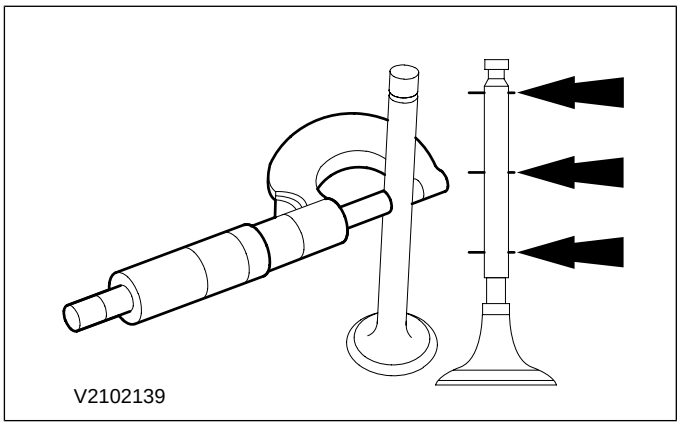
1. **Measure the bearing bore in two directions. The difference is the connecting rod bore out-of-round. Verify the out-of-round and the bearing bore is within specification.**



GENERAL PROCEDURES

Valve Stem Diameter

1. **Using a micrometer measure the diameter of the valve stems.**
   - If the measurements are not to specification, install a new valve.



GENERAL PROCEDURES

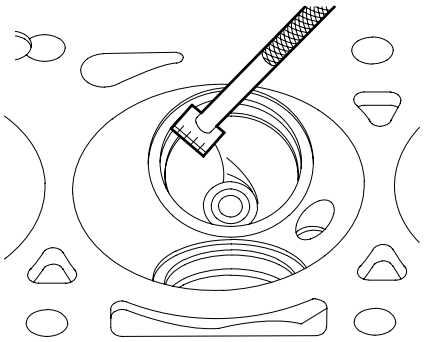
Valve Seat Inspection

General Equipment

Valve seat width scale

1. Measure the width of the valve seat.

- Measure the valve seat width using the Valve seat width scale.
- If the value is not to specification rework the valve seat.



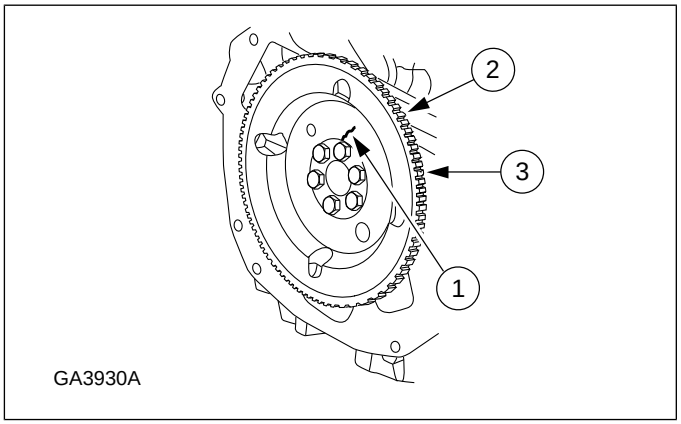
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GENERAL PROCEDURES

Flywheel Inspection

1. Inspect the flywheel. If there is evidence of the following, install a new flywheel.

1. Cracks.
2. Worn ring gear teeth.
3. Chipped or cracked ring gear teeth.



GENERAL PROCEDURES

Flywheel Inspection — Vehicles With: Dual Mass Flywheel

1. **Inspection details for the dual mass flywheel are contained in the Diagnosis and Testing procedure.For additional information, refer to:(308-00 Manual Transmission/Transaxle and Clutch - General Information)**

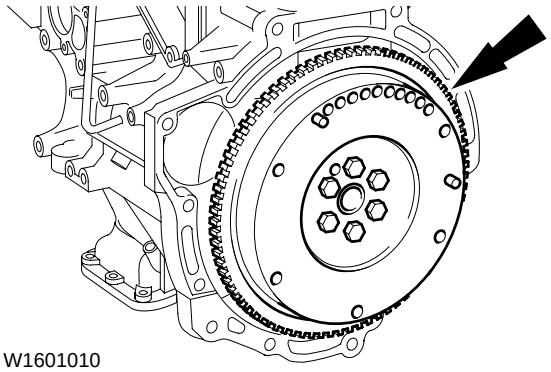
   Manual Transmission and Clutch - Vehicles With: MT-75 (Diagnosis and Testing),
   Manual Transaxle and Clutch - Vehicles With: VXT-75 (Diagnosis and Testing),
   Manual Transmission and Clutch - Vehicles With: MT82 (Diagnosis and Testing).

GENERAL PROCEDURES

Flywheel Clutch Surface Inspection

1. Check the flywheel for:

- burning
- grooves
- cracks
- Renew the flywheel if necessary.



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GENERAL PROCEDURES

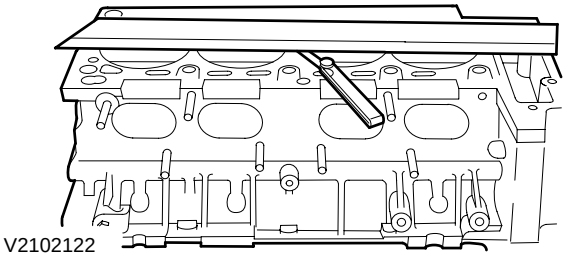
Cylinder Head Distortion

General Equipment

Feeler gauge
Straight edge

1. Using a straight edge and feeler gauge, measure the cylinder head distortion.

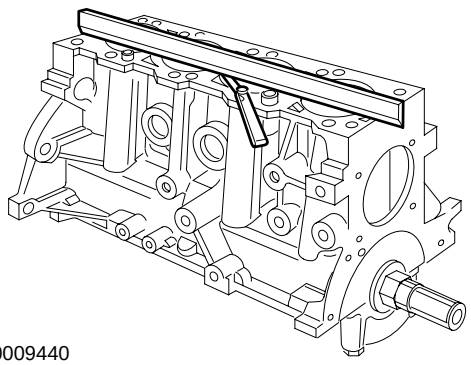
- Measure the mating face distortion.
- Refer to Specifications in the appropriate engine section.


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GENERAL PROCEDURES

Cylinder Block Distortion

1. **Using a Straight Edge and a Feeler Gauge, measure the cylinder block/cylinder head distortion.**
   - Measure the mating face distortion.
   - If the value is not to specification rework the mating face (if allowed).



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GENERAL PROCEDURES

Exhaust Manifold Cleaning and Inspection

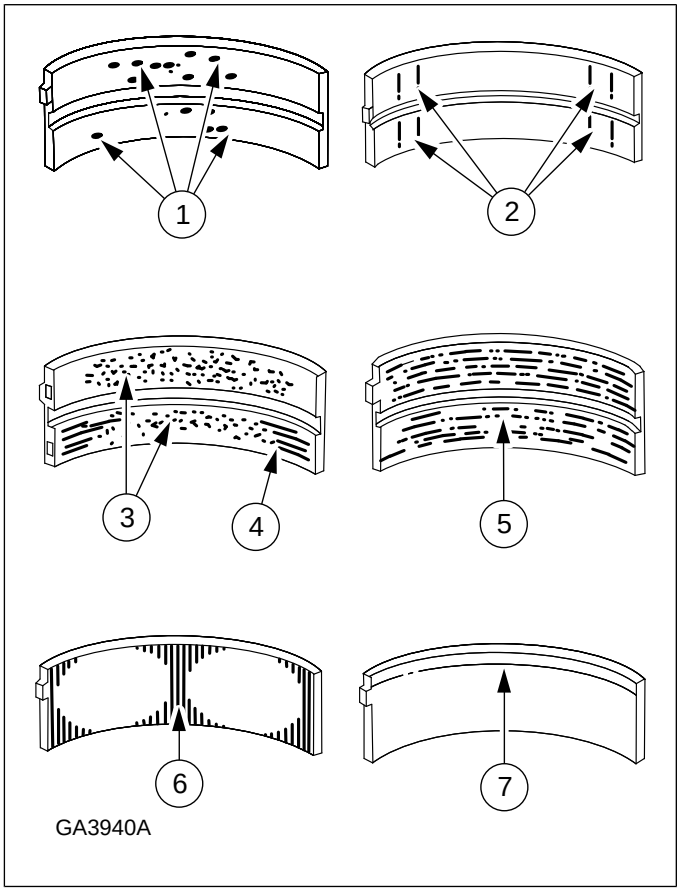
1. **Inspect the cylinder head joining flanges of the exhaust manifold for evidence of exhaust gas leaks.**
2. **Inspect the exhaust manifold for cracks, damaged gasket surfaces, or other damage that would make it unfit for further use.**

GENERAL PROCEDURES

Bearing Inspection

1. Inspect bearings for the following defects.

1. Cratering - fatigue failure
2. Spot polishing - incorrect seating.
3. Imbedded dirt engine oil.
4. Scratching - dirty engine oil.
5. Base exposed - poor lubrication.
6. Both edges worn - journal damaged.
7. One edge worn - journal tapered or bearing not seated.



SECTION 303-01A Engine — 2.4L Duratorq-TDCi (Puma) Diesel

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 303-01A-3
- Engine Data — 100 PS 303-01A-3
- Engine Data — 115 PS 303-01A-3
- Engine Data — 140 PS 303-01A-3
- Engine Oil Capacity 303-01A-4
- Cylinder Block Dimensions 303-01A-4
- Piston Dimensions 303-01A-4
- Crankshaft Dimensions 303-01A-4
- Connecting Rod Dimensions 303-01A-5
- Piston Pin Dimensions 100 PS 303-01A-5
- Piston Pin Dimensions 115 PS and 140 PS 303-01A-5
- Camshaft Dimensions 303-01A-5
- Valve Dimensions 303-01A-5
- Cylinder Head Dimensions 303-01A-5
- Oil Pressure Specifications 303-01A-6

DESCRIPTION AND OPERATION

Engine 303-01A-7

DIAGNOSIS AND TESTING

Engine 303-01A-11

IN-VEHICLE REPAIR

Intake Manifold ..... (21 183 0) 303-01A-12
Valve Cover ..... (21 141 0) 303-01A-13
Crankshaft Front Seal ..... (21 467 0) 303-01A-14
Engine Front Cover ..... (21 148 0) 303-01A-16
Valve Springs 303-01A-21
Valve Seals ..... (21 238 0) 303-01A-23
Valves ..... (21 215 4) 303-01A-24
Camshafts ..... (21 284 0) 303-01A-26
Exhaust Manifold ..... (21 187 0) 303-01A-31
Cylinder Head ..... (21 163 0) 303-01A-33
Oil Pan ..... (21 154 0) 303-01A-37
Oil Pump ..... (21 714 0) 303-01A-39
Crankshaft Rear Seal ..... (21 468 4) 303-01A-41

REMOVAL

Engine 303-01A-43

DISASSEMBLY

Engine 303-01A-48

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

Cylinder Head ..... (21 165 6) 303-01A-55

ASSEMBLY

Engine 303-01A-57

INSTALLATION

Engine 303-01A-65

SPECIFICATIONS

Engine Data — 100 PS

Description	
Code	PHFA
Firing order	1-3-4-2
Bore diameter	89.9 mm
Stroke	94.6 mm
Displacement	2402 cc
Compression ratio	17.5:1
Power output at 3500 rpm	74 kW (100 PS)
Torque between 1600 to 2200 rpm	285 Nm
Idle speed	750 rpm
Maximum oil consumption	0.1L /1000 Km

Engine Data — 115 PS

Description	
Code	JXFA
Firing order	1-3-4-2
Bore diameter	89.9 mm
Stroke	94.6 mm
Displacement	2402 cc
Compression ratio	17.5:1
Power output at 3500 rpm	85 kW (115 PS)
Torque between 1750 to 2000 rpm	310 Nm
Idle speed	750 rpm
Maximum oil consumption	0.1L /1000 Km

Engine Data — 140 PS

Description	
Code	H9FB
Firing order	1-3-4-2
Bore diameter	89.9 mm
Stroke	94.6 mm
Displacement	2402 cc
Compression ratio	17.5:1
Power output at 3500 rpm	103 kW (140 PS)
Torque between 2000 to 2250 rpm	375 Nm
Idle speed	750 rpm
Maximum oil consumption	0.1L /1000 Km

SPECIFICATIONS

Engine Oil Capacity

Description	Liters
Initial fill including oil filter	7.20
Service fill including oil filter	6.86

Cylinder Block Dimensions

Description	mm
Cylinder bore diameter — Class 1	89.900 - 89.910
Cylinder bore diameter — Class 2	89.910 - 89.920
Cylinder bore diameter — Class 3	89.920 - 89.930
Main bearing shells 1 to 4 inner diameter — bearings installed	65.003 - 65.030
Main bearing shell 5 inner diameter — bearings installed	70.004- 70.033
Main bearings 1 to 4 radial clearance	0.005 - 0.051
Main bearing 5 radial clearance	0.004 - 0.054
Main bearings 1 to 4 parent bore diameter — vertical measurement	69.504 - 64.520
Main bearing 5 parent bore diameter — vertical measurement	74.504 - 74.520
Main bearings 1 to 4 parent bore diameter — horizontal measurement	69.502 - 69.525
Main bearing 5 parent bore diameter — horizontal measurement	74.502 - 74.525

Piston Dimensions

Description	mm
Piston diameter — Class 1	89.84 - 89.85
Piston diameter — Class 2	89.85 - 89.86
Piston diameter — Class 3	89.86 - 89.87
Piston clearance in cylinder	0.05 - 0.07
Piston ring end gaps	
— upper compression ring	0.25 - 0.40
— lower compression ring	0.50 - 0.75
— oil control ring	0.25 - 0.50
Piston ring gap position: The piston ring end gaps must be distributed evenly around the circumference of the piston. This also applies to the oil control ring elements. Align the piston ring end gaps at 120 degrees to each other.	

Crankshaft Dimensions

Description	mm
Main bearing journal end float	0.090 - 0.305
Main bearing journals 1 to 4 diameter	64.950 - 64.970
Main bearing journal 5 diameter	69.950 - 69.970
Connecting rod bearing journal diameter	52.980 - 53.000

SPECIFICATIONS

Connecting Rod Dimensions

Description	mm
Large end bore diameter	55.096 - 56.015
Small end bore diameter	30.010 - 30.018
Connecting rod bearing shell inner diameter — bearings installed	53.017 - 53.043
Connecting rod bearing radial clearance	0.034 - 0.100
Connecting rod bearing axial clearance	0.100 - 0.320

Piston Pin Dimensions 100 PS

Description	mm
Piston pin length	66.00
Piston pin diameter	32.000
Piston pin slide clearance	0.008 - 0.018

Piston Pin Dimensions 115 PS and 140 PS

Description	mm
Piston pin length	70.95
Piston pin diameter	32.000
Piston pin slide clearance	0.008 - 0.018

Camshaft Dimensions

Description	mm
Camshaft end float	0.014 - 0.200
Camshaft bearing journal diameter	26.450
Camshaft bearing clearance — radial measurement	0.065

Valve Dimensions

Description	mm
Valve stem to valve guide clearance — intake valve	0.045
Valve stem to valve guide clearance — exhaust valve	0.055

Cylinder Head Dimensions

Description	mm
Maximum distortion — measured longitudinally and diagonally	0.10
Peak to valley height of mating surface	0.02
Cylinder head gasket thickness	
Piston protrusion of 0.310 - 0.400 mm	1.1 (one hole/tooth)
Piston protrusion of 0.401 - 0.450 mm	1.15 (two holes/teeth)
Piston protrusion of 0.451 - 0.500 mm	1.2 (three holes/teeth)

SPECIFICATIONS

Oil Pressure Specifications

Description	bar
Minimum oil pressure at idle speed	1.25
Minimum oil pressure at 2000 rpm	2.0

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Ford Formula E SAE 5W-30 engine oil	WSS-M2C913-B
Sealer — oil pan, camshaft carrier and engine front cover	WSE-M4G323-A4

DESCRIPTION AND OPERATION

Engine

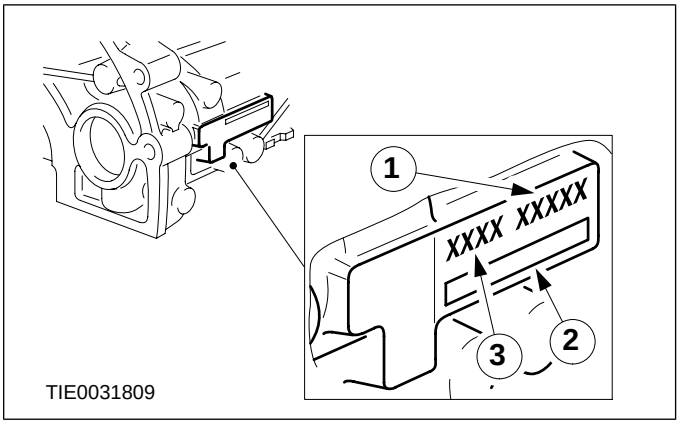
General view

- The 2.4L Duratorq-TDCi (Puma) diesel engine is available in three different power output versions: 74 kW (100 PS), 85 kW (115 PS) and 103 kW (140 PS).
- The 2.4L engines are equipped with the Denso common rail fuel system.
- The service interval is 25,000 km or one year for all versions other than the 140 PS version.
- The service interval for the 140 PS version is 50,000 km or two years. A service interval indicator in the instrument cluster alerts the driver when servicing is required.
- The 74 kW (100 PS) version is the entry-level version for the rear wheel drive vehicles.
- The 85 kW (115 PS) version additionally has oil spray nozzles for cooling the piston crowns as well as fuel injector nozzles with an increased flow rate.
- The 103 kW (140 PS) version has an electrical actuator for turbocharger guide vane adjustment, an oil level/temperature sensor as well as a centrifugal oil filter.

Engine identification code

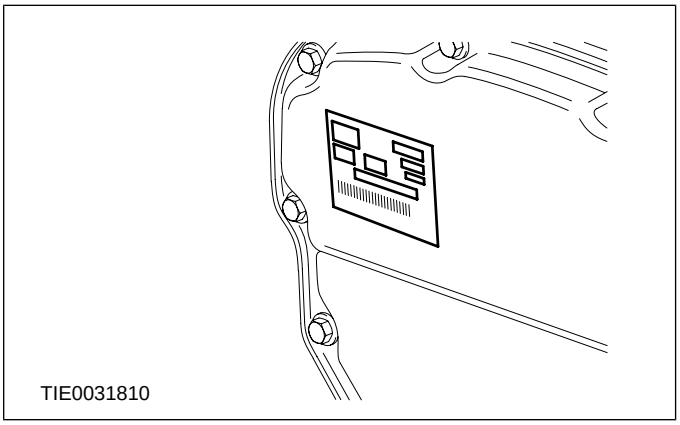
On the 2.4L engine the engine code (4 digits) and the engine serial number (2 letters for the year and month and 5 figures for the serial number) are stamped in the cylinder block on the exhaust side (in line with cylinder No. 4).

If the engine or cylinder block is changed, the vehicle identification number must be stamped in the indicated location.



Item	Description
1	Engine serial number
2	Vehicle identification number
3	Engine code

Engine identification plate



The engine identification plate is located on the cover of the timing cover. It contains the following data:

- date and time of manufacture
- engine part number

Engine management

Visteon

Engine emission control

Meets emission standard Stage IV

Electrical Exhaust Gas Recirculation (EGR) valve with water cooling

Diagnostics

Worldwide Diagnostic System (WDS)

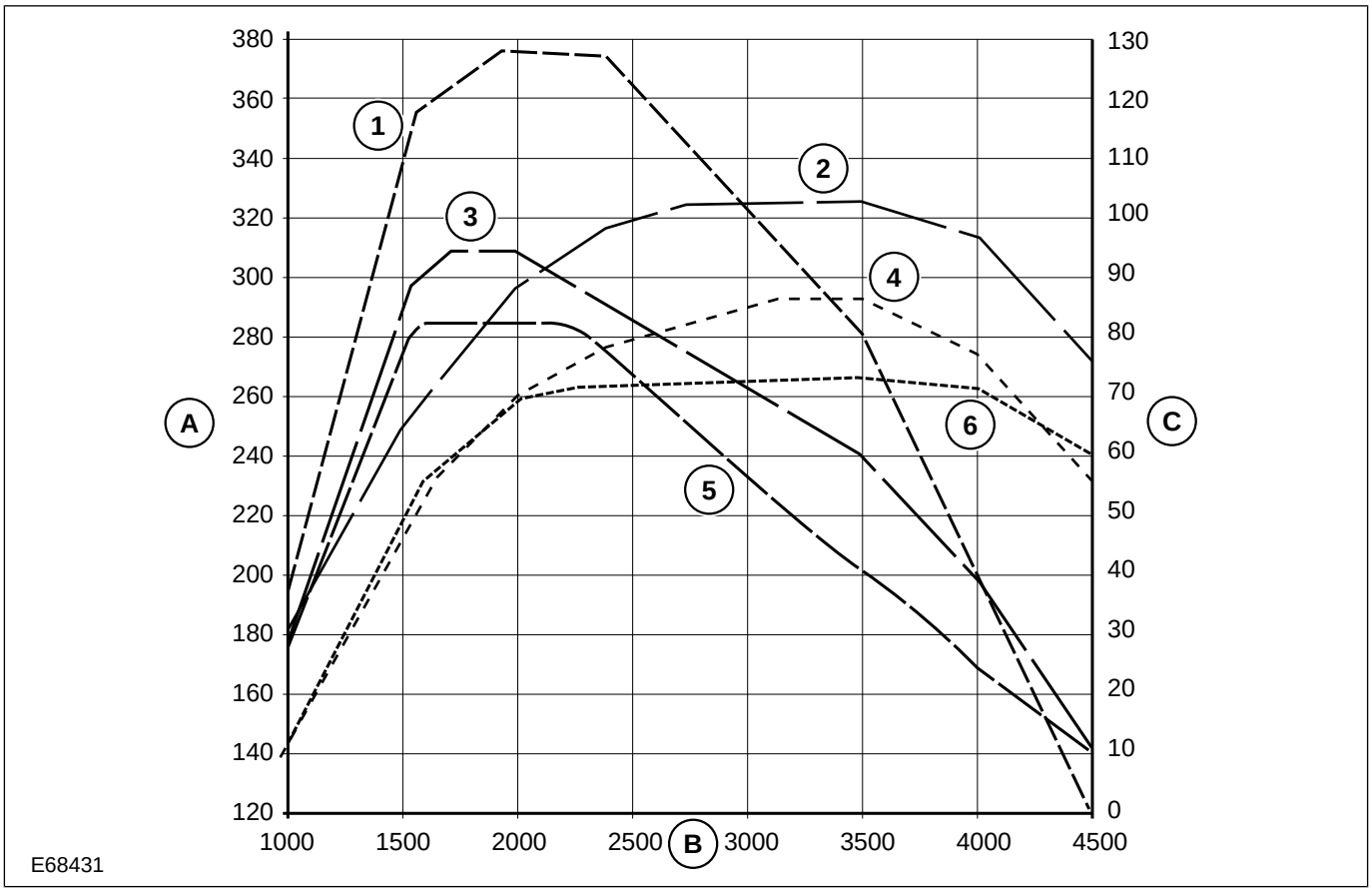
DESCRIPTION AND OPERATION

Technical data

2.4L Duratorq-TDCi (Puma) Diesel	
Engine code 74 kW (100 PS)	PHFA
Engine code 85 kW (115 PS)	JXFA
Engine code 103 kW (140 PS)	H9FB
Cubic capacity	2,402 cc
Stroke	94.6 mm
Bore diameter	89.9 mm
Compression ratio	17.5:1

2.4L Duratorq-TDCi (Puma) Diesel	
Firing order	1-3-4-2
Engine idle speed	750 rpm
Max. power output, torque	74 kW (100 PS) at 3,500 rpm, 285 Nm at 1,600 rpm
Max. power output, torque	85 kW (115 PS) at 3,500 rpm, 310 Nm at 1,750 rpm
Max. power output, torque	103 kW (140 PS) at 3,500 rpm, 375 Nm at 2,000 rpm
Fuel	Diesel

Power and torque curves



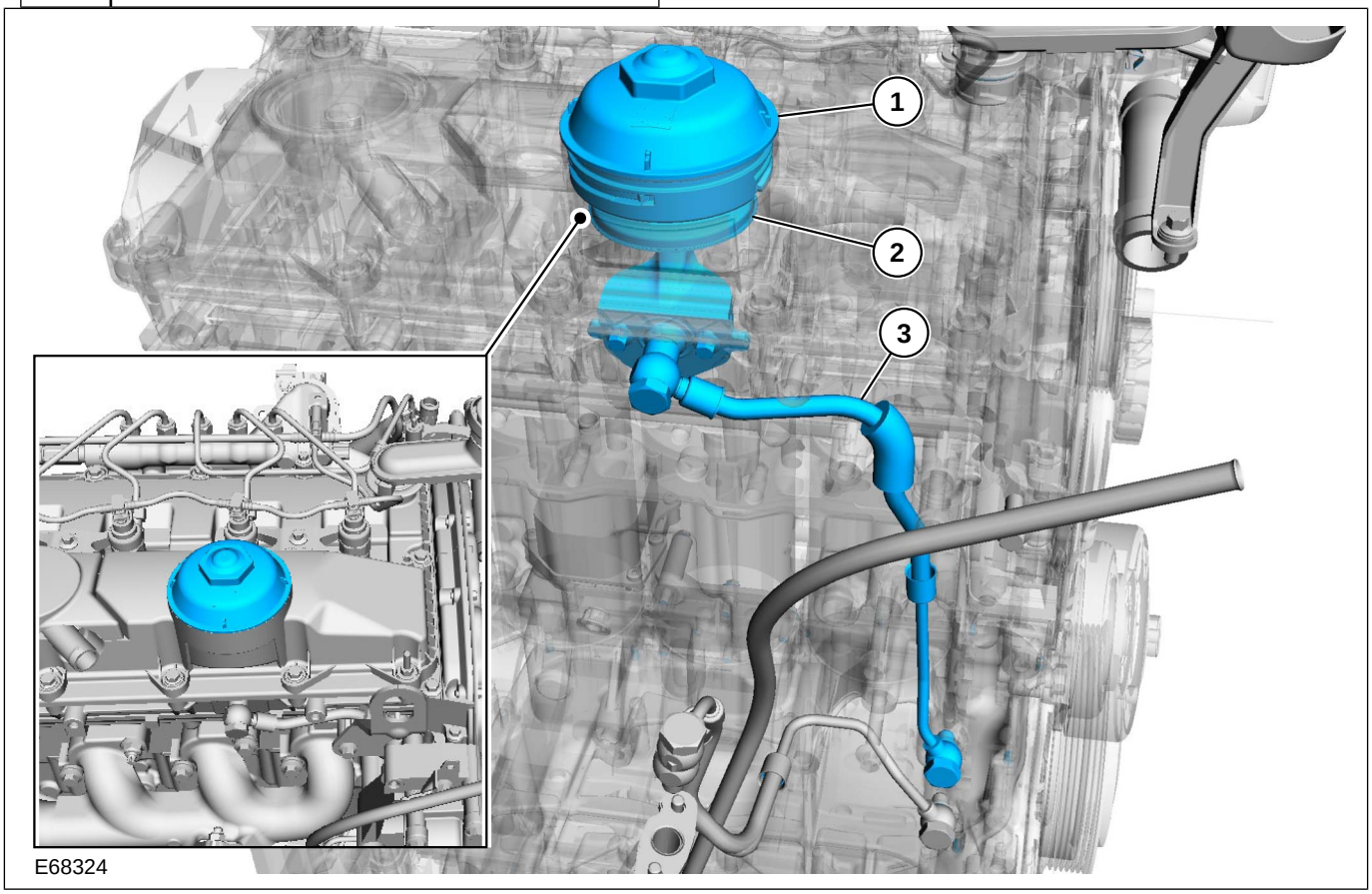
Item	Description
A	Torque (Nm)
B	Engine speed (rpm)
C	Power output (kW)
1	Torque curve for 103 kW (140 PS) engine

Item	Description
2	Power curve for 103 kW (140 PS) engine
3	Torque curve for 85 kW (115 PS) engine
4	Power curve for 85 kW (115 PS) engine

DESCRIPTION AND OPERATION

Item	Description
5	Torque curve for 74 kW (100 PS) engine
6	Power curve for 74 kW (100 PS) engine

Centrifugal oil filter (140 PS version only)



E68324

Item	Description
1	Cover cap
2	Centrifuge (under the valve cover)
3	Oil pressure line to the centrifugal oil filter

The 140 PS version of the 2.4L Duratorq-TDCi (Puma) diesel engine has a centrifugal oil filter that in conjunction with the oil level/temperature sensor facilitates a service interval of up to 50,000 km.

The centrifugal oil filter is located in the cylinder head and comprises:

– a cover cap (in the valve cover)
– a replaceable rotor (filter element)

The oil from the oil pan is pumped into the rotor via an additional pressure line installed on the outside of the engine block. Inside the rotor is a pivot axis with two outlet openings on opposite sides.

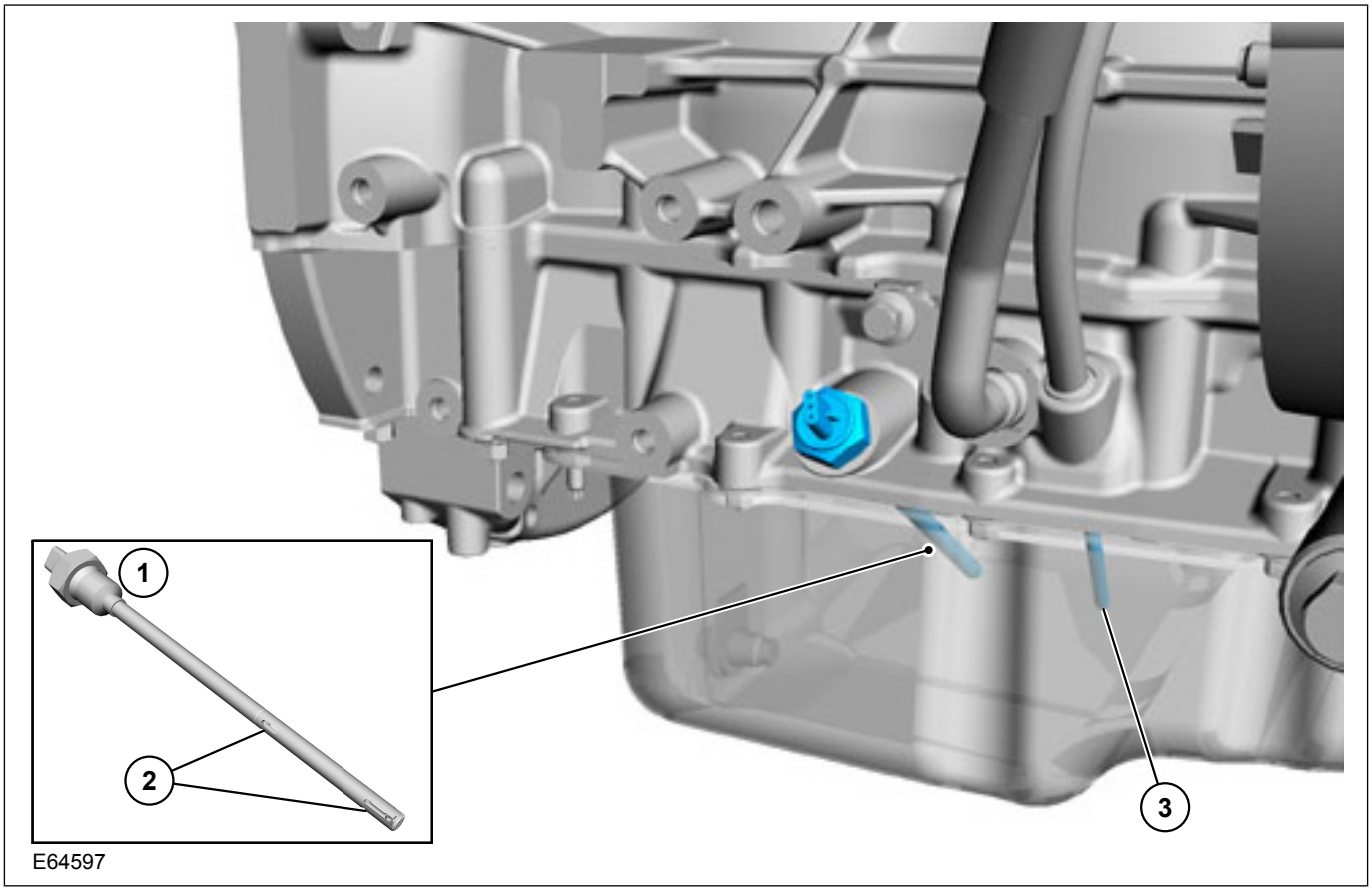
The oil pressure and the shape of the rotor cause this pivot axis to turn, forcing the oil in the rotor outwards. The centrifugal force presses the particles floating in the oil (contamination) against the outer wall of the rotor, where they form a solid mass.

The oil in the rotor is filtered in this manner and then flows back into the oil circuit.

The centrifugal oil filter can even catch small particles of dirt that cannot be filtered using normal oil filters. This increases the service life of the oil.

Oil level/temperature sensor (140 PS version only)

DESCRIPTION AND OPERATION



E64597

Item	Description
1	Oil level/temperature sensor
2	Openings
3	Engine oil dipstick

An oil level/temperature sensor located on the front of the engine directly beside the engine oil dipstick is provided for the service interval indicator.

A wire coil that is fitted inside the sensor and continuously supplied with current is used to measure the oil level.

The resistance of the wire coil changes according to how deeply the sensor is immersed in the oil. The measurement values are registered by the Powertrain Control Module (PCM).

The change in the voltage drop serves as an input variable for calculating the oil level.

The oil temperature is sensed simultaneously via the integrated temperature sensor. The temperature is used as a corrective factor in the calculation.

The PCM calculates the next oil change on the basis of an integrated strategy (which also takes into consideration the mileage and engine operating conditions) and displays it in the instrument panel.

In addition, a separate indicator in conjunction with a corresponding message in the instrument cluster display warns the driver when the oil quantity falls below the minimum level.

Service instruction

The interval indicator must be reset after an oil change on all vehicles with a diesel engine.

In the case of the 103 kW (140 PS) version it must be ensured that the vehicle is standing on a flat surface.

DIAGNOSIS AND TESTING

Engine

REFER to Section 303-00 [Engine System - General Information].

IN-VEHICLE REPAIR

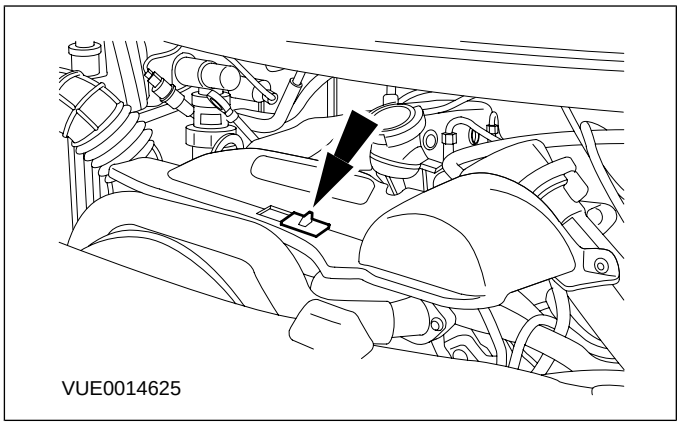
Intake Manifold (21 183 0)

Removal

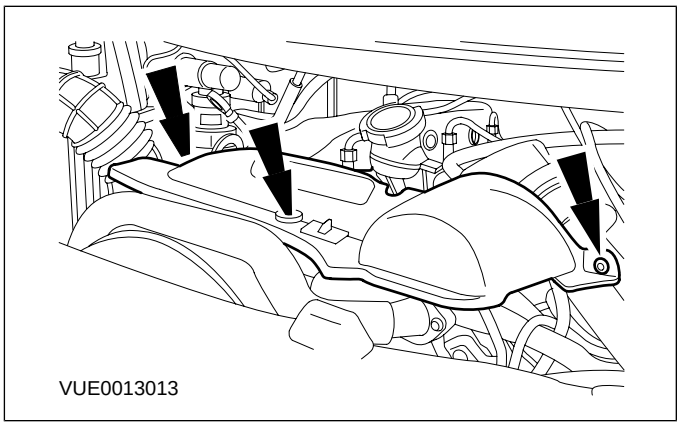
1. Disconnect the battery ground cable.

   For additional information, refer to: Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

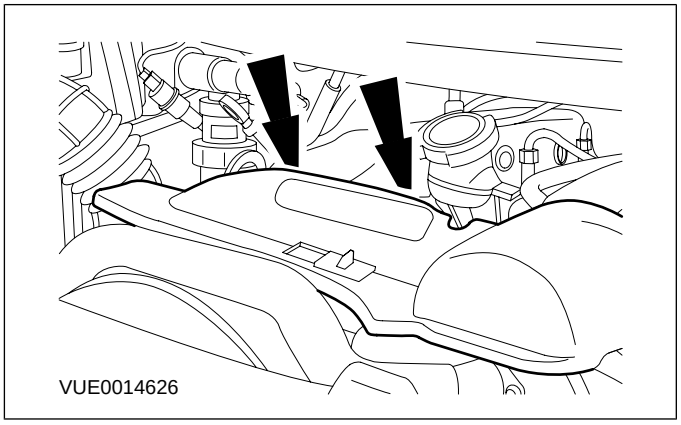
2. Slide open the bolt cover.



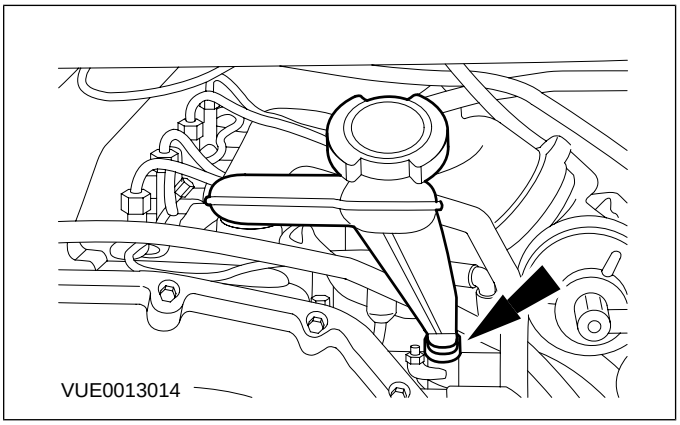
3. Remove the accessory drive belt shield retaining bolts.



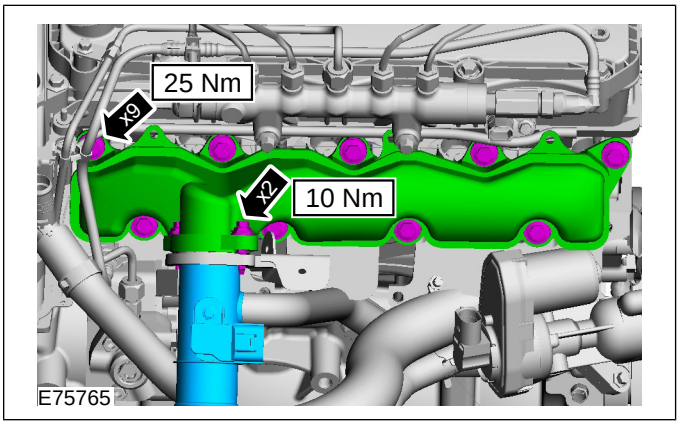
4. Detach the fuel charging wiring harness and remove the accessory drive belt shield.



5. Remove the engine oil filler pipe.



6. Remove the intake manifold.



Installation

1. NOTE: Install a new intake manifold gasket.

   To install, reverse the removal procedure.

IN-VEHICLE REPAIR

Valve Cover (21 141 0)

General Equipment

Pneumatic Vacuum Gun

Removal

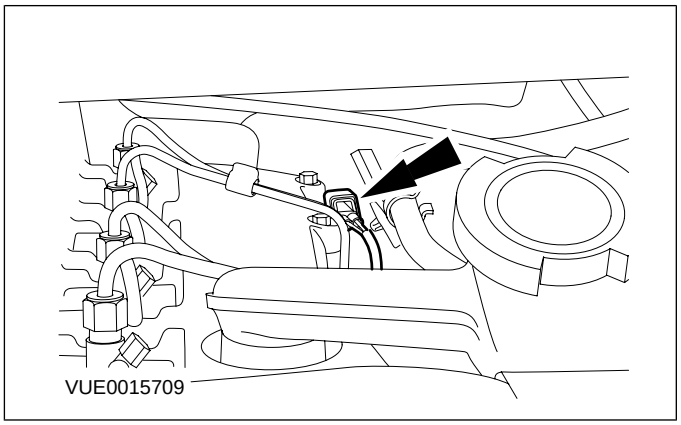
WARNING:Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may ignite. Failure to follow these instructions may result in personal injury.

CAUTION:Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install blanking plugs to any open orifices or lines.

1. **Remove the fuel injectors.**

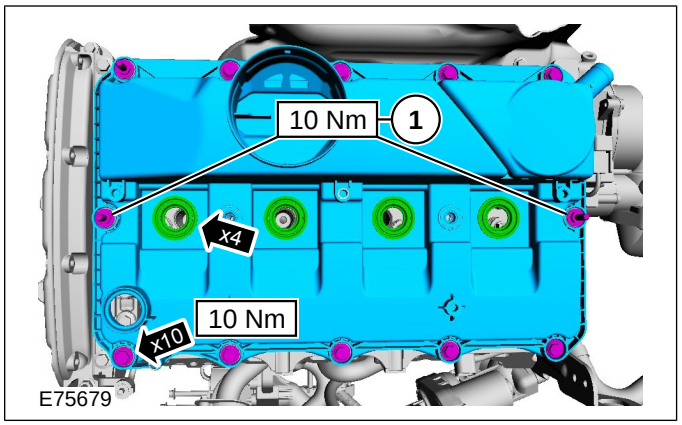
   For additional information, refer to:Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).

2. **Disconnect the cylinder head temperature (CHT) sensor electrical connector.**



3. **Remove the valve cover.**

1. Discard the studs.



Installation

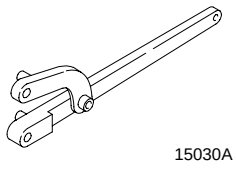
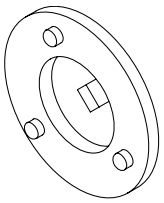
1. **NOTE:Install a new valve cover gasket as necessary.**

   To install reverse the removal procedure.

IN-VEHICLE REPAIR

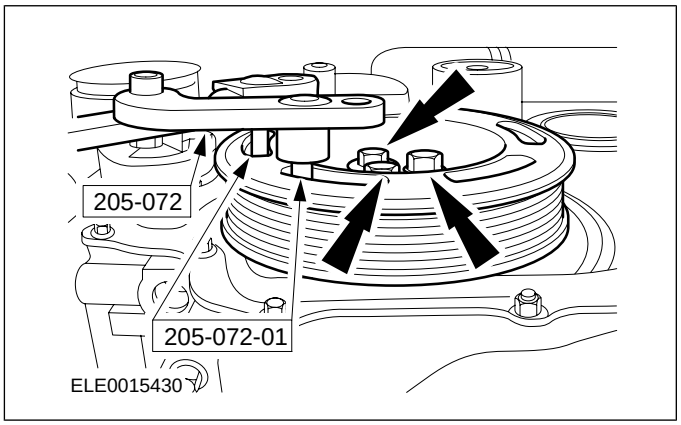
Crankshaft Front Seal (21 467 0)

Special Tool(s)

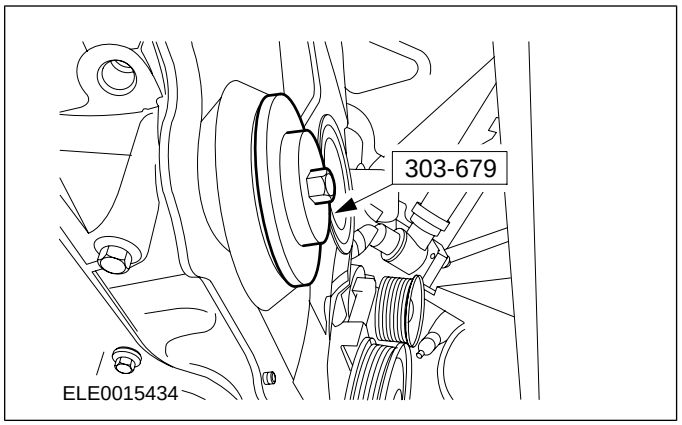
	Flange Holding Wrench, Universal 205-072 (15-030A)
	Remover/Installer, Crankshaft Front Oil Seal 303-679 (21-238)

Removal

1. **Remove the accessory drive belt. For additional information, refer to Section 303-05 [Accessory Drive].**
2. **Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].**
3. **Using the special tool, remove the crankshaft pulley.**



4. **Using the special tool, remove the crankshaft front oil seal.**
   - Discard the seal.

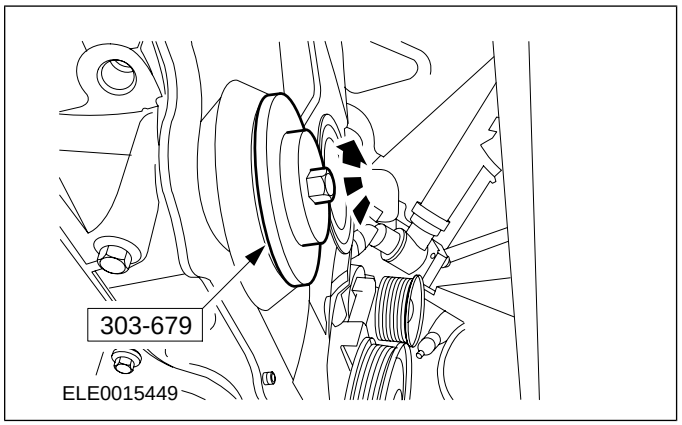


Installation

1. **NOTE:Install a new crankshaft front oil seal.**

NOTE:A new crankshaft front oil seal is supplied with an alignment sleeve that will be pushed out during installation.

Using the special tool, install the crankshaft front oil seal.



2. **⚠CAUTION:Crankshaft pulley retaining bolts must only be used three times.**

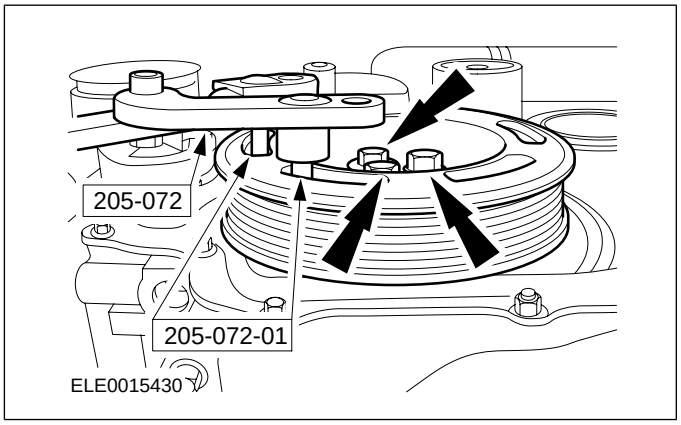
NOTE: Stamp the crankshaft pulley retaining bolt heads with a center punch to indicate usage.

Using the special tool, install the crankshaft pulley.

- Tighten the bolts in two stages.
- Stage 1: 30 Nm.

IN-VEHICLE REPAIR

- Stage 2: 95 degrees.

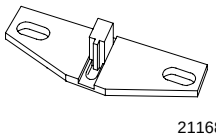
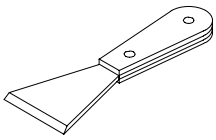
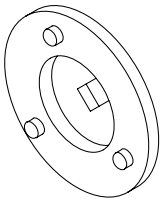
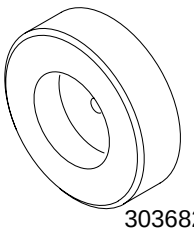
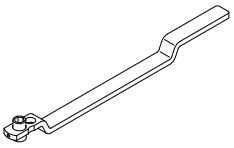


3. **Lower the vehicle.**
4. **Install the accessory drive belt. For additional information, refer to Section 303-05 [Accessory Drive].**

IN-VEHICLE REPAIR

Engine Front Cover (21 148 0)

Special Tool(s)

 21168	Lockin Tool, Flywheel 303-393
 21179	Separator, Oil Pan 303-428 (21-179)
 303679	Remover/Installer Crankshaft Front Oil Seal 303-679
 303682	Aligner, Front Cover 303-682
 E62044	Holding Wrench, Crankshaft 303-1177

General Equipment

Spatula
Two M10 x 60 mm locating studs

Materials

Name	Specification
Sealer	WSE-M4G323-A4

Removal

1. **Drain the cooling system. For additional information, refer to:(303-03 Engine Cooling)**

   Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (General Procedures),
   Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (General Procedures).

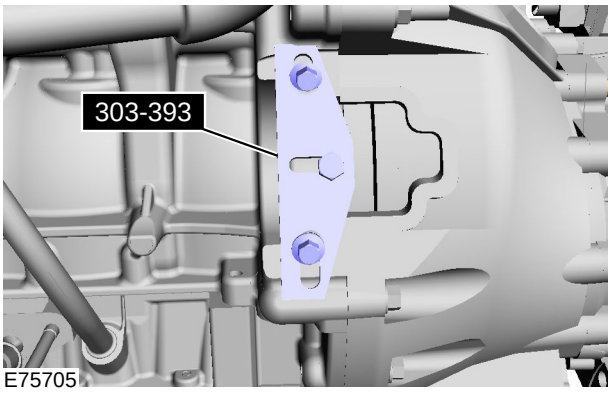
2. **Remove the cooling fan motor and shroud.**

   For additional information, refer to:Cooling Fan Motor and Shroud (303-03 Engine Cooling, Removal and Installation).

3. **Remove the starter motor.**

   For additional information, refer to:Starter Motor - 2.4L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation).

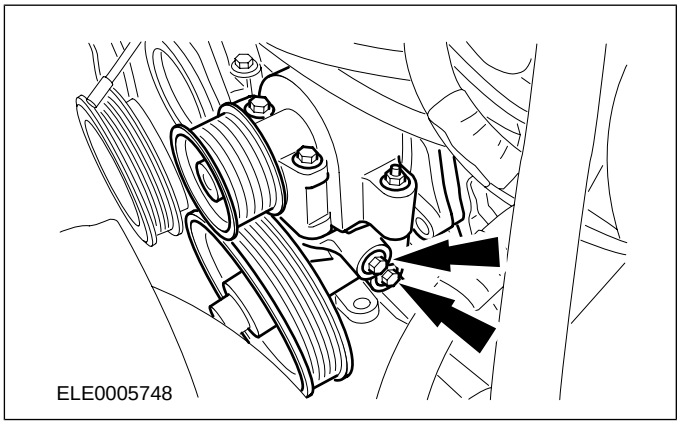
4. **Install the special tool.**



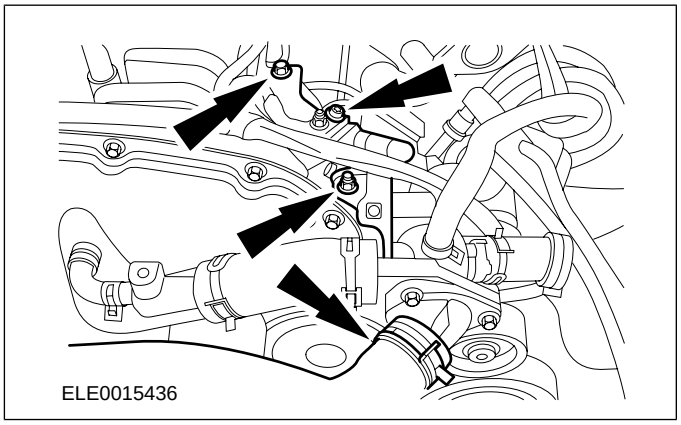
5. **Detach the water pump and the brake vacuum pump from the engine and position them to one side (four bolts).**

IN-VEHICLE REPAIR

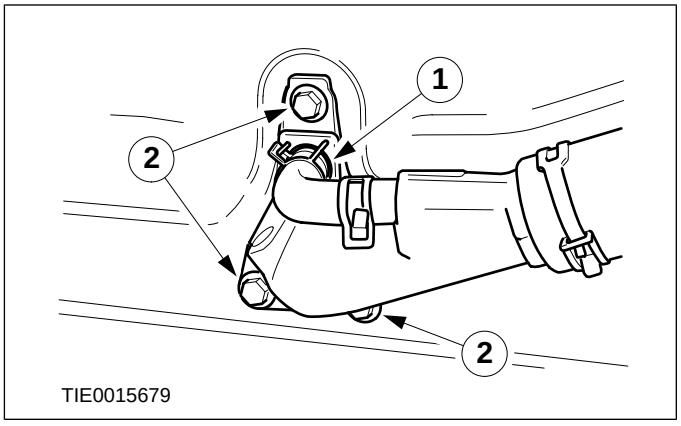
- Discard the gasket.



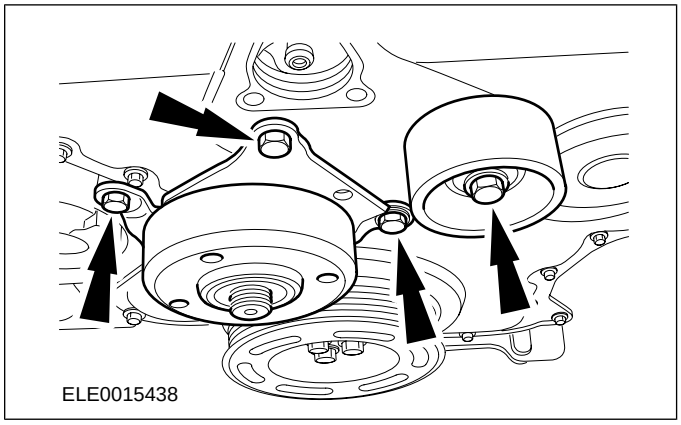
6. **Detach the thermostat housing support bracket from the cylinder head and disconnect the radiator upper hose from the thermostat housing.**



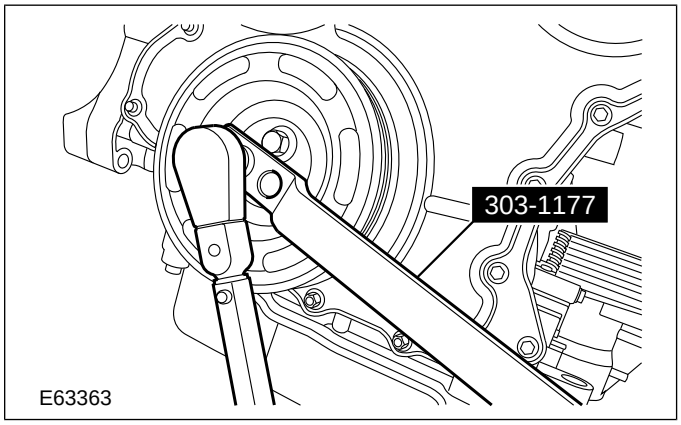
7. **Disconnect the coolant outlet and degas connector from the engine.**
   1. Disconnect the degas hose.
   - Discard the hose.
   2. Remove the bolts.
   - Discard the O-ring seal.



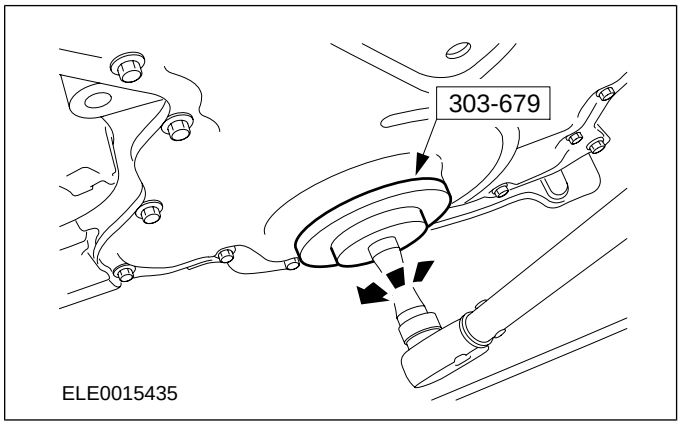
8. **Remove the accessory drive belt idler pulley and the cooling fan pulley.**



9. **Using the special tool, remove the crankshaft pulley.**



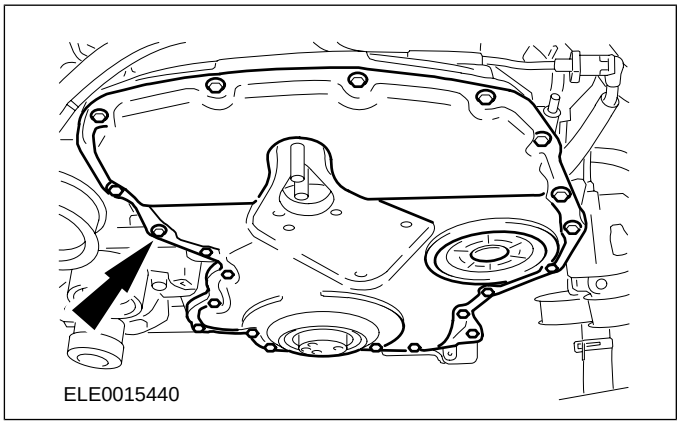
10. **Using the special tool, remove the crankshaft front oil seal.**
    - Discard the seal.



11. **Remove the engine front cover nuts and bolts.**
    - 2 nuts.

IN-VEHICLE REPAIR

- 20 bolts.

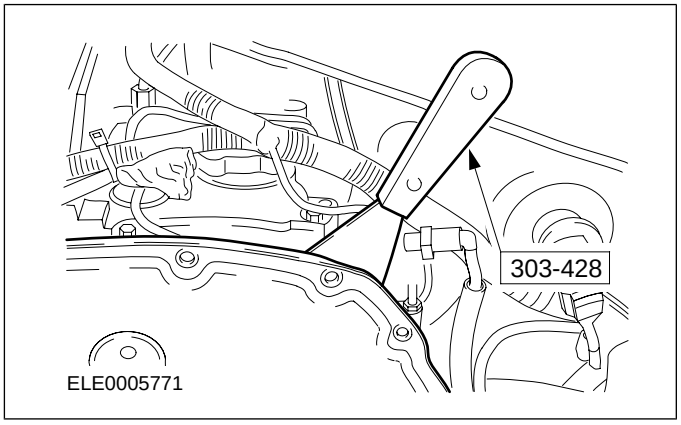


12. **NOTE:Lubricate the spatula with clean engine oil.**

NOTE: Engine front cover can be distorted during removal.

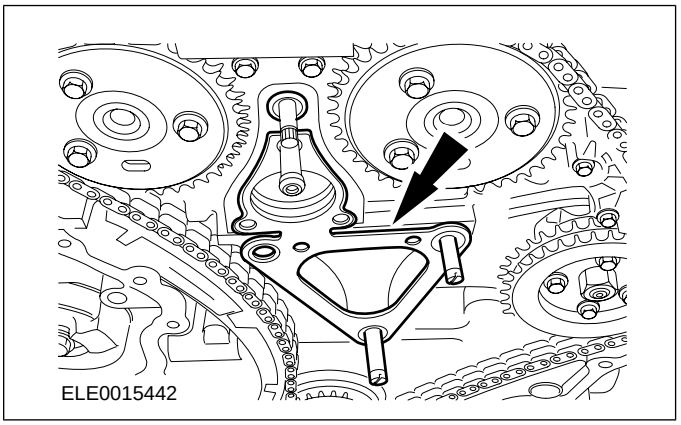
Using the special tool and a spatula, separate the engine front cover from the engine.

- Insert the special tool between the engine front cover and the engine, slide the special tool counterclockwise, make enough room for the spatula and return the special tool to the original position.
- Slide the spatula counterclockwise around the engine front cover, cutting the silicone gasket.
- Remove and discard the engine front cover.



Installation

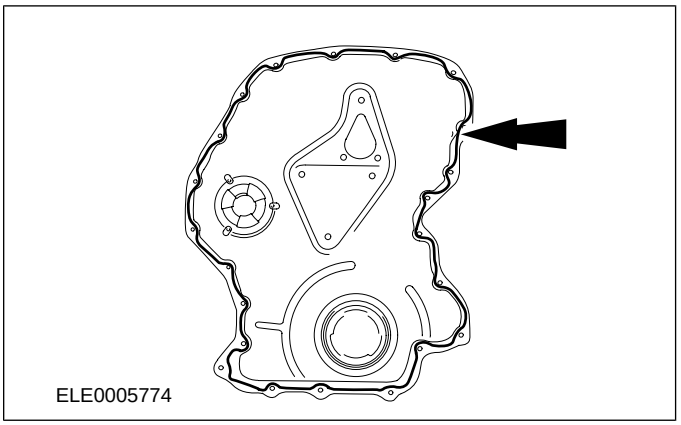
1. **Clean the mating faces of the engine and the engine front cover.**
2. **Install two M10 x 60 mm locating studs to the cylinder block to aid installation of the engine front cover gasket.**
3. **Install a new engine front cover gasket.**



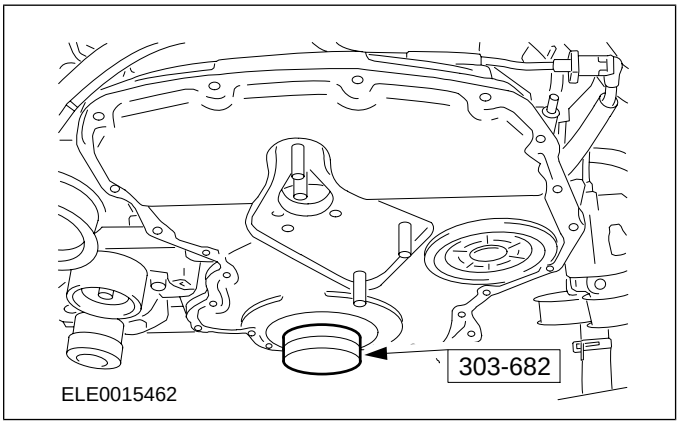
4. **⚠CAUTION:Install the engine front cover within five minutes of applying the sealer.**

NOTE: Install a new engine front cover.

Apply a 3 mm diameter bead of sealer to the engine front cover.



5. **Using the special tool, install the engine front cover.**

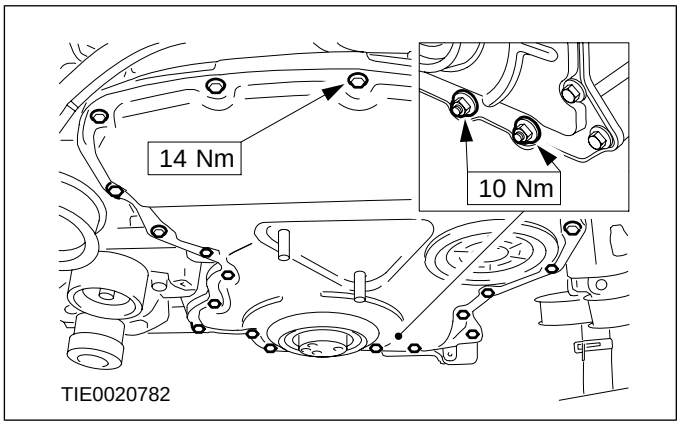


6. **Remove the locating studs.**
7. **⚠CAUTION:Install new M6 x 16 mm engine front cover bolts, if necessary.**

IN-VEHICLE REPAIR

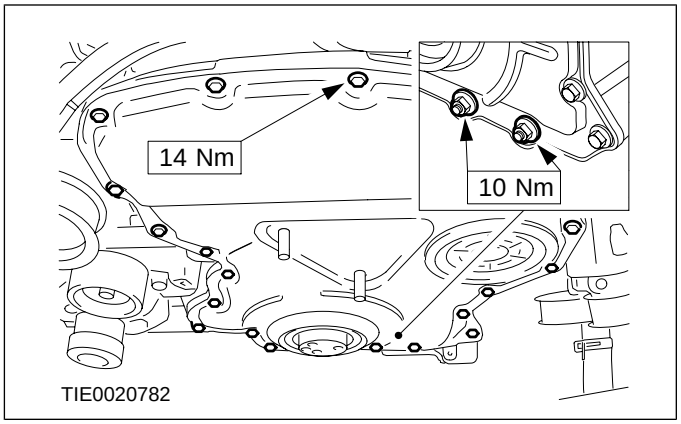
Install the engine front cover nuts and bolts.

- 2 nuts.
- 20 bolts.



8. Install the engine front cover nuts and bolts.

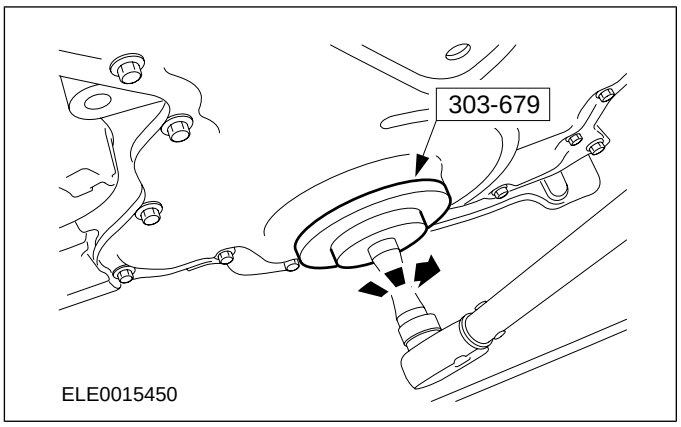
- 2 nuts.
- 20 bolts.



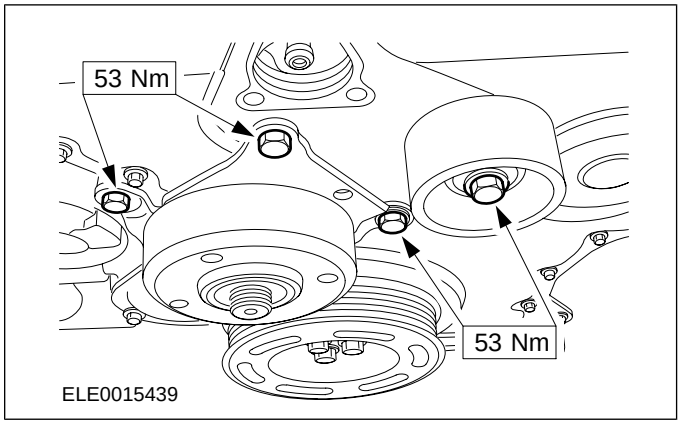
9. NOTE:Install a new crankshaft front oil seal.

NOTE:A new crankshaft front oil seal is supplied with an alignment sleeve that will be pushed out during installation.

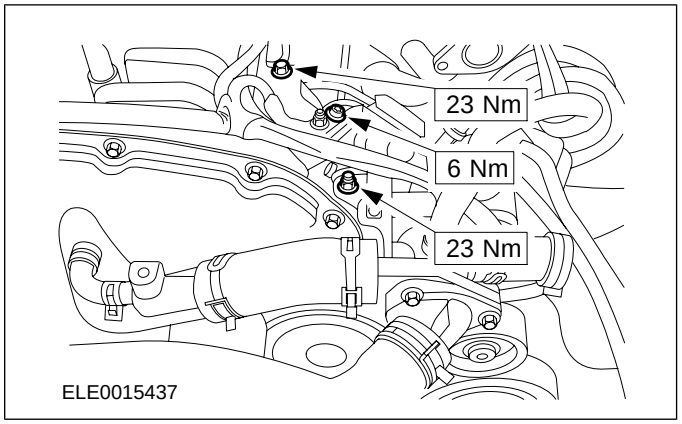
Using the special tool, install the crankshaft front oil seal.



10. Install the accessory drive belt idler pulley and the cooling fan pulley.



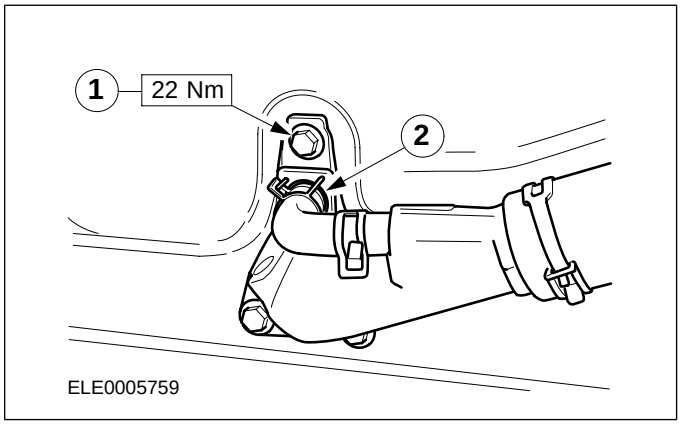
11. Attach the thermostat housing support bracket to the cylinder head and connect the radiator upper hose to the thermostat housing.



12. NOTE:Install a new coolant outlet connector O-ring seal and a new degas hose.

Connect the coolant outlet and degas connector to the engine.

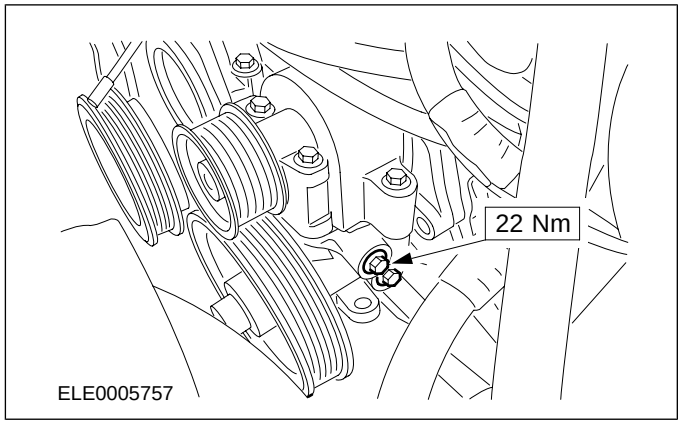
1. Install the bolts.
2. Connect the hose.



13. NOTE:Install a new water pump gasket.

IN-VEHICLE REPAIR

Attach the water pump and brake vacuum pump to the engine (four bolts).

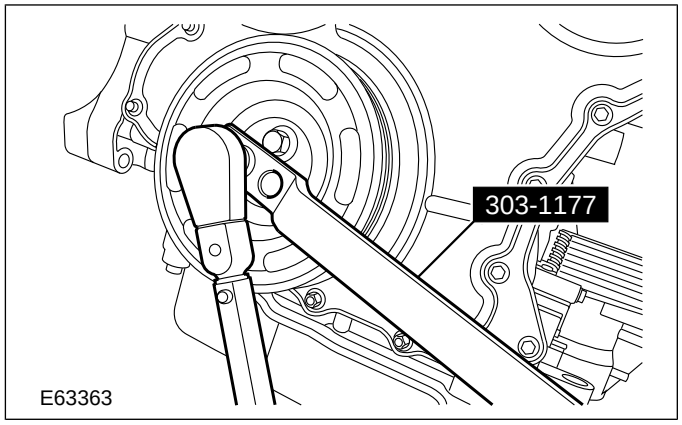


14. **CAUTION:Crankshaft pulley retaining bolts must only be used three times.**

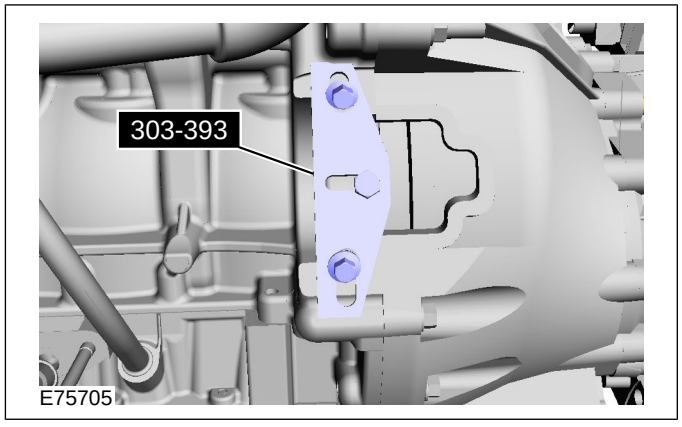
NOTE: Stamp the crankshaft pulley retaining bolt heads with a center punch to indicate usage.

Using the special tool, install the crankshaft pulley.

- Tighten the bolts in two stages.
- Stage 1: 45 Nm.
- Stage 2: 90 degrees.



15. **Remove the special tool.**



16. **Install the starter motor.**

For additional information, refer to:Starter Motor - 2.4L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation).

17. **Install the cooling fan motor and shroud.**

For additional information, refer to:Cooling Fan Motor and Shroud (303-03 Engine Cooling, Removal and Installation).

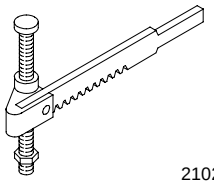
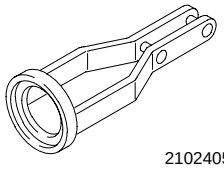
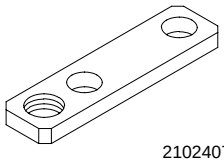
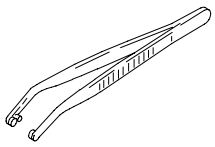
18. **Fill and bleed the cooling system. For additional information, refer to:(303-03 Engine Cooling)**

Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (General Procedures),
Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (General Procedures).

IN-VEHICLE REPAIR

Valve Springs

Special Tool(s)

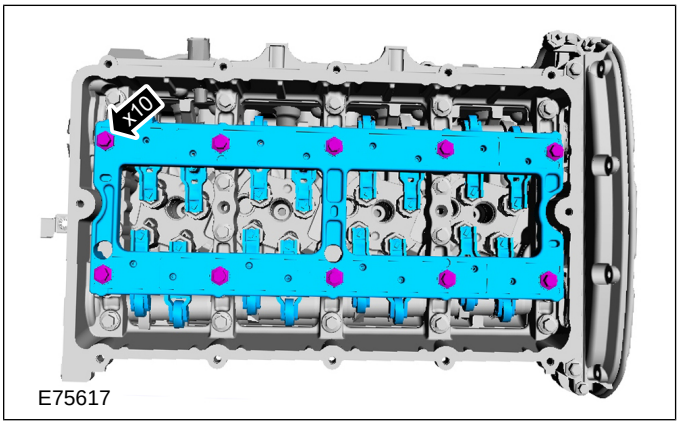
 21024	Compressor, Valve Spring 303-060 (21-024)
 2102405	Adapter for 303-060 303-060-05 (21-024-05)
 2102407	Adapter for 303-060 303-060-07 (21-024-07)
 21156	Installer, Valve Stem Collets 303-362 (21-156)

Removal

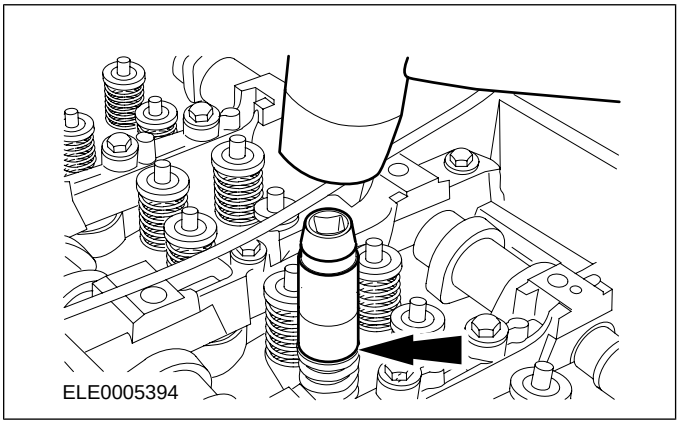
1. **Remove the valve cover.**

   For additional information, refer to: Valve Cover (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

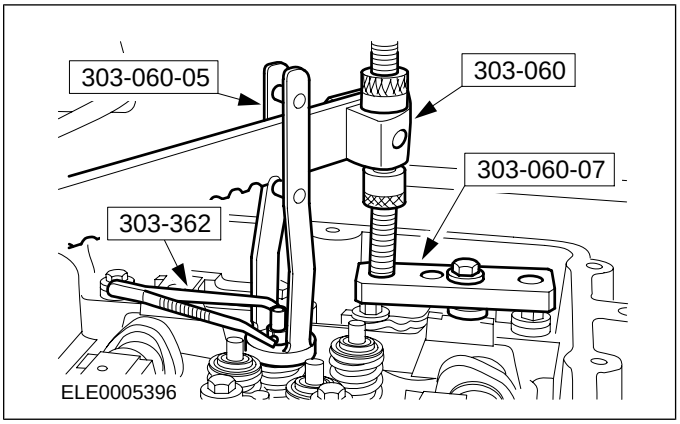
2. **Remove the rocker carrier.**



3. **Loosen the valve collets.**
   - Position a socket on the valve spring seat and gently strike it with a hammer.



4. **Position the appropriate piston at top dead center (TDC).**
5. **Using the special tools, remove the valve collets.**

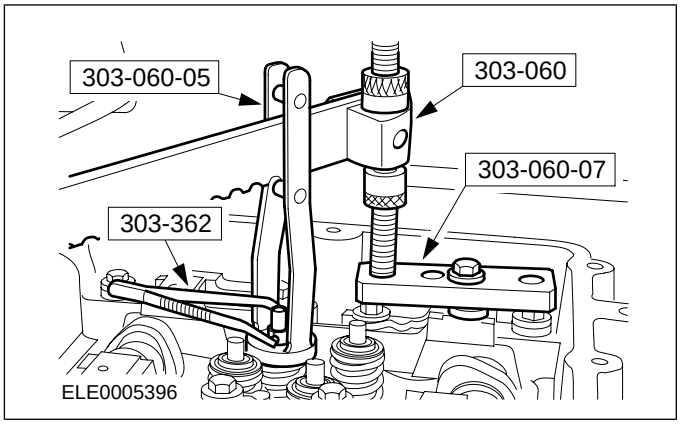


6. **Remove the valve springs.**

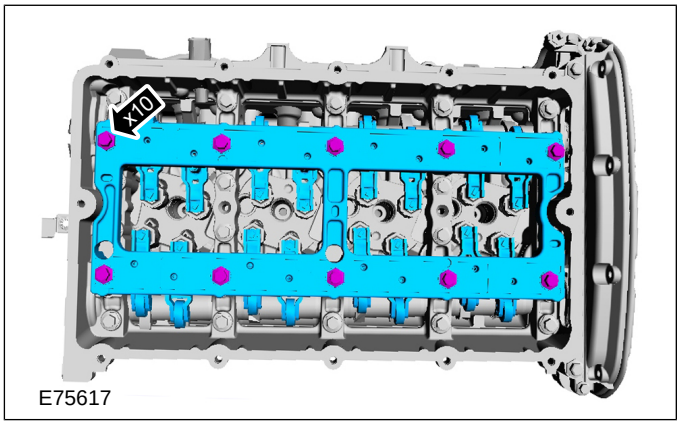
IN-VEHICLE REPAIR

Installation

1. **Install the valve springs.**
2. **Using the special tools, install the valve collets.**



3. **Install the rocker carrier.**
   - Tighten the bolts in two stages.
   - Stage1: 10 Nm
   - Stage 2: 30 degrees



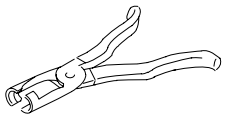
4. **Install the valve cover.**

   For additional information, refer to: Valve Cover (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

IN-VEHICLE REPAIR

Valve Seals (21 238 0)

Special Tool(s)

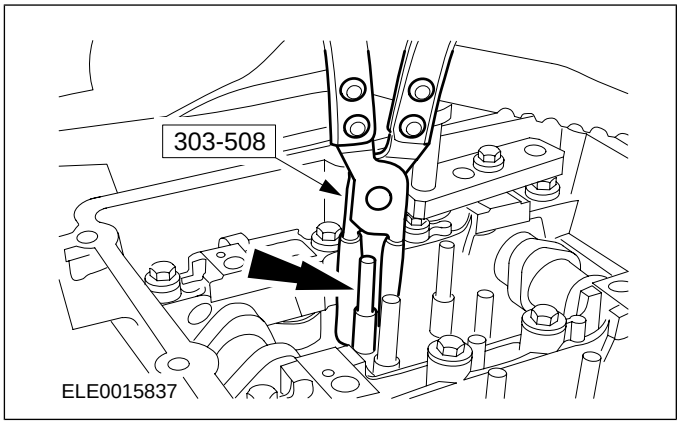
	Pliers, Valve Stem Oil Seal 303-508 (21-211)

Removal

1. **Remove the valve springs.**

   For additional information, refer to Valve Springs in this section.

2. **Using the special tool, remove the valve seals.**



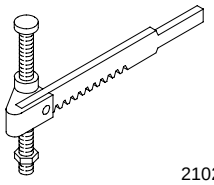
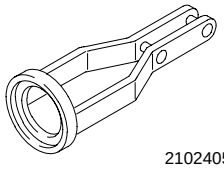
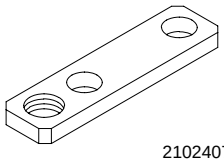
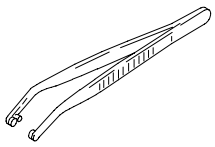
Installation

1. **To install reverse the removal procedure.**

IN-VEHICLE REPAIR

Valves (21 215 4)

Special Tool(s)

 21024	Compressor, Valve Spring 303-060 (21-024)
 2102405	Adaptor for 303-060 303-060-05 (21-024-05)
 2102407	Adaptor for 303-060 303-060-07 (21-024-07)
 21156	Installer, Valve Stem Collets 303-362 (21-156)

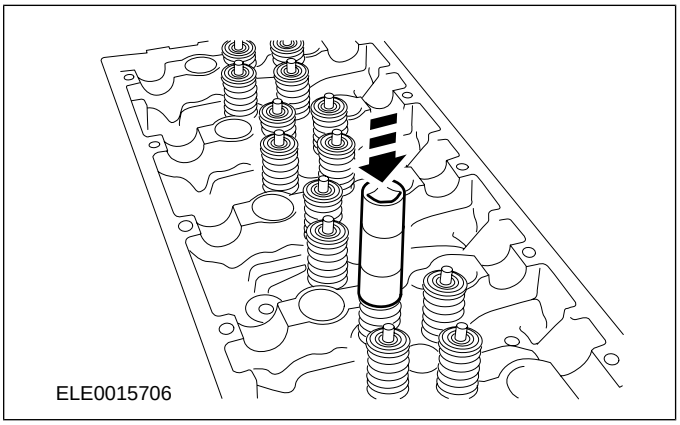
Removal

1. **Remove the cylinder head.**

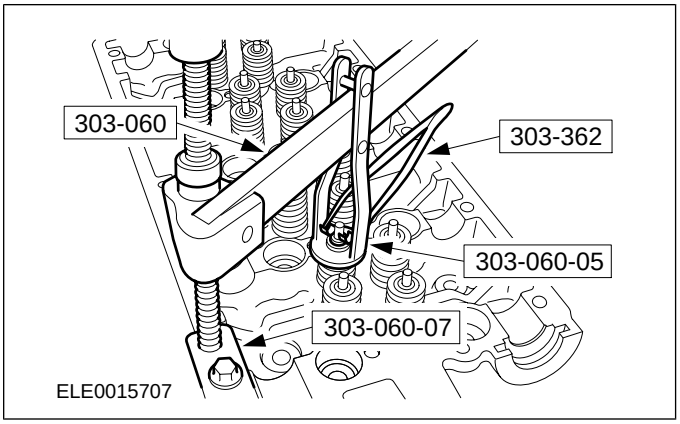
   For additional information, refer to Cylinder Head in this section.

2. **Loosen the valve collets.**

   - Position a socket on the valve spring seat and gently strike it with a hammer.



3. **Using the special tools, remove the valve collets.**



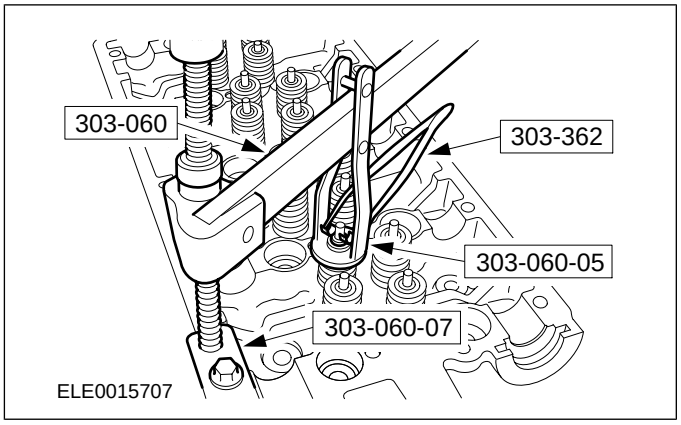
4. **Remove the valves springs.**
5. **Remove the valves.**

Installation

1. **Install the valves.**
2. **Install the valves springs.**

IN-VEHICLE REPAIR

3. **Using the special tools, install the valve collets.**



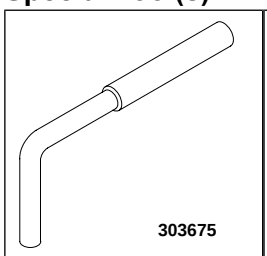
4. **Install the cylinder head.**

   For additional information, refer to Cylinder Head in this section.

IN-VEHICLE REPAIR

Camshafts (21 284 0)

Special Tool(s)

	Timing Tool, Crankshaft TDC 303-675 (21-234)

General Equipment

Three 6 mm drill bits

Materials

Name	Specification
Loctite 510	WSK-M2G348-A7

Removal

1. **Remove the valve cover.**

   For additional information, refer to:Valve Cover (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

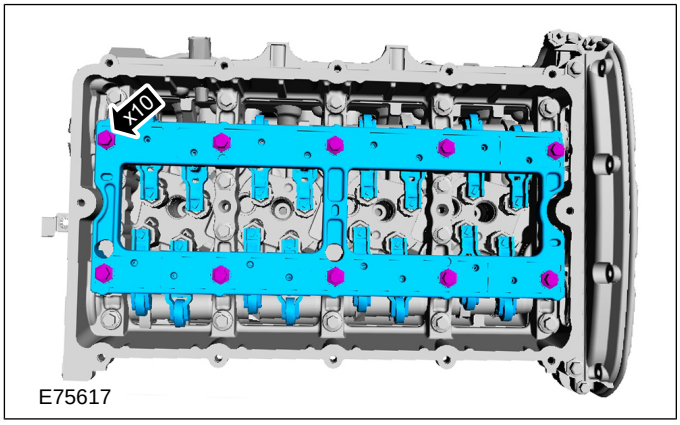
2. **Remove the engine front cover.**

   For additional information, refer to:Engine Front Cover (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

3. **Remove the crankshaft position (CKP) sensor.**

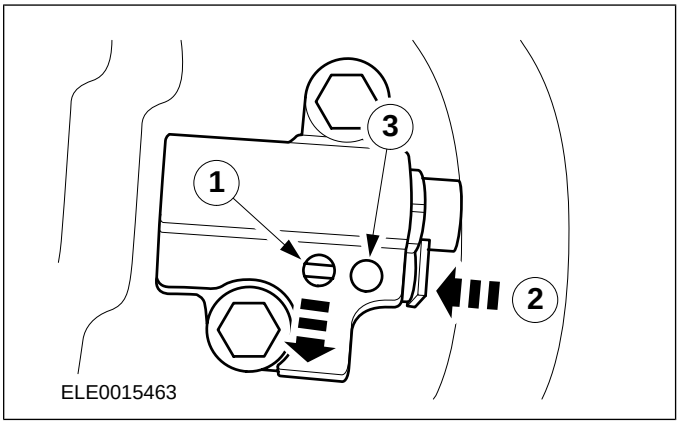
   For additional information, refer to:Crankshaft Position (CKP) Sensor - 2.4L Duratorq-TDCi (Puma) Diesel (303-14 Electronic Engine Controls, Removal and Installation).

4. **Remove the rocker carrier.**



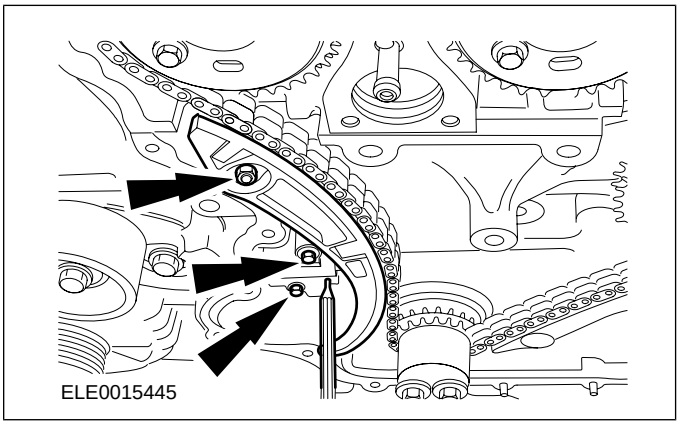
E75617

5. **Detension and lock the timing chain tensioner.**
   1. Retract the pawl.
   2. Push the lock in.
   3. Insert a pin.

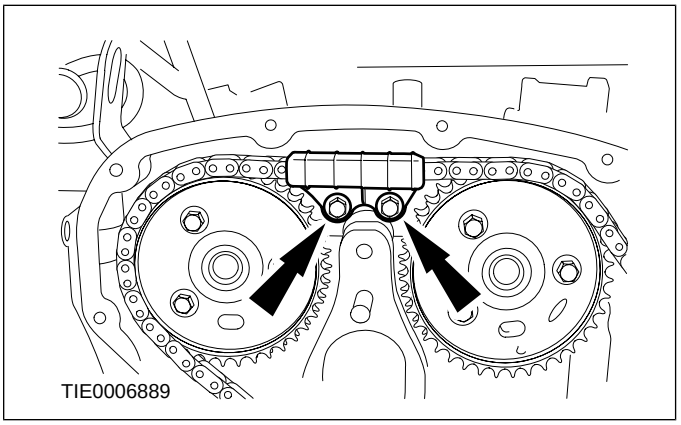


ELE0015463

6. **Remove the timing chain tensioner and the right-hand timing chain guide.**

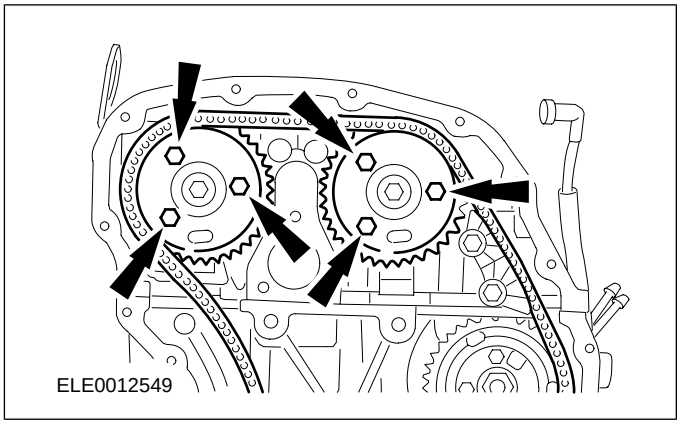

ELE0015445

7. **Remove the timing chain upper guide.**


TIE0006889

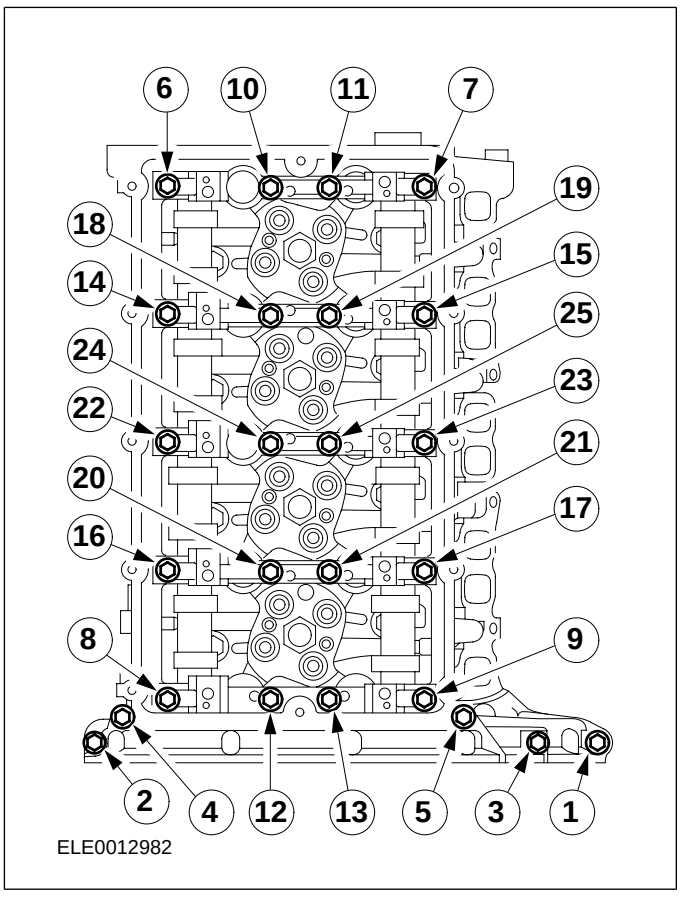
IN-VEHICLE REPAIR

8. **Remove the camshaft sprockets and the timing chain.**



9. **⚠CAUTION:Remove the camshaft carrier bolts in the sequence shown.**

   Remove the camshaft carrier.

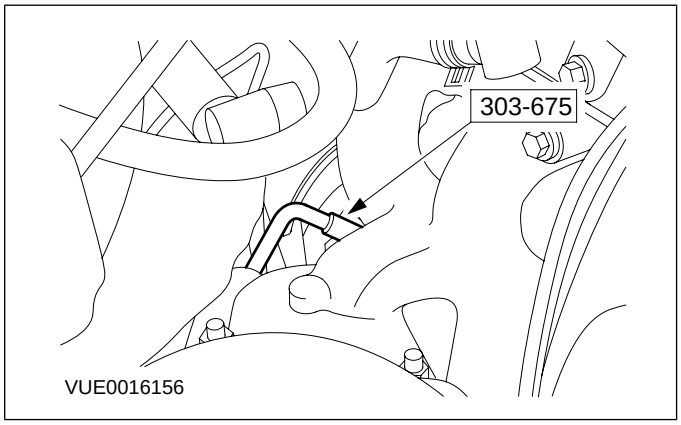


10. **Remove the camshafts.**

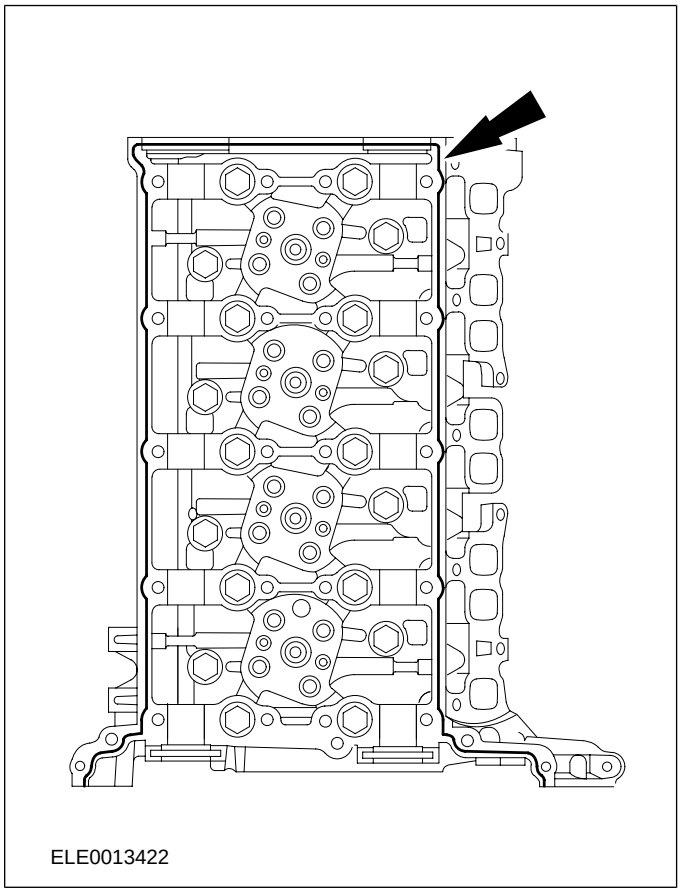
Installation

1. **Clean the mating faces of the camshaft carrier and the cylinder head.**

2. **Turn engine to 50 degrees before top dead center (TDC) and insert the special tool through the CKP sensor hole.**



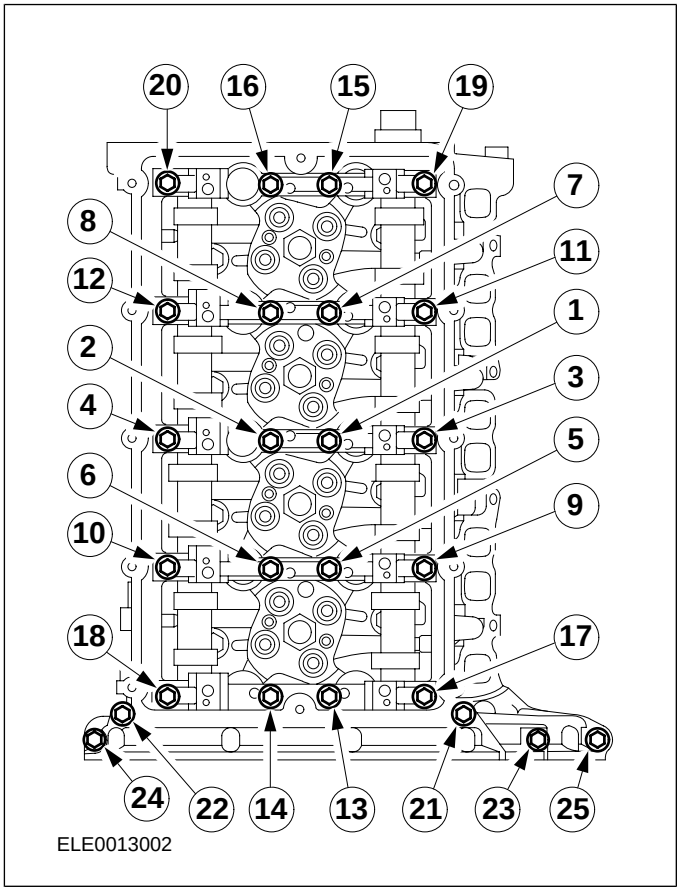
3. **Apply a 2.5 mm diameter bead of Loctite 510 to the mating face of the cylinder head.**



4. **Install the camshafts.**
5. **Install the camshaft carrier.**
   - Tighten the bolts in the sequence shown in two stages.
   - Stage 1: Tighten bolts 1 through 22 to 23 Nm.

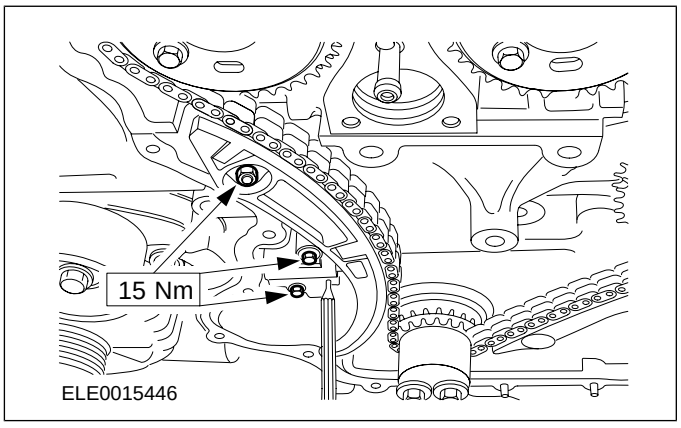
IN-VEHICLE REPAIR

- Stage 2: Tighten bolts 23 through 25 to 10 Nm.



ELE0013002

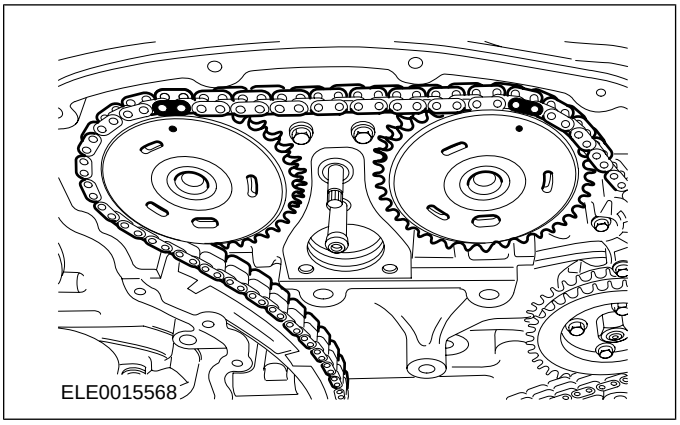
6. Install the timing chain tensioner and the right-hand timing chain guide.



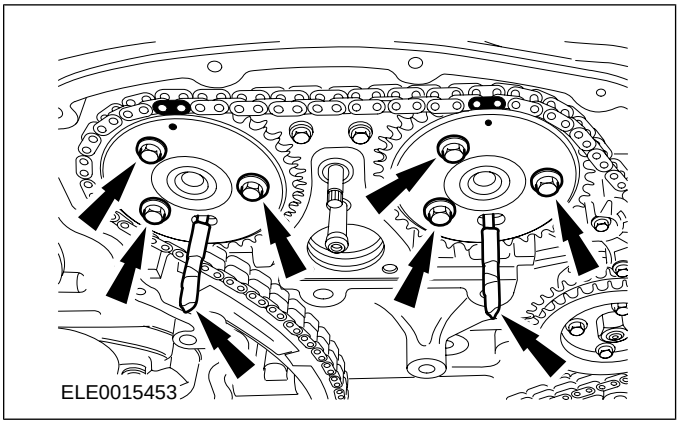
ELE0015446

7. ⚠CAUTION:The copper links of the timing chain must align with the timing marks on the camshaft sprockets.

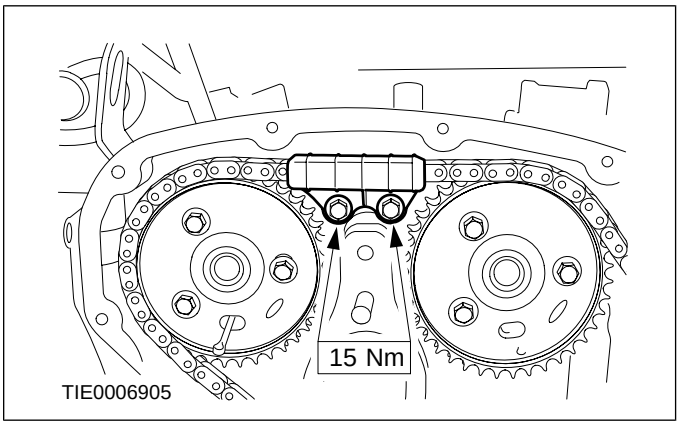
Install the camshaft sprockets and the timing chain.


ELE0015568

8. Insert 6 mm drill bits through the holes in the camshaft sprockets and tighten the camshaft sprocket retaining bolts finger tight.


ELE0015453

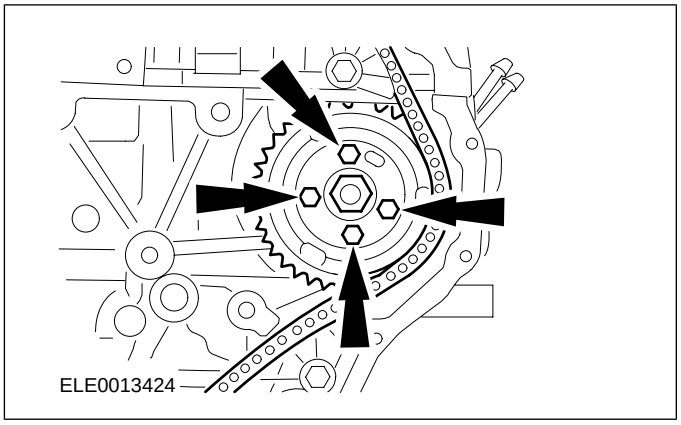
9. Install the timing chain upper guide.



TIE0006905

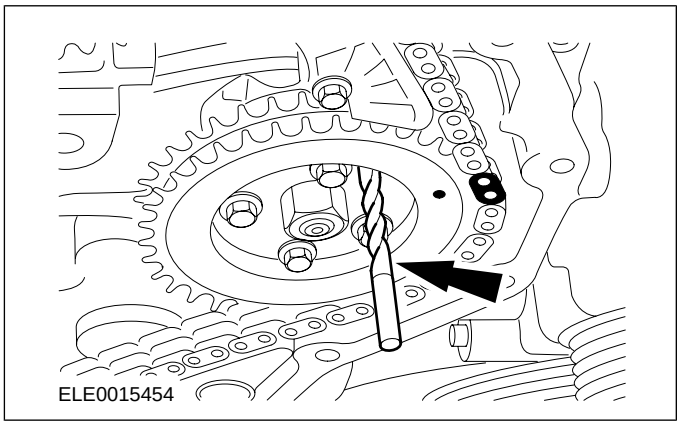
IN-VEHICLE REPAIR

10. Loosen the fuel injection pump sprocket retaining bolts.



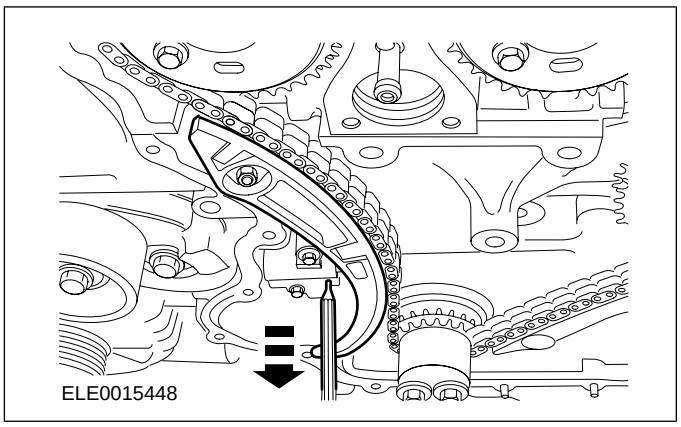
11. CAUTION:The copper link of the timing chain must align with the timing mark on the fuel injection pump sprocket.

    Insert a 6 mm drill bit through the hole in the fuel injection pump sprocket and tighten the fuel injection pump sprocket retaining bolts finger tight.

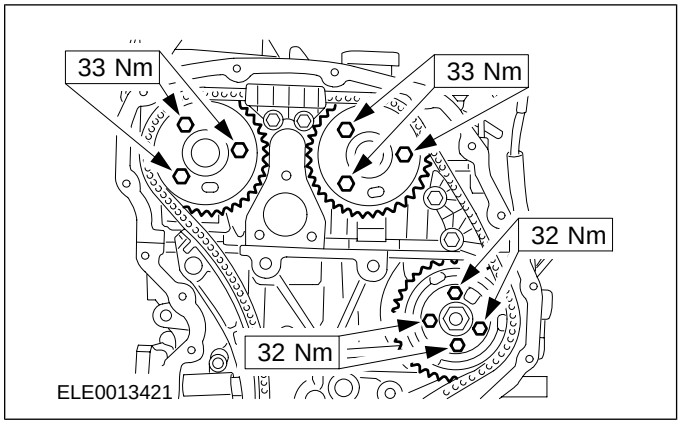


12. NOTE:Make sure the timing chain tensioner is completely released.

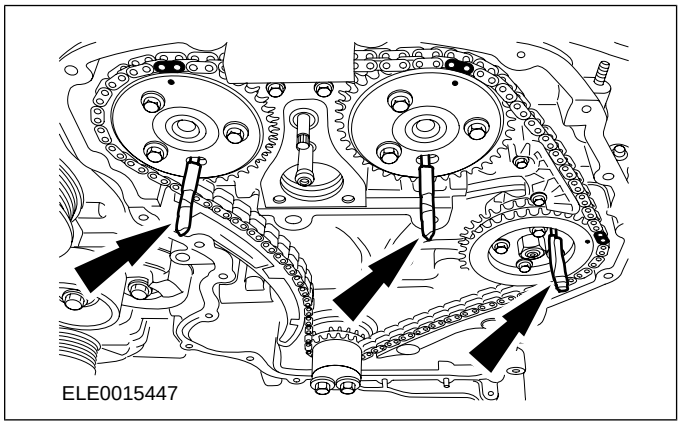
    Unlock the timing chain tensioner by removing the pin.



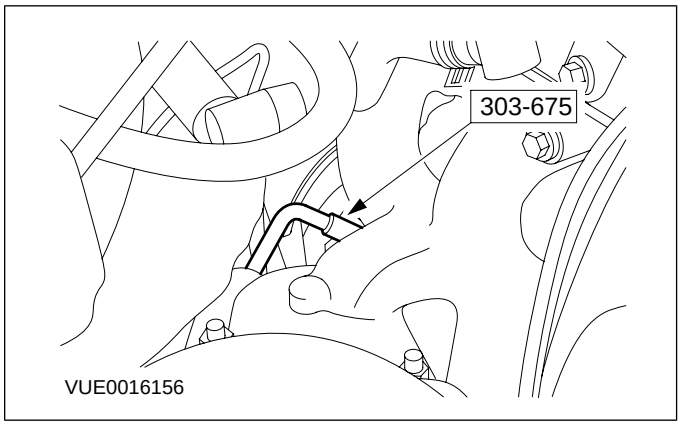
13. Tighten the camshaft sprocket and fuel injection pump sprocket retaining bolts.



14. Remove the drill bits from the holes in the camshaft sprockets and fuel injection pump sprocket.



15. Remove the special tool from the CKP sensor hole.

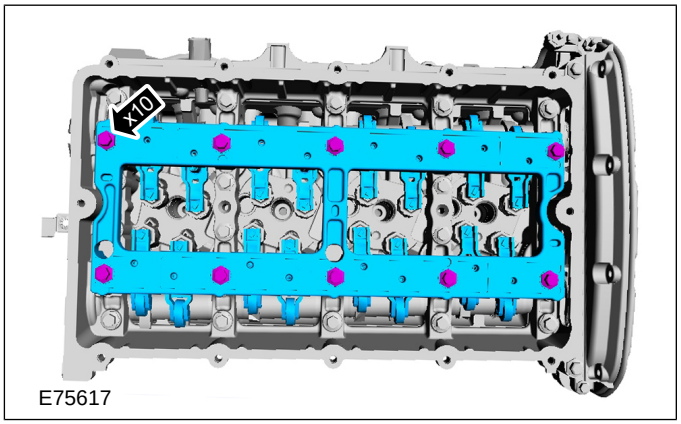


16. Install the rocker carrier.

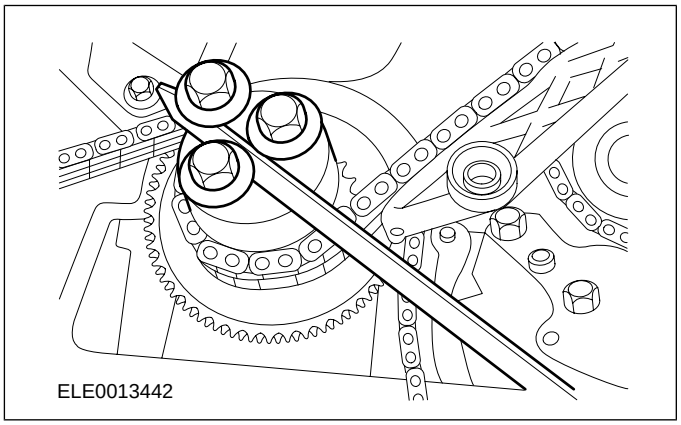
- Tighten the bolts in two stages.
- Stage 1: 10 Nm

IN-VEHICLE REPAIR

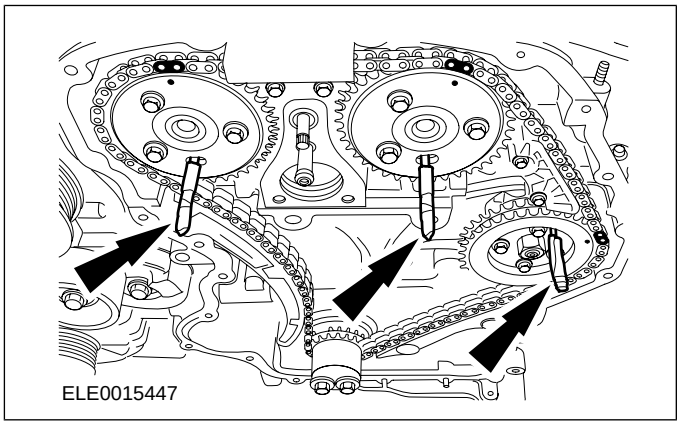
- Stage 2: 30 degrees



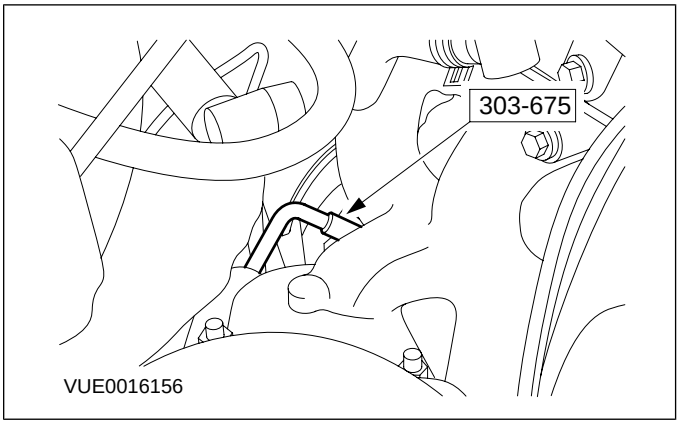
17. Rotate the crankshaft clockwise two revolutions.



18. Check the camshaft timing by inserting the 6 mm drill bits through the holes in the camshaft sprockets and fuel injection pump sprocket.



19. Check the timing by inserting the special tool in the CKP sensor hole.



20. Remove the special tool from the CKP sensor hole.
21. Remove the drill bits from the holes in the camshaft sprockets and fuel injection pump sprocket.
22. Install the CKP sensor.

    For additional information, refer to:Crankshaft Position (CKP) Sensor - 2.4L Duratorq-TDCi (Puma) Diesel (303-14 Electronic Engine Controls, Removal and Installation).
23. Install the engine front cover.

    For additional information, refer to:Engine Front Cover (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).
24. Install the valve cover.

    For additional information, refer to:Valve Cover (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

IN-VEHICLE REPAIR

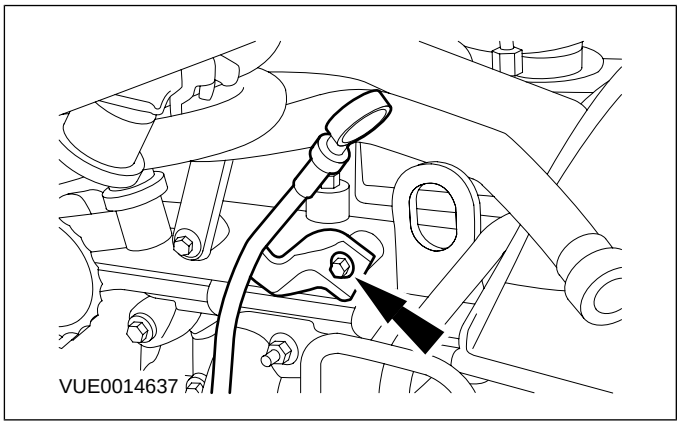
Exhaust Manifold (21 187 0)

Removal

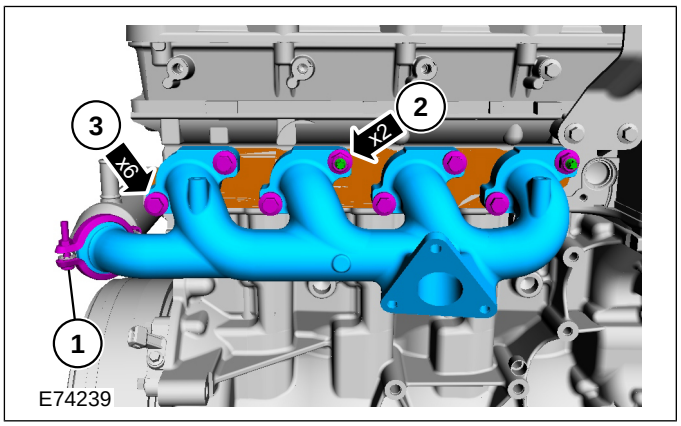
1. **Remove the turbocharger. For additional information, refer to:(303-04 Fuel Charging and Controls - Turbocharger)**

   Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS) (Removal and Installation),
   Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (140 PS) (Removal and Installation).

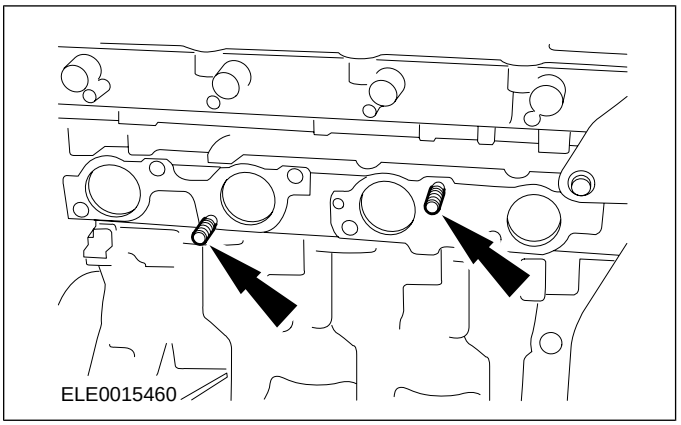
2. **Remove the oil level indicator and tube.**
   - Discard the O-ring seal.



3. **Remove the exhaust manifold.**



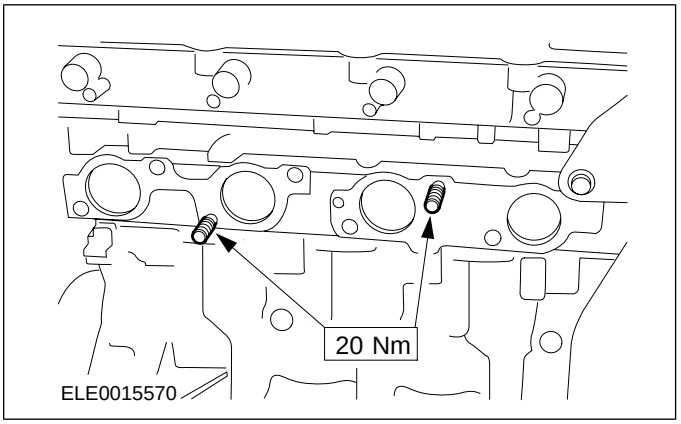
4. **Remove the exhaust manifold studs.**
   - Discard the studs.



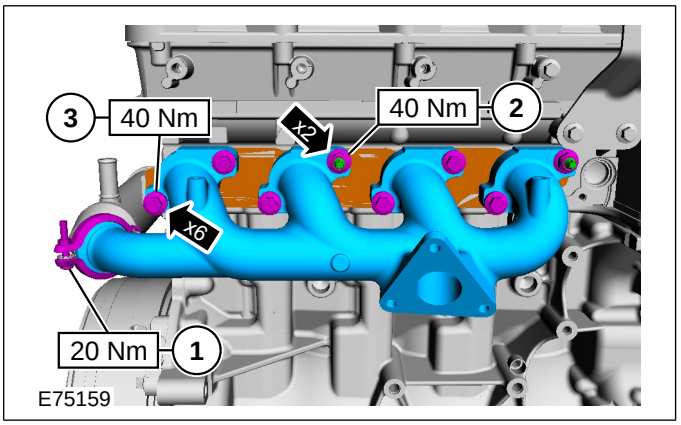
Installation

1. **NOTE:Install new exhaust manifold studs, bolts, nuts, gaskets and O-ring seals.**

   Install the exhaust manifold studs.

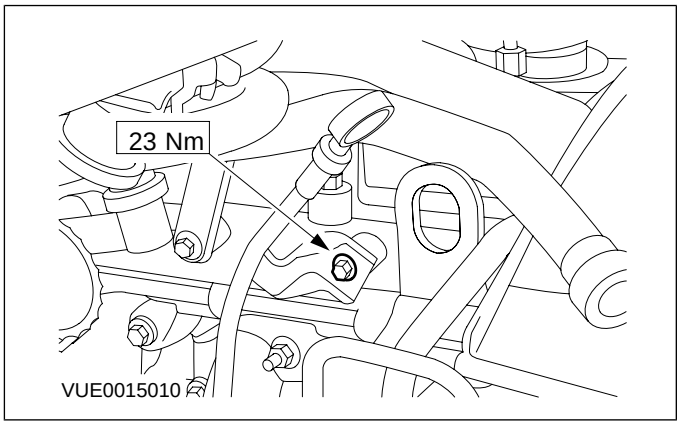


2. **Install the exhaust manifold.**



IN-VEHICLE REPAIR

3. Install the oil level indicator tube.



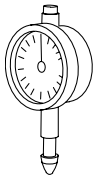
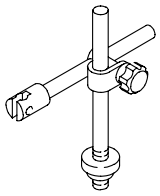
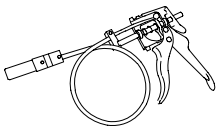
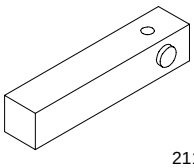
4. Install the turbocharger. For additional information, refer to:(303-04 Fuel Charging and Controls - Turbocharger)

   Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS) (Removal and Installation),
   Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (140 PS) (Removal and Installation).

IN-VEHICLE REPAIR

Cylinder Head (21 163 0)

Special Tool(s)

 15046	Dial Indicator Gauge (Metric) 205-069 (15-046)
 15022A	Holding Fixture, Dial Indicator Gauge 205-070 (15-022A)
 24003	Remover/Installer, Cooling Hose Clamp 303-397 (24-003)
 21183	Holding Fixture, Dial Indicator Gauge 303-432 (21-183)

Removal

1. **Drain the cooling system. For additional information, refer to:(303-03 Engine Cooling)**

   Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (General Procedures),
   Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (General Procedures).

2. **Remove the generator.**

   For additional information, refer to:Generator - 2.4L Duratorq-TDCi (Puma) Diesel (414-02 Generator and Regulator, Removal and Installation).

3. **Remove the intake manifold.**

   For additional information, refer to:Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

4. **Remove the exhaust manifold.**

   For additional information, refer to:Exhaust Manifold (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

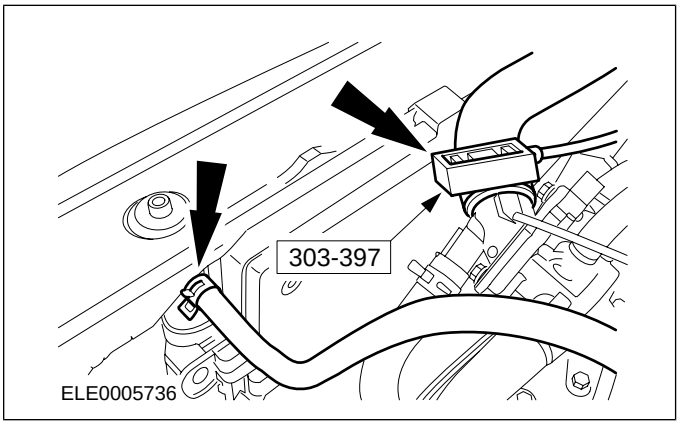
5. **Remove the exhaust gas recirculation (EGR) cooler.**

   For additional information, refer to:Exhaust Gas Recirculation (EGR) Cooler - 2.4L Duratorq-TDCi (Puma) Diesel (303-08 Engine Emission Control, Removal and Installation).

6. **Remove the camshafts.**

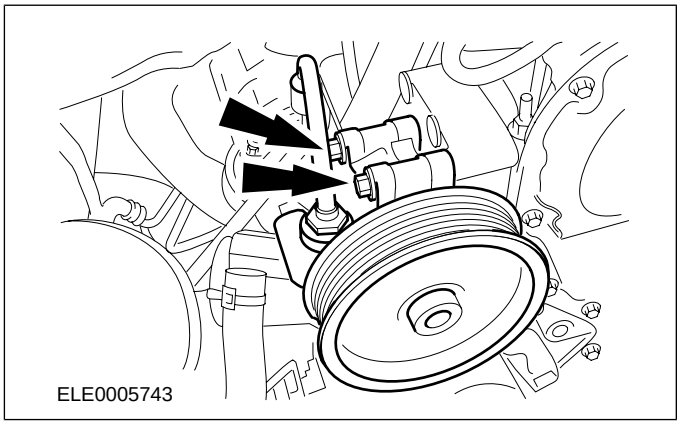
   For additional information, refer to:Camshafts (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

7. **Using the special tool, disconnect the coolant expansion tank hose and the radiator upper hose.**

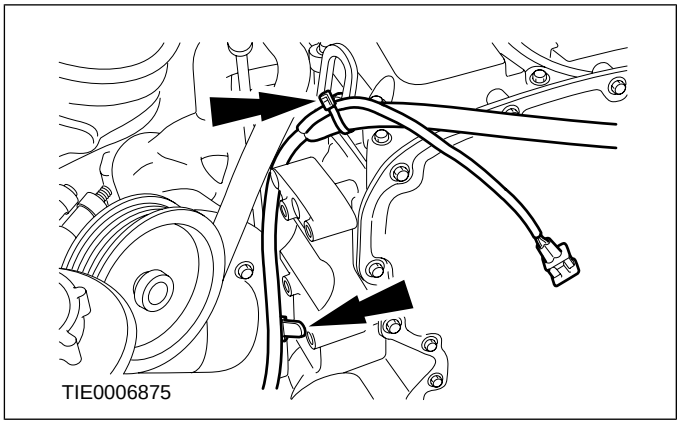


IN-VEHICLE REPAIR

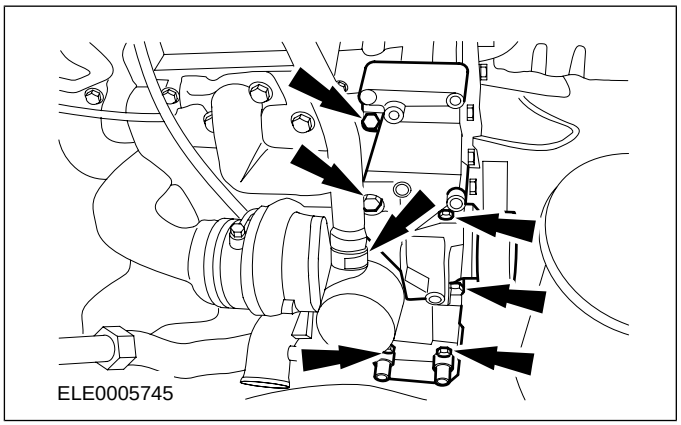
8. **Detach the power steering pump from the engine and position it to one side (four bolts).**



9. **Detach the generator wiring harness from the engine lifting eye and the power steering pump and generator mounting bracket.**



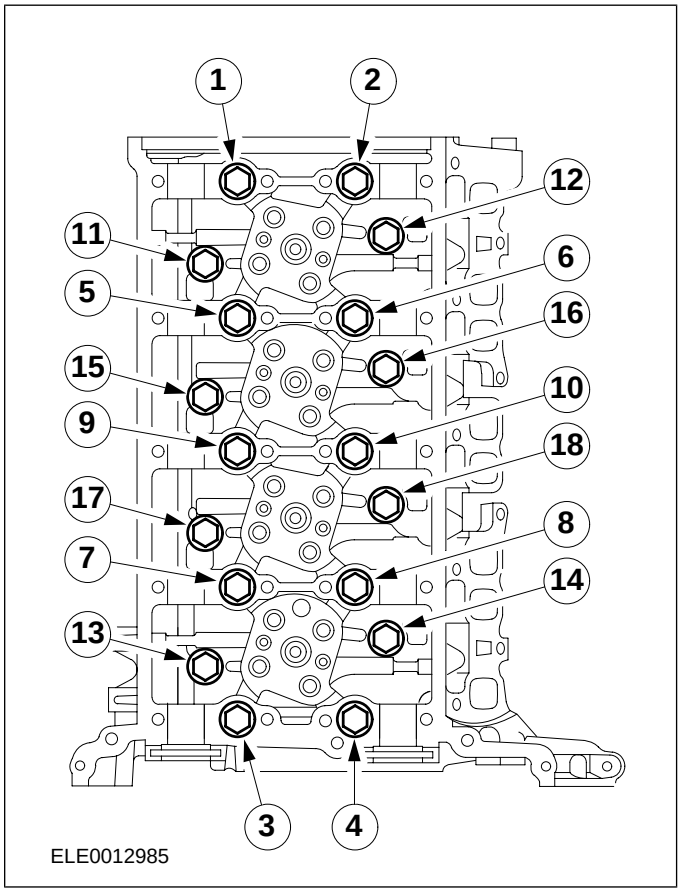
10. **Remove the power steering pump and generator mounting bracket.**



11. **CAUTION:Remove the cylinder head bolts in the sequence shown.**

    Remove the cylinder head.

- Discard the gasket and the bolts.



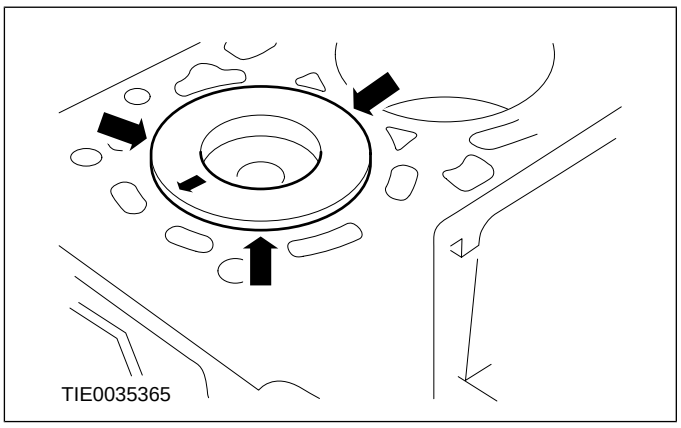
Installation

1. **Clean the mating faces of the cylinder head and the cylinder block with Loctite 7070.**
2. **Check the cylinder head for distortion.**

   For additional information, refer to:Specifications (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, Specifications).
3. **NOTE:Measure the piston protrusion of each cylinder at top dead center (TDC).**

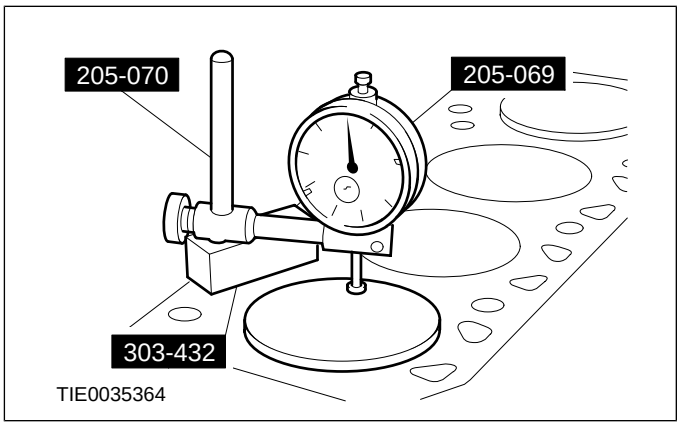
IN-VEHICLE REPAIR

Measure the distance between the piston crown and the cylinder block at the points indicated.



4. **NOTE:The largest measurement determines the choice of the cylinder head gasket.**

   Using the special tools, measure the piston protrusion.



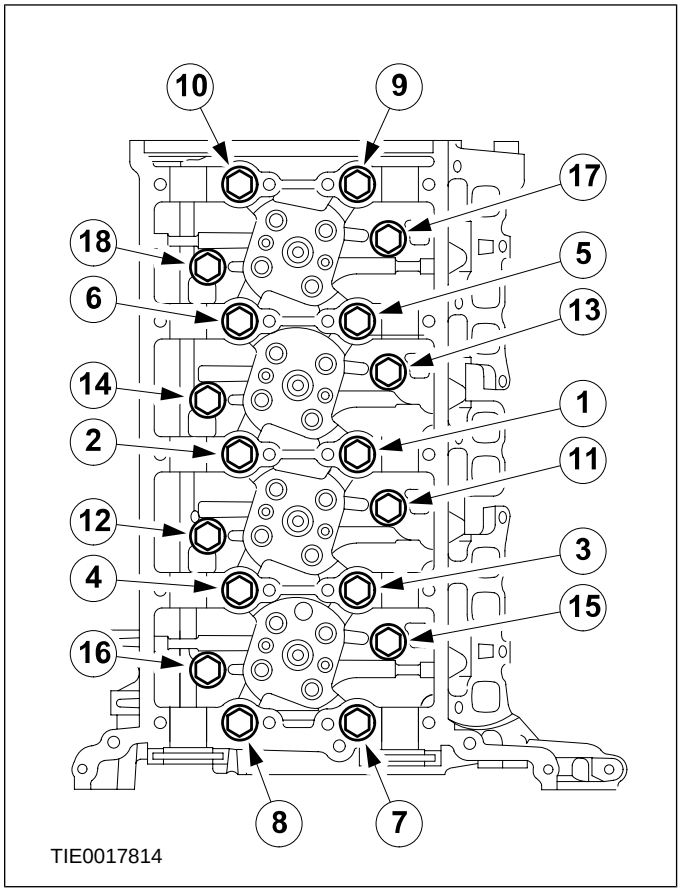
5. **Determine the cylinder head gasket.**

   For additional information, refer to:Specifications (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, Specifications).

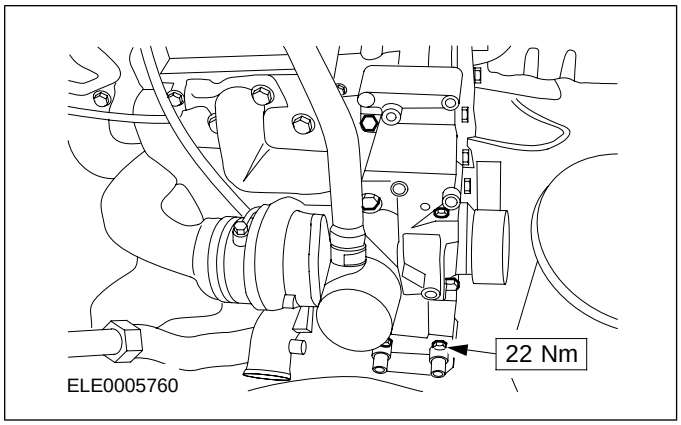
6. **⚠CAUTION:Install new cylinder head bolts.**

   Install the cylinder head.

   - Tighten the bolts in the sequence shown in eight stages.
   - Stage 1: Tighten bolts 1 through 10 to 10 Nm.
   - Stage 2: Tighten bolts 11 through 18 to 5 Nm.
   - Stage 3: Tighten bolts 1 through 10 to 20 Nm
   - Stage 4: Tighten bolts 11 through 18 to 10 Nm.
   - Stage 5: Tighten bolts 1 through 10 to 40 Nm.
   - Stage 6: Tighten bolts 11 through 18 to 20 Nm.
   - Stage 7: Tighten bolts 1 through 10 to 180 degrees.
   - Stage 8: Tighten bolts 11 through 18 to 180 degrees.

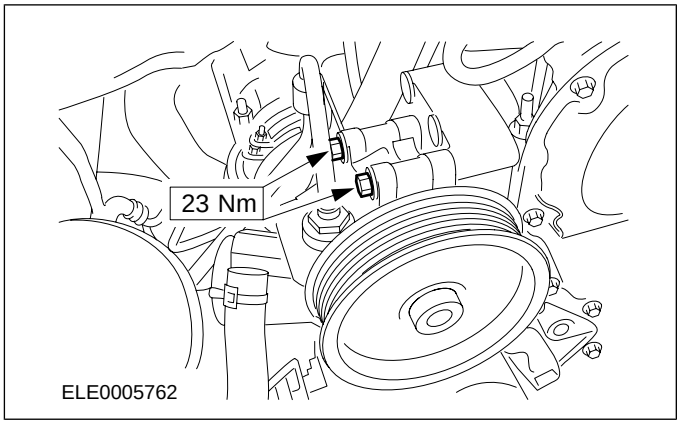


7. **Install the power steering pump and generator mounting bracket.**

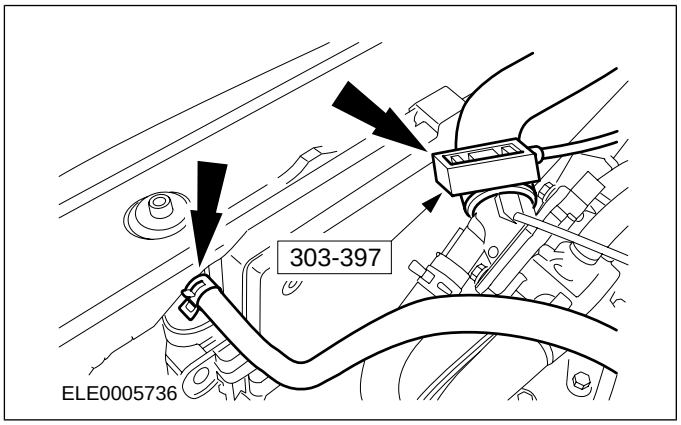


IN-VEHICLE REPAIR

8. Attach the power steering pump to the engine (four bolts).



9. Using the special tool, connect the coolant expansion tank hose and the radiator upper hose.



10. Install the camshafts.

    For additional information, refer to:Camshafts (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

11. Install the EGR cooler.

    For additional information, refer to:Exhaust Gas Recirculation (EGR) Cooler - 2.4L Duratorq-TDCi (Puma) Diesel (303-08 Engine Emission Control, Removal and Installation).

12. Install the exhaust manifold.

    For additional information, refer to:Exhaust Manifold (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

13. Install the intake manifold.

    For additional information, refer to:Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

14. Install the generator.

    For additional information, refer to:Generator - 2.4L Duratorq-TDCi (Puma) Diesel (414-02 Generator and Regulator, Removal and Installation).

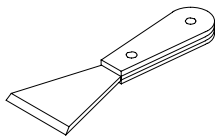
15. Fill and bleed the cooling system. For additional information, refer to:(303-03 Engine Cooling)

    Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (General Procedures),
    Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (General Procedures).

IN-VEHICLE REPAIR

Oil Pan (21 154 0)

Special Tool(s)

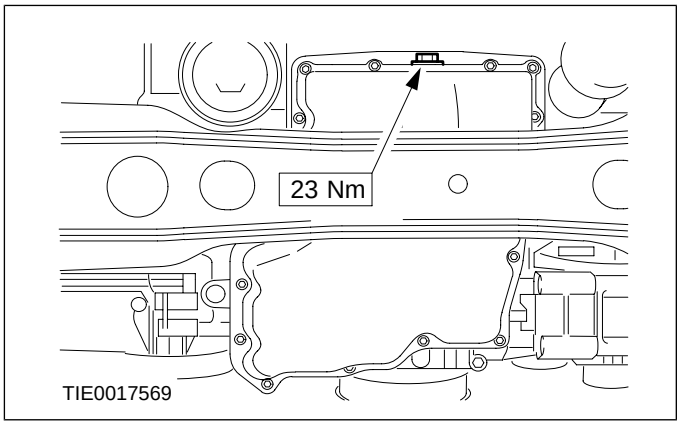
 21179	Seperator, Oil Pan 303-428 (21-179)

Materials	
Name	**Specification**
Three M6 x 20 mm locating studs	
Silicon sealer	WSE-M4G323-A4
Engine oil	WSS-M2C913-A1

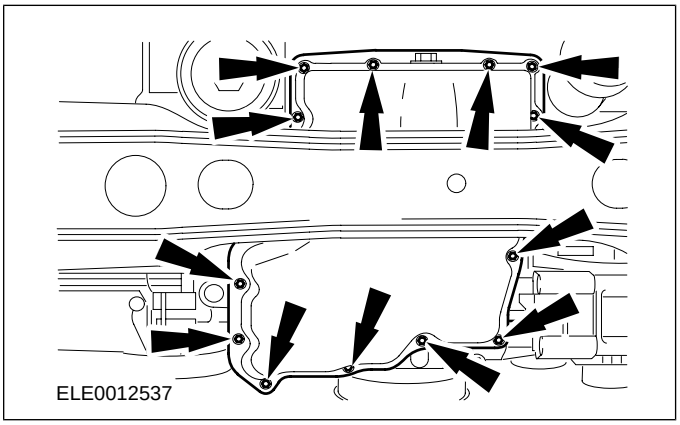
Removal

1. **Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].**
2. **Drain the engine oil.**
3. **NOTE:Inspect the oil pan drain plug seal for damage. Install a new drain plug and seal if required.**

   Install the drain plug.



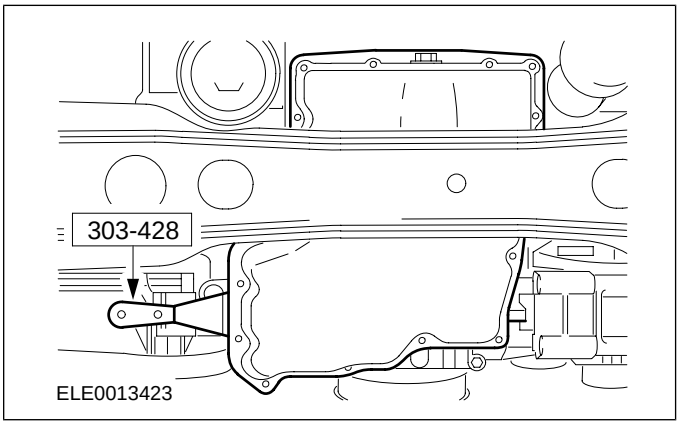
4. **Remove the oil pan retaining bolts (16 bolts).**



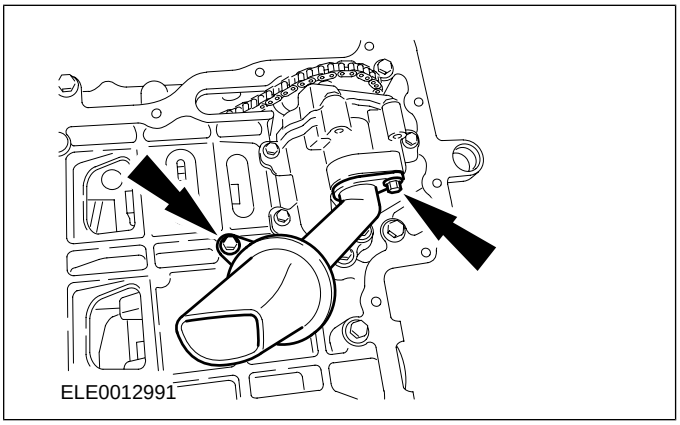
5. **CAUTION:Do not distort the oil pan.**

   Using the special tool, detach the oil pan from the cylinder block.

   - Slide the special tool around the profile of the oil pan.



6. **Remove the oil pump pickup tube.**



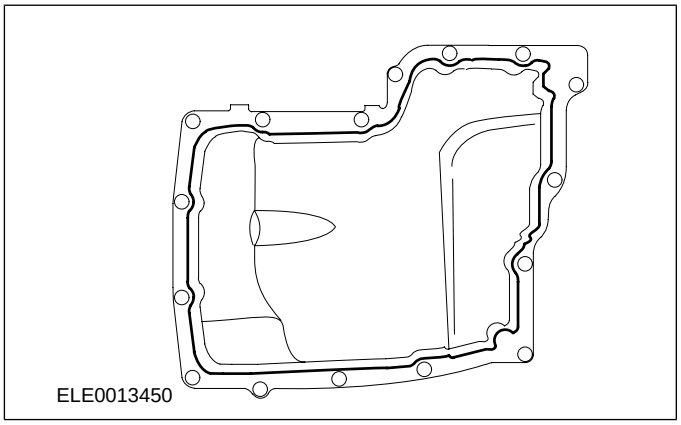
7. **Remove the oil pan.**

IN-VEHICLE REPAIR

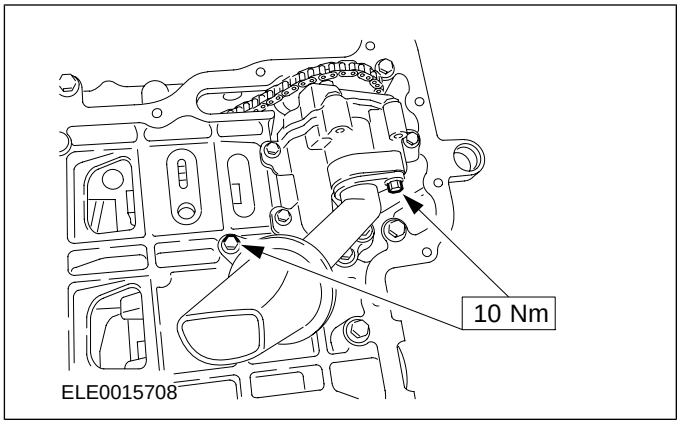
Installation

1. **Install three M6 x 20 mm locating studs to the cylinder block to aid installation of the oil pan.**
2. **⚠CAUTION:Install the oil pan within five minutes of applying the sealer.**

   Apply a 3 mm diameter bead of sealer to the mating face of the oil pan.



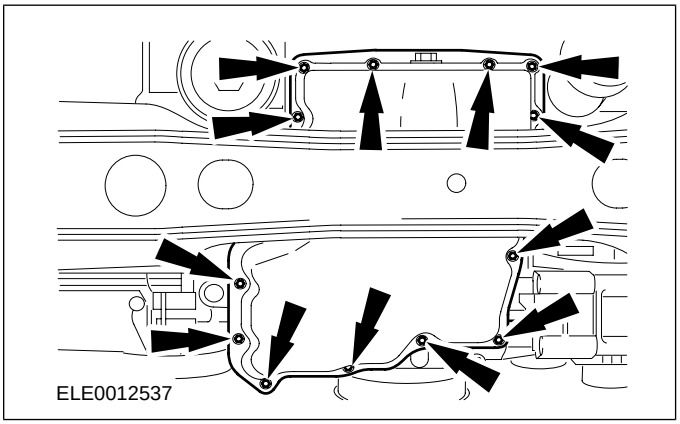
3. **Position the oil pan above the engine crossmember.**
4. **Install the oil pump pickup tube.**



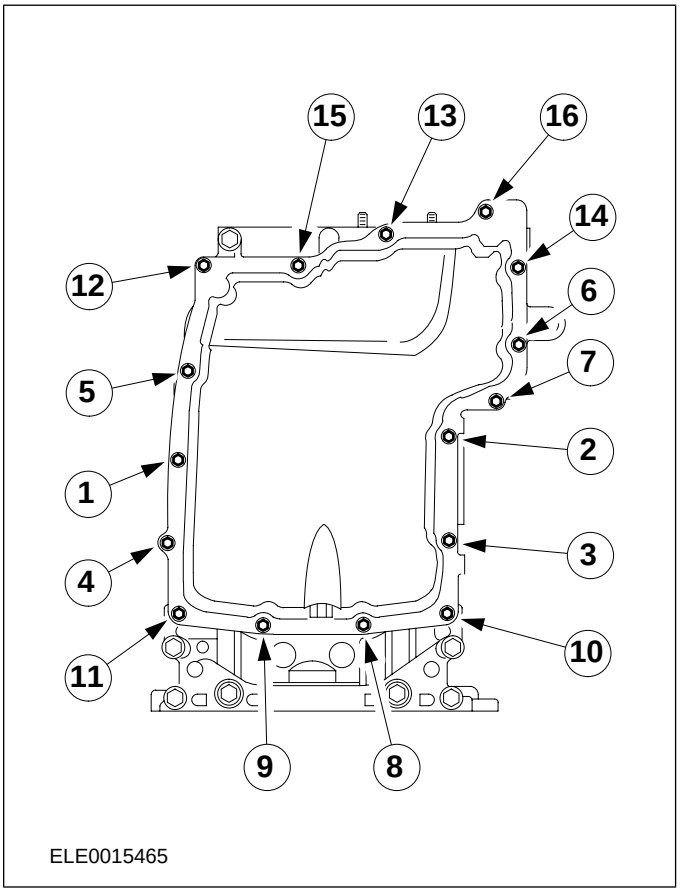
5. **NOTE:Do not fully tighten the oil pan retaining bolts at this stage.**

   Install the oil pan (16 bolts).

- Remove the locating studs.



6. **Tighten the oil pan retaining bolts.**
   - Tighten the bolts in the sequence shown in two stages.
   - Stage 1: Tighten bolts 1 through 16 to 7 Nm.
   - Stage 2: Tighten bolts 1 through 16 to 14 Nm.

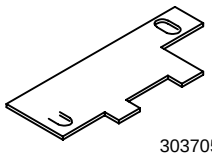


7. **Lower the vehicle.**
8. **Fill the engine with oil.**

IN-VEHICLE REPAIR

Oil Pump (21 714 0)

Special Tool(s)

 303705	Aligner, Oil Pump 303-705 (21-256)

Removal

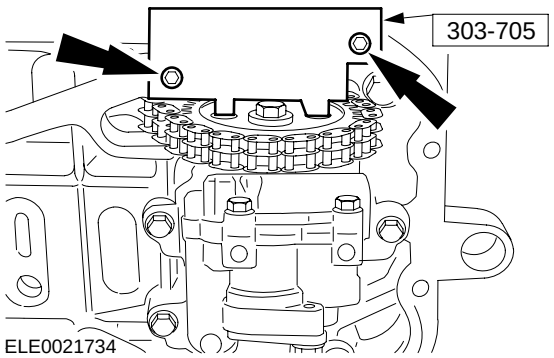
1. **Remove the oil pan.**

   For additional information, refer to: Oil Pan (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair) / Oil Pan (303-01 Engine - 2.2L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

2. **NOTE: The profile of the special tool must be in contact with the oil pump sprocket.**

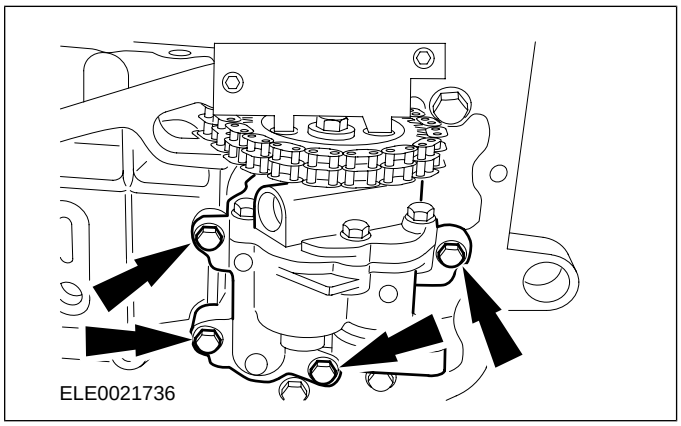
   Install the special tool to the engine block and finger tighten the two bolts.

   - Push the special tool against the oil pump sprocket.
   - Tighten the two bolts.



3. **Remove the oil pick up pipe.**

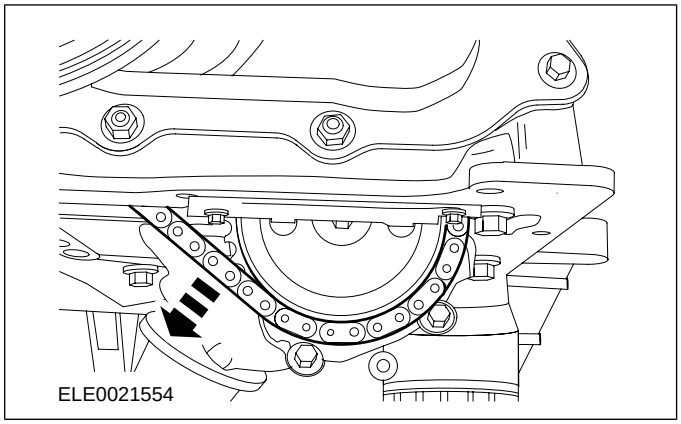
4. **Remove the oil pump retaining bolts.**



5. **NOTE: On engines equipped with hydraulic chain tensioner, engine oil will be expelled when the chain is pulled down.**

   Remove the oil pump.

   - Pull down on the oil pump chain to release the chain from the sprocket.



Installation

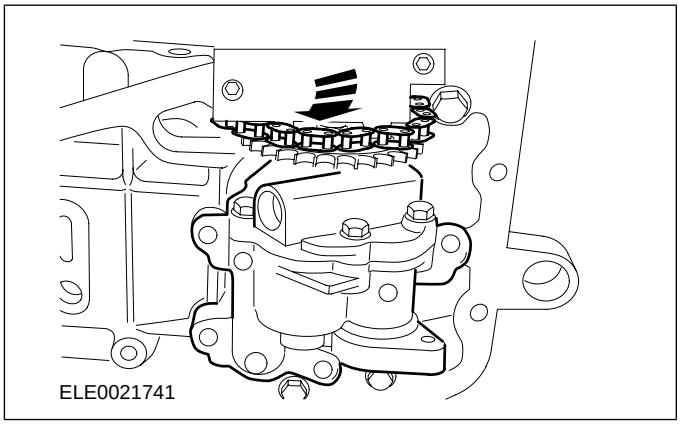
1. **NOTE: Do not fully tighten the oil pump retaining bolts at this stage.**

   Install the oil pump.

   - Install the chain onto the oil pump sprocket.

IN-VEHICLE REPAIR

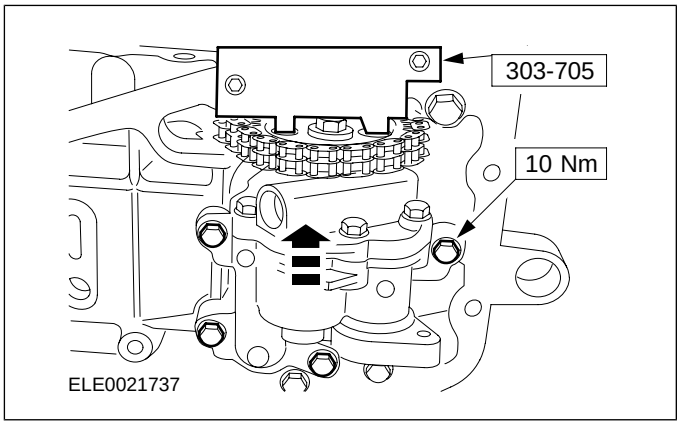
- Install the oil pump retaining bolts finger tight.



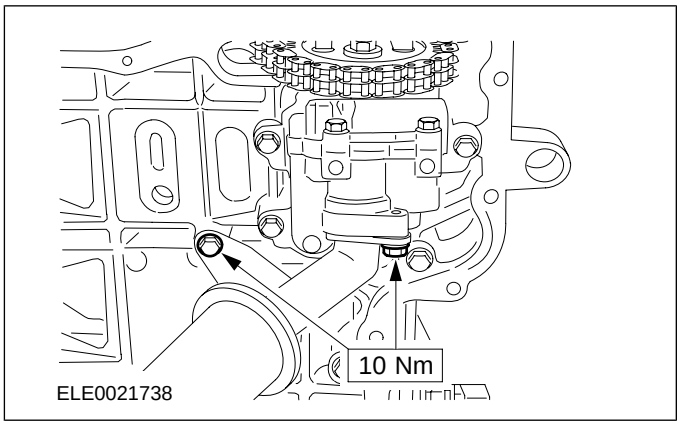
2. **NOTE:The profile of the special tool must be in contact with the oil pump sprocket.**

   Push the oil pump forward so that the sprocket is in contact with the special tool.

   - Tighten the oil pump retaining bolts.



3. **Remove the special tool.**
4. **Install the oil pick up pipe.**



5. **Install the oil pan.**

   For additional information, refer to:Oil Pan (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair) / Oil Pan (303-01 Engine - 2.2L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

IN-VEHICLE REPAIR

Crankshaft Rear Seal (21 468 4)

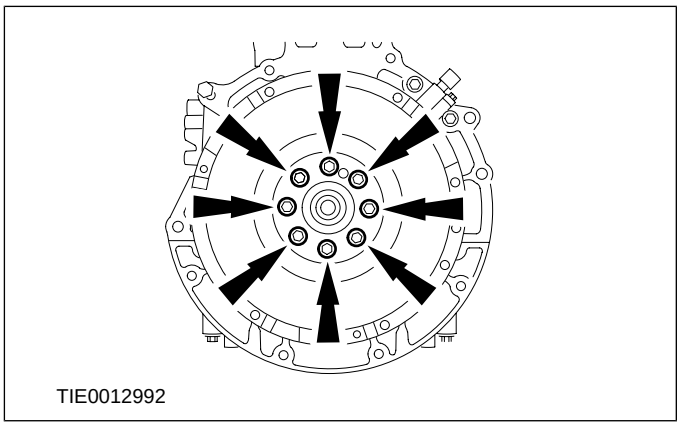
Materials	
Name	**Specification**
Silicone Sealant	WSE-M4G323-A4

Removal

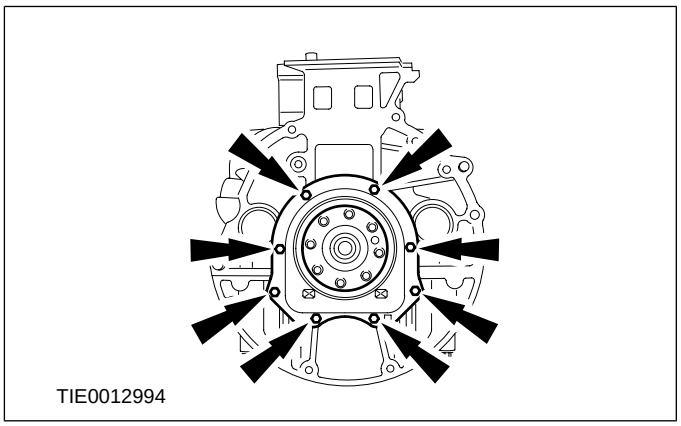
1. **Remove the clutch disc and pressure plate. For additional information, refer to:**

   Clutch Disc and Pressure Plate (308-01 Clutch - Vehicles With: MT-75, Removal and Installation),
   Clutch Disc and Pressure Plate (308-01 Clutch - Vehicles With: MT82, Removal and Installation).

2. **Remove the flywheel.**
   - Discard the bolts.



3. **Remove the crankshaft rear oil seal carrier.**
   - Discard the carrier.

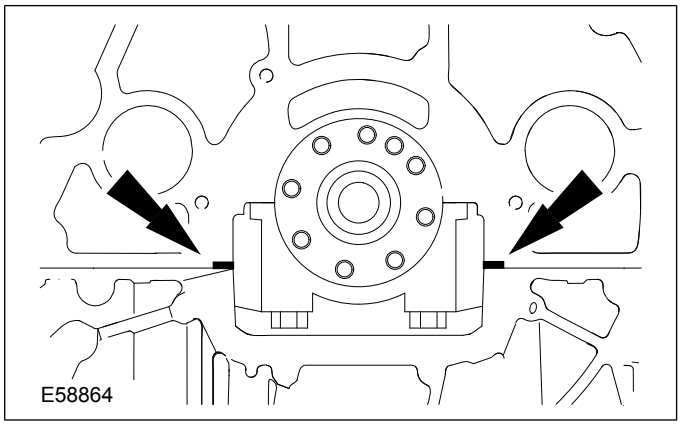


Installation

1. **⚠CAUTION:A new crankshaft rear seal carrier is supplied with an alignment sleeve that must not be removed until the crankshaft rear seal is fully installed. Failure to follow this instruction may result in damage to the vehicle.**

NOTE: Clean the area on the cylinder block before installing a new crankshaft rear seal carrier.

Check the two foam pads are located as shown on the ladder frame gasket.



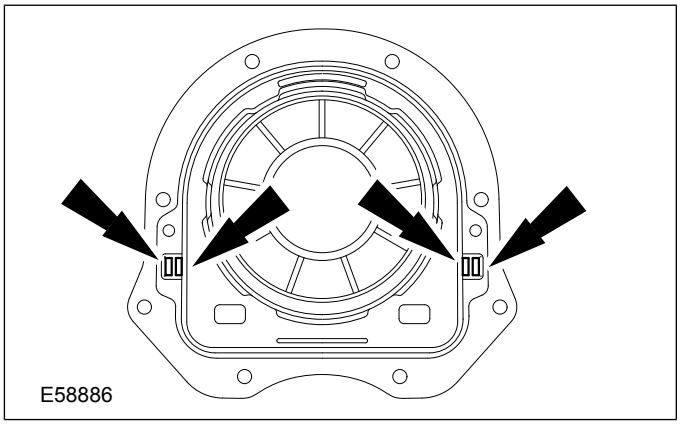
2. **CAUTIONS:**

   ⚠Install the new crankshaft rear seal carrier within five minutes of applying the recommended sealant. Failure to follow this instruction may result in damage to the vehicle.

   ⚠Do not add any more than the specified quantity of sealant or add the sealant anywhere other than the area shown.

IN-VEHICLE REPAIR

If the foam pads are not present on inspection, fill the square areas shown with 75% of sealant.



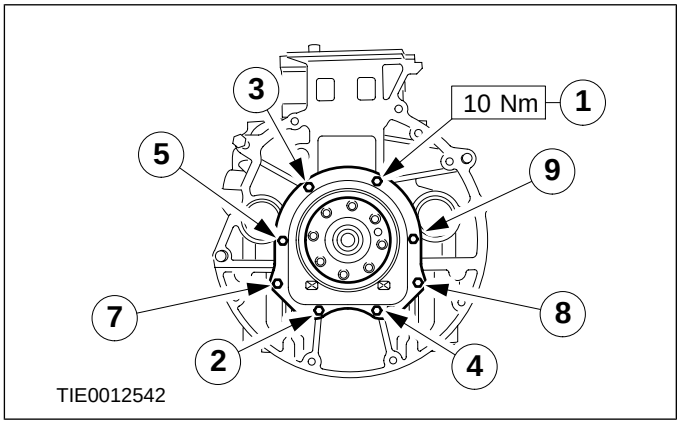
3. **NOTE:Install a new crankshaft rear oil seal carrier and crankshaft rear oil seal carrier retaining bolts.**

NOTE:A new crankshaft rear oil seal carrier is supplied with an alignment sleeve that must be removed following installation.

NOTE: Do not fully tighten the crankshaft rear oil seal carrier retaining bolts at this stage.

Install the crankshaft rear oil seal carrier.

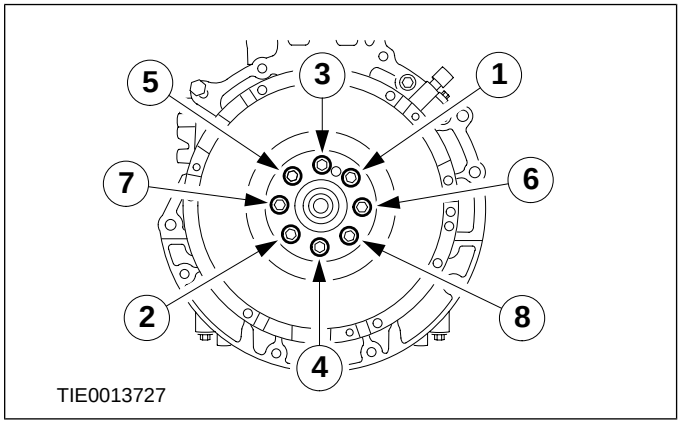
4. **Tighten the crankshaft rear oil seal carrier retaining bolts.**
   - Tighten the bolts in the sequence shown.



5. **Remove the crankshaft rear oil seal carrier alignment sleeve.**
6. **NOTE:Install new flywheel bolts.**

Install the flywheel.

- Tighten the bolts in the sequence shown in three stages.
- Stage 1: Tighten bolts 1 through 8 to 25 Nm.
- Stage 2: Tighten bolts 1 through 8 to 40 Nm.
- Stage 3: Tighten bolts 1 through 8 to 48 degrees.



7. **Install the clutch disc and pressure plate. For additional information, refer to:**

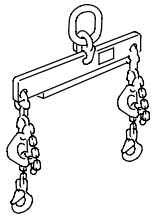
Clutch Disc and Pressure Plate (308-01 Clutch - Vehicles With: MT-75, Removal and Installation),
Clutch Disc and Pressure Plate (308-01 Clutch - Vehicles With: MT82, Removal and Installation).

REMOVAL

Engine

Removal

Special Tool(s)

 21068A	Lifting Bracket, Engine 303-122

General Equipment

Worldwide Diagnostic System (WDS)
Coolant hose clamp remover/installer
Vehicle/axle stands
Trolley jack
Hydraulic jib crane

1. Remove the following items:

1. Air cleaner

   Refer to:Air Cleaner - 2.3L Duratec-HE (MI4)/2.4L Duratorq-TDCi (Puma) Diesel (303-12 Intake Air Distribution and Filtering, Removal and Installation).

2. Front Bumber

   Refer to:Front Bumper (501-19 Bumpers, Removal and Installation).

3. Condenser Core

   Refer to:Condenser Core (412-03 Air Conditioning, Removal and Installation).

4. Radiator

   Refer to:Radiator (303-03 Engine Cooling, Removal and Installation).

5. Power Steering Pump

   Refer to:Power Steering Pump - 2.4L Duratorq-TDCi (Puma) Diesel (211-02 Power Steering, Removal and Installation).

6. Accessory Drive Belt

   Refer to:Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).

7. Catalytic Converter

   Refer to:Catalytic Converter - 2.4L Duratorq-TDCi (Puma) Diesel (309-00 Exhaust System, Removal and Installation).

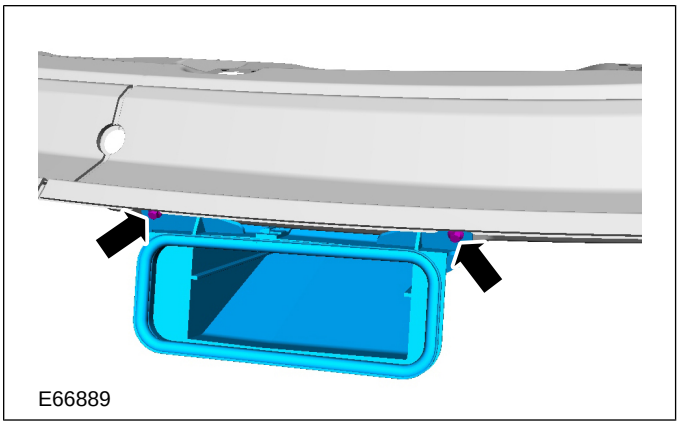
2. Disconnect the battery ground cable.

Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

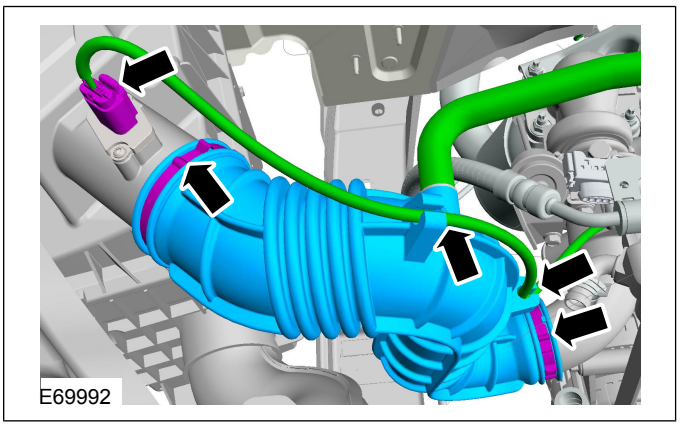
3. Within the datalogger function of WDS, check that the fuel pressure has dropped to zero and that the fuel temperature has either reached ambient temperature or is below 30ºC whichever is the greater.

General Equipment: Worldwide Diagnostic System (WDS)

4.

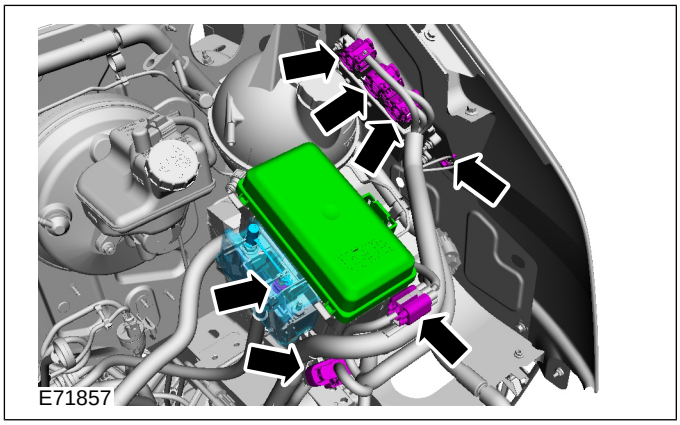


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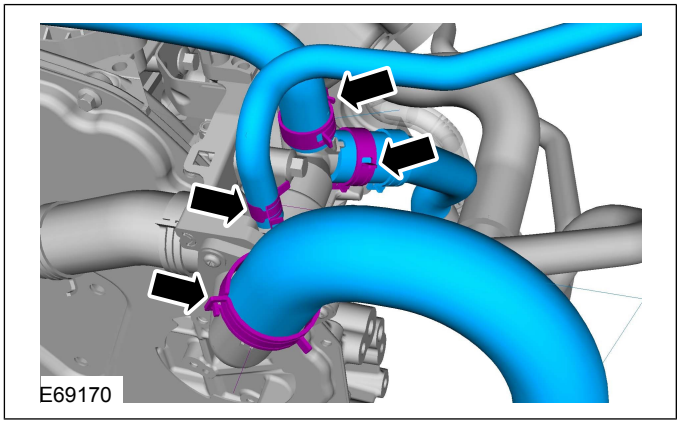


REMOVAL

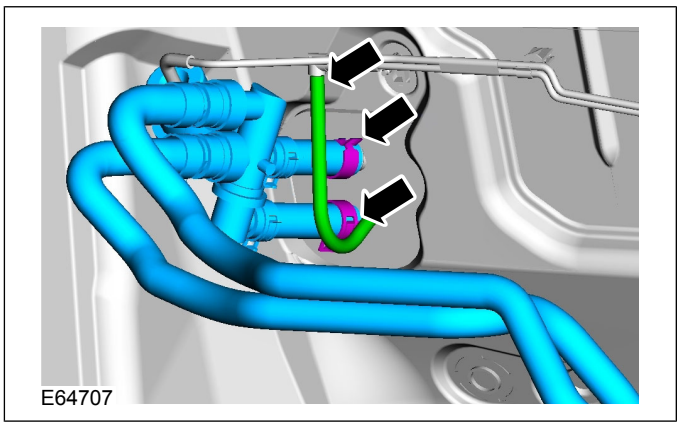
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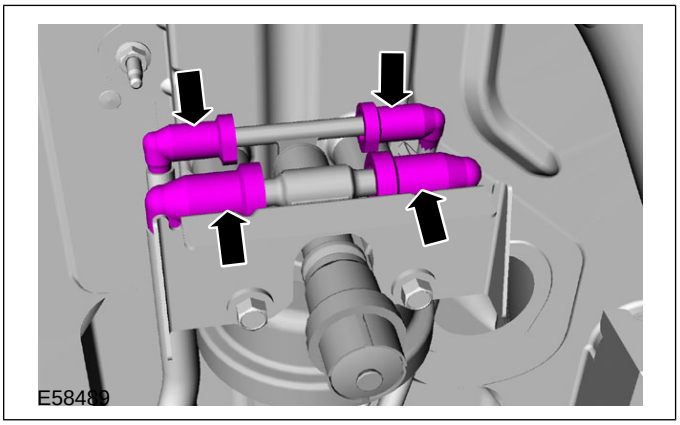
7. General Equipment: Coolant hose clamp remover/installer



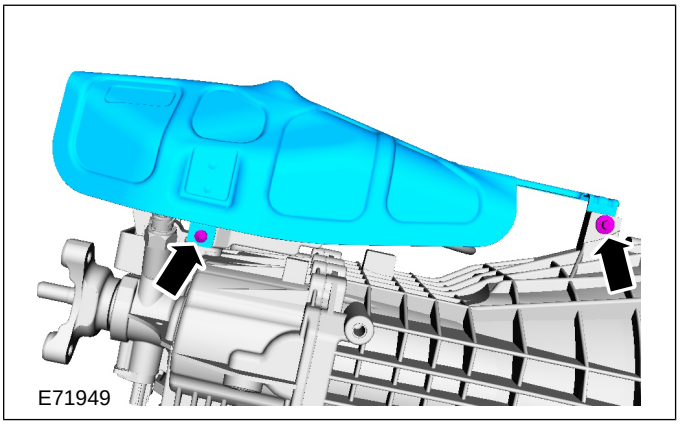
8. General Equipment: Coolant hose clamp remover/installer



9.

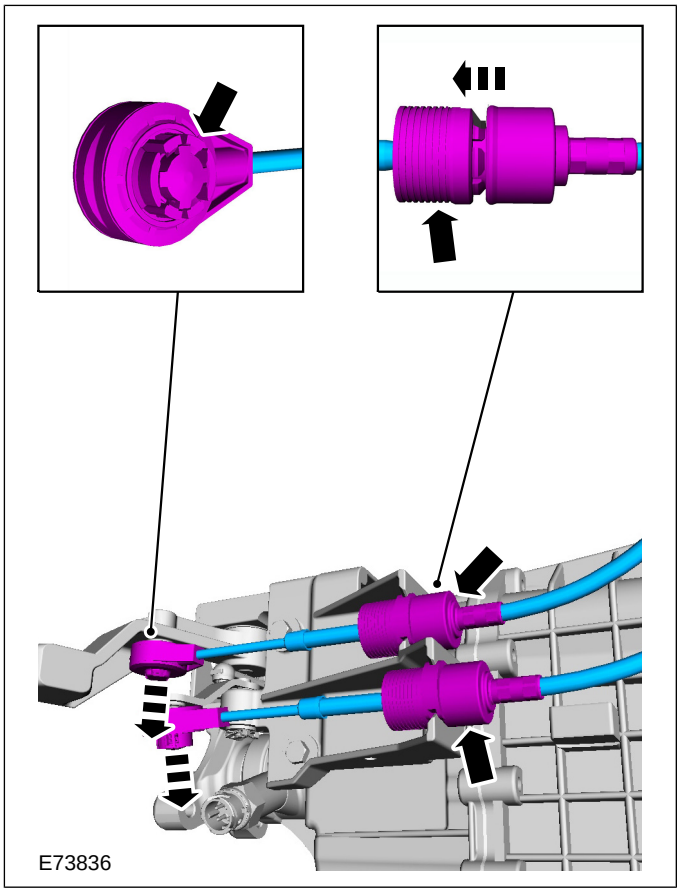


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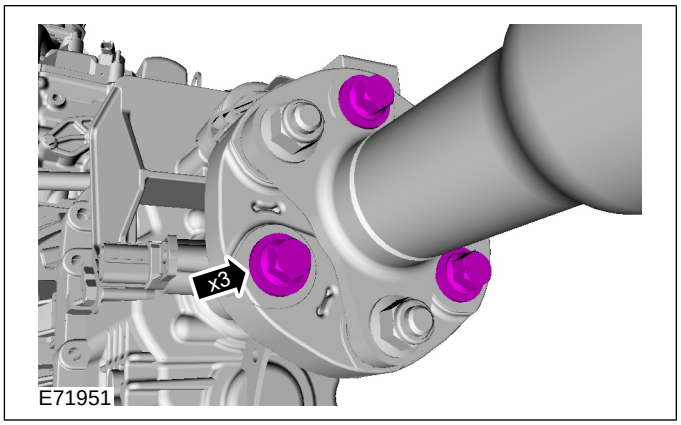


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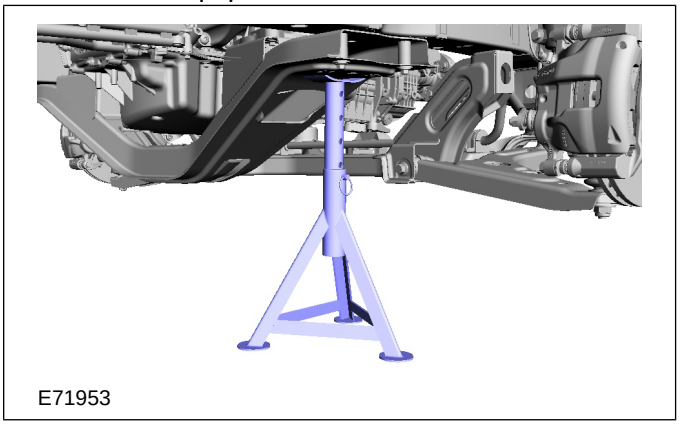
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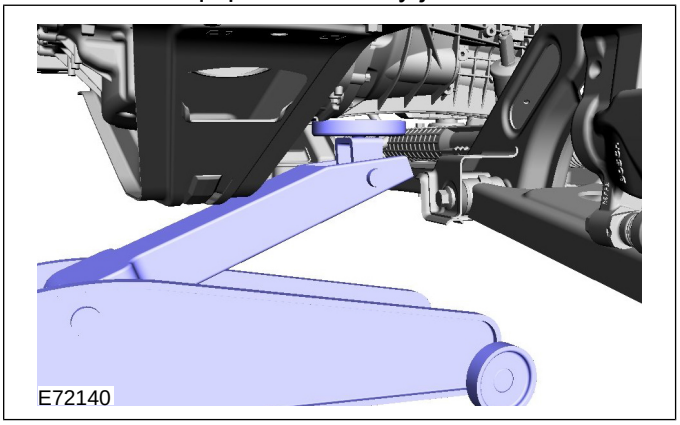
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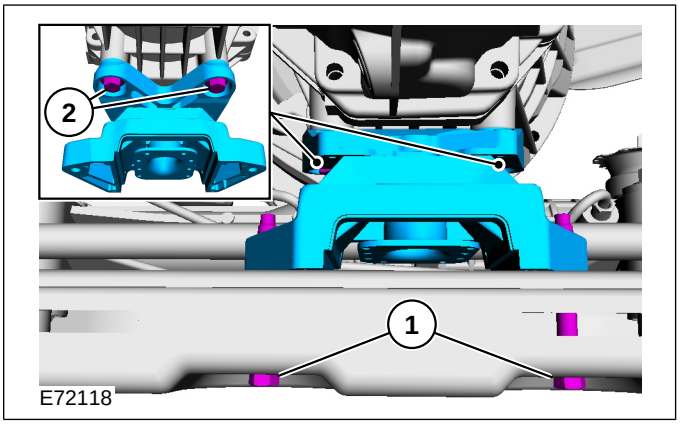
13. General Equipment: Vehicle/axle stands



14. General Equipment: Trolley jack

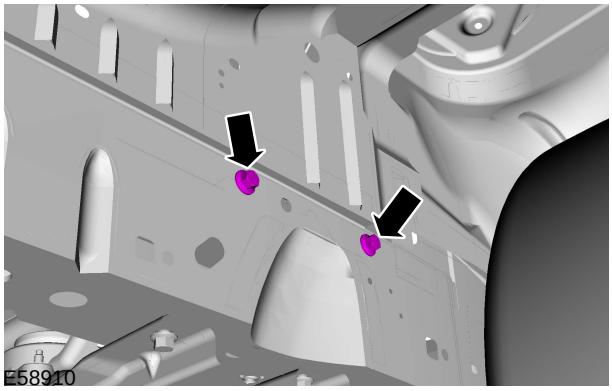


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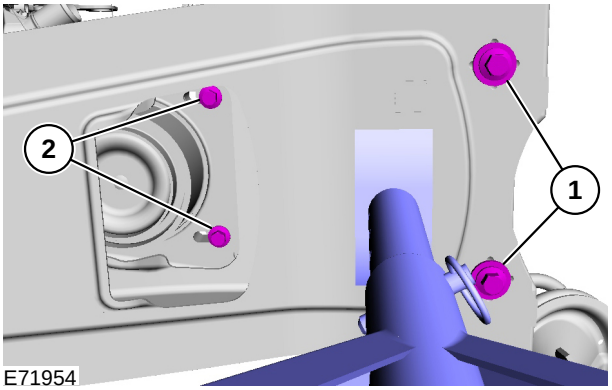


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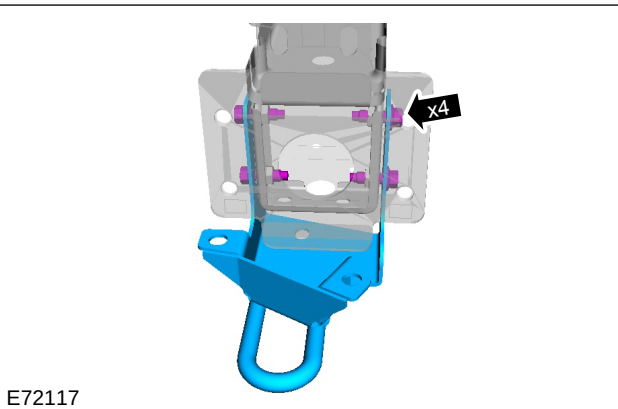
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17.



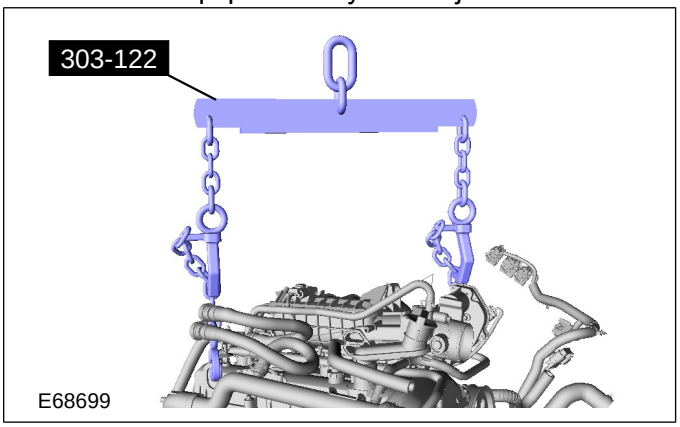
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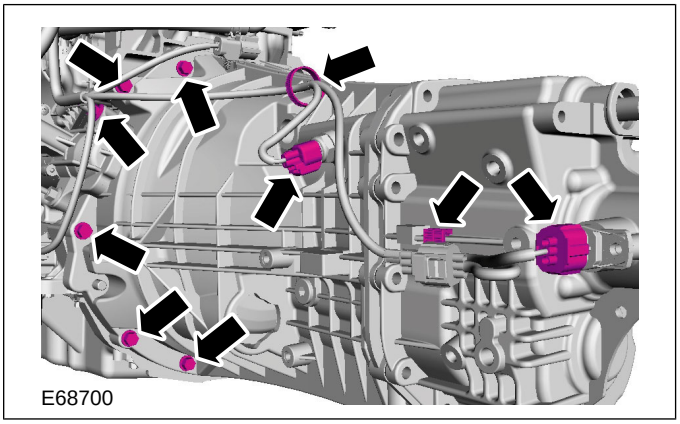
19. Push the vehicle back.

20. Install the special tool.

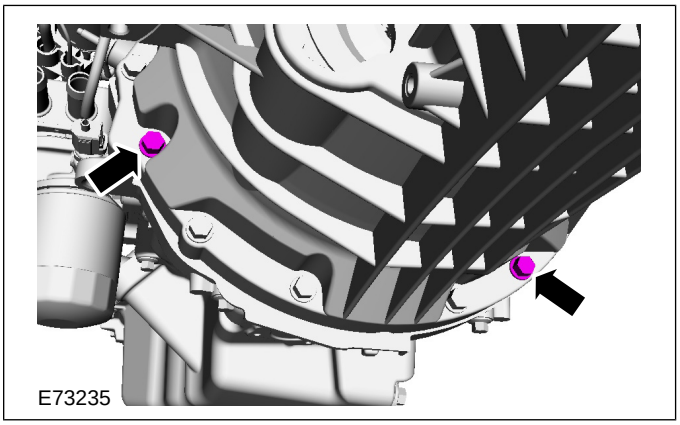
Special Tool(s): 303-122
General Equipment: Hydraulic jib crane



21.

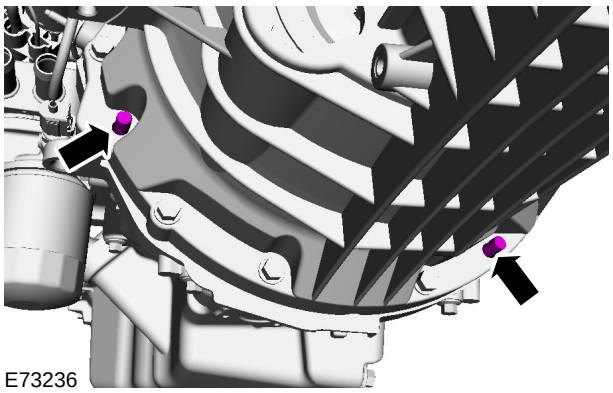


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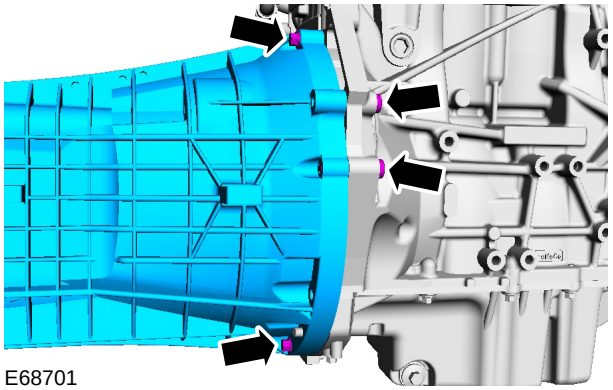


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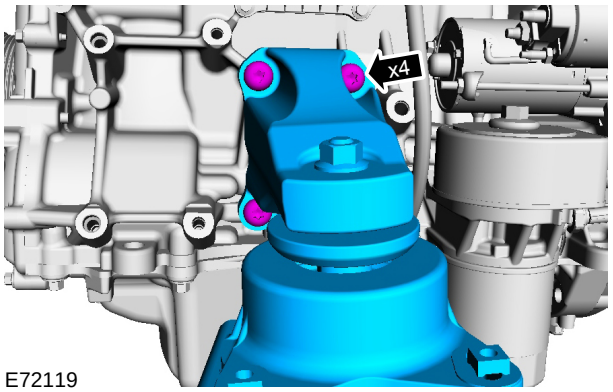
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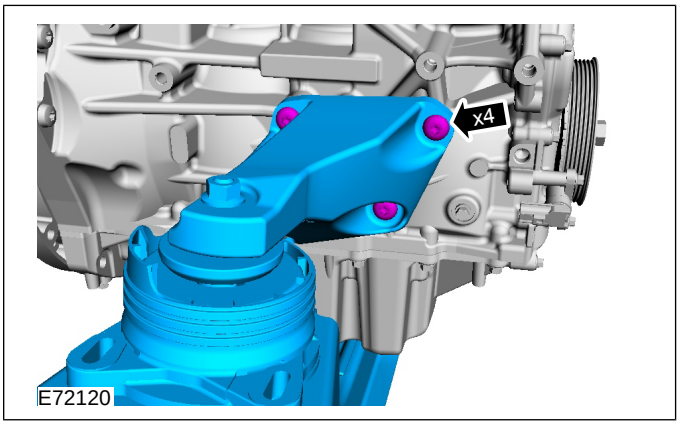
24.



25.



26.

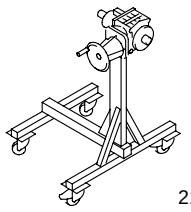
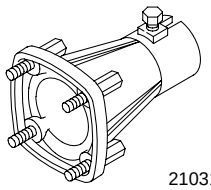
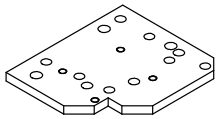
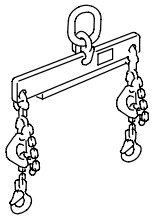
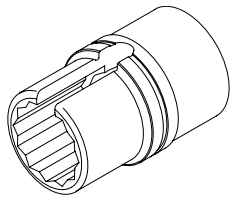
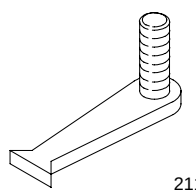


DISASSEMBLY

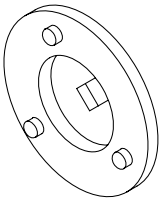
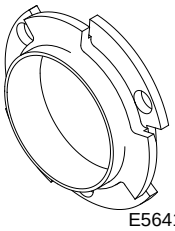
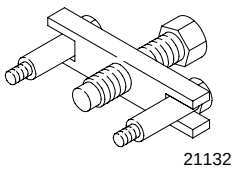
Engine

Disassembly

Special Tool(s)

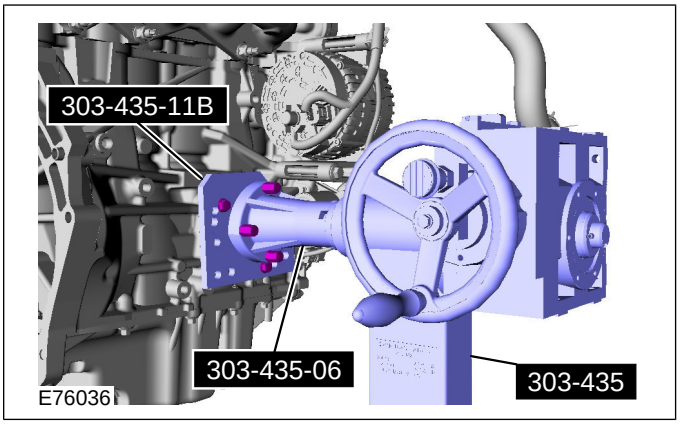
 21187	Mounting Stand 303-435
 21031B	Mounting Bracket for 303-435 303-435-06
 E68386	Mounting Plate for 303-435-06 303-435-11B
 21068A	Lifting Bracket, Engine 303-122
 303680	Socket, Cylinder Head Temperature Sensor 303-680
 21135	Locking Tool, Flywheel 303-254

Special Tool(s)

 303679	Remover/Installer, Engine Front Cover Inspection Plate 303-679
 E56412	Locking Tool, Fuel Injection Pump Sprocket 303-1151
 21132	Remover, Crankshaft Timing Pulley 303-249

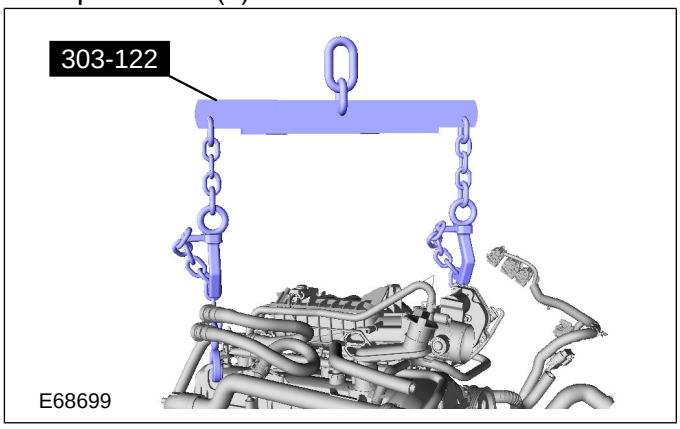
1. Install the special tools.

   Special Tool(s): 303-435, 303-435-06, 303-435-11B

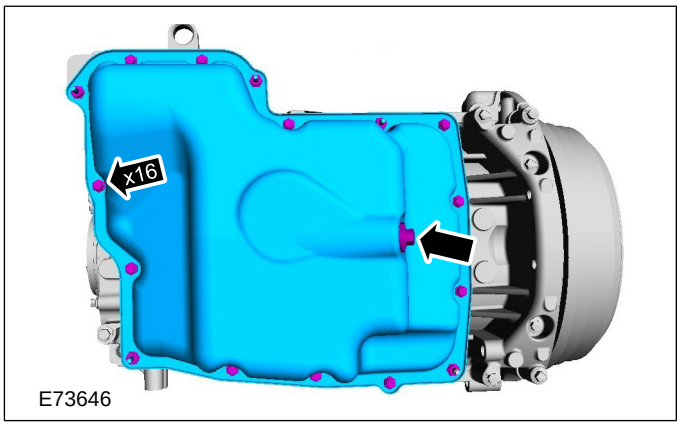


DISASSEMBLY

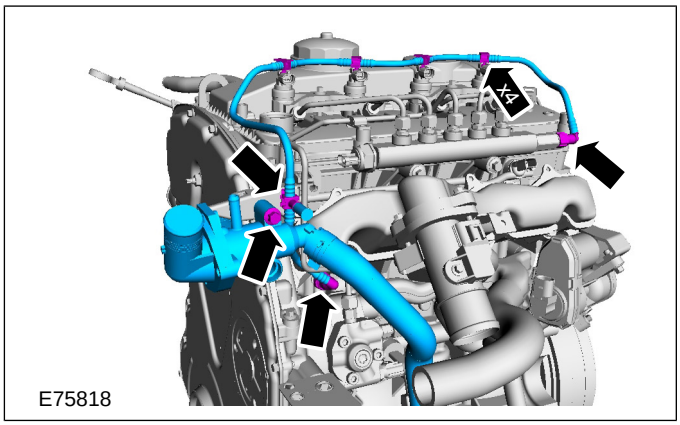
2. Remove the special tool.
Special Tool(s): 303-122



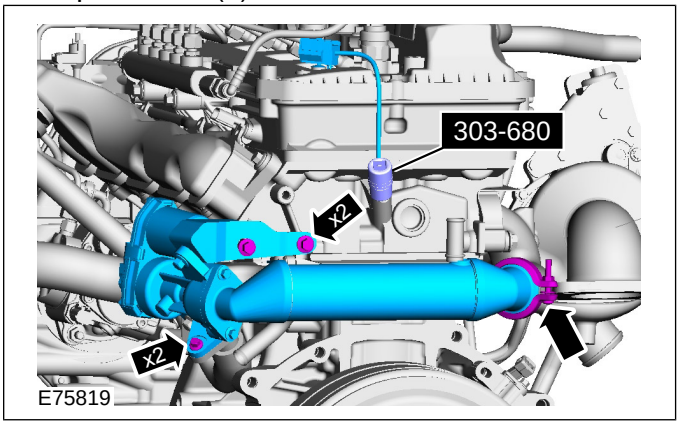
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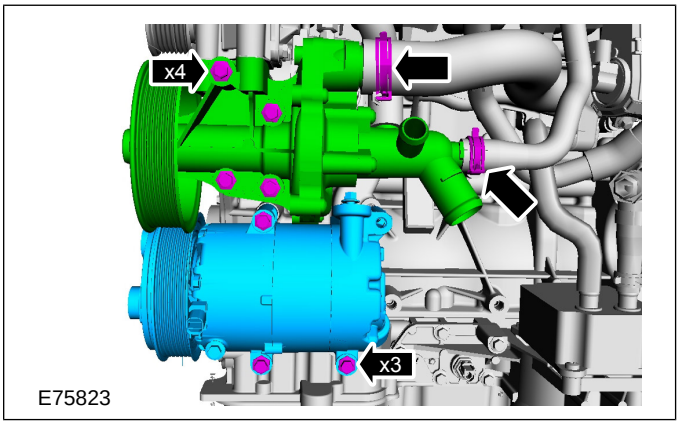
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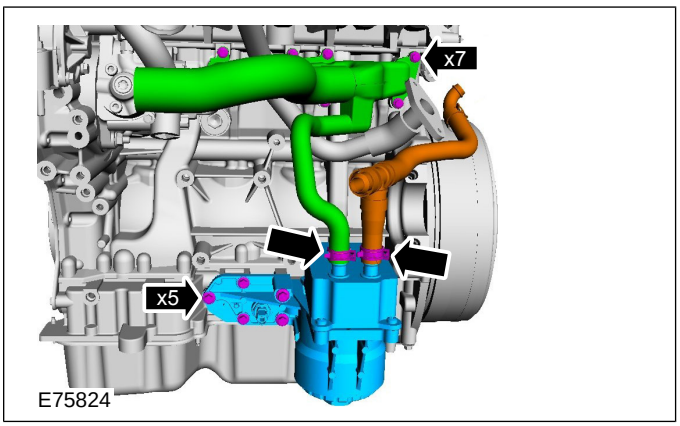
5. Special Tool(s): 303-680



6.

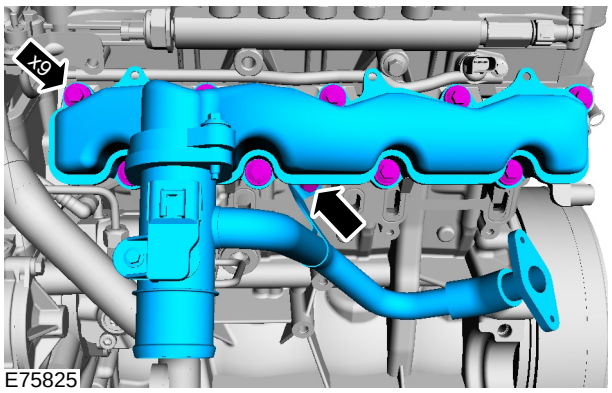


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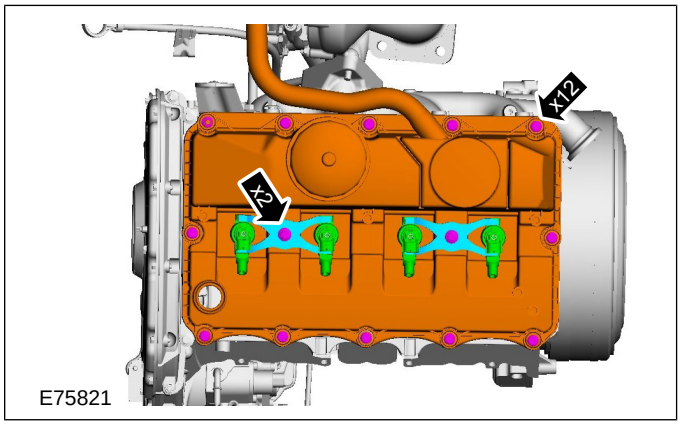


DISASSEMBLY

8.



11.



9. CAUTIONS:

Make sure that the fuel line remains in contact at both ends until both unions nuts have been unscrewed and the area around the joints thoroughly cleaned.

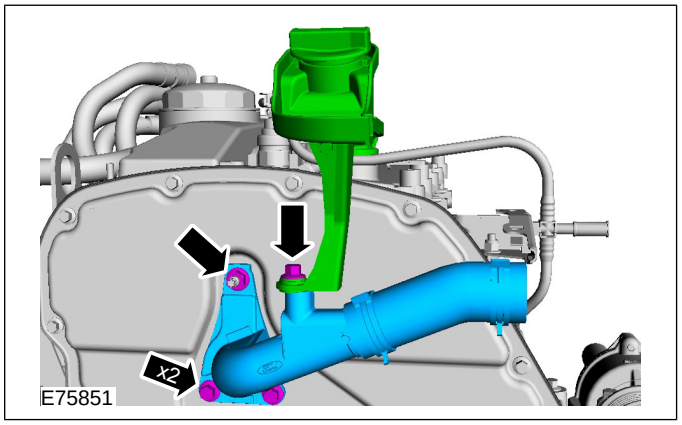
Make sure that the high-pressure fuel supply line remains in contact with both the fuel pump and the fuel rail until both unions have been detached and cleaned.

Make sure that all openings are sealed. Use new blanking caps.

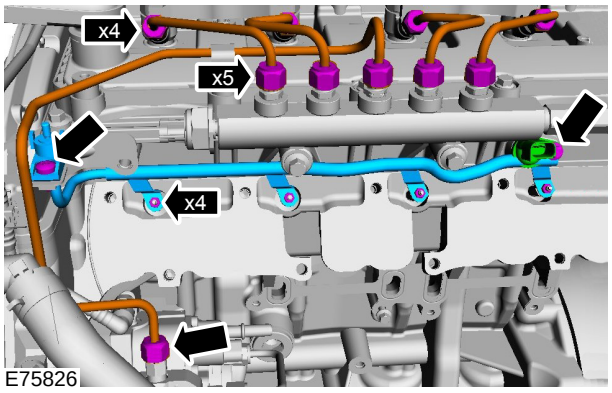
Vacuum foreign material from the high-pressure fuel supply line, the fuel pump and the fuel rail.

Refer to: Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).

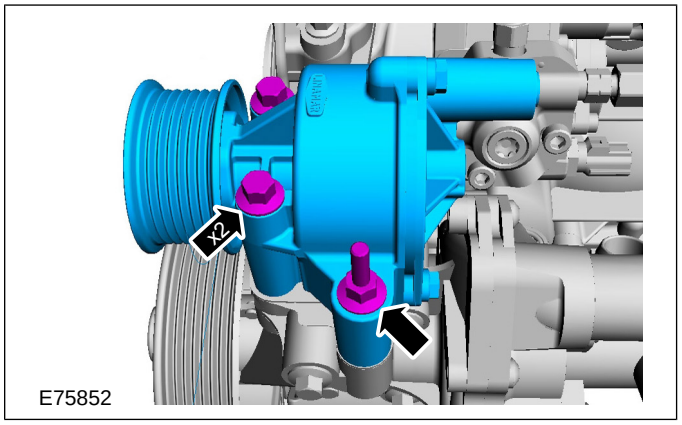
12.



10. Discard the high-pressure fuel supply lines.

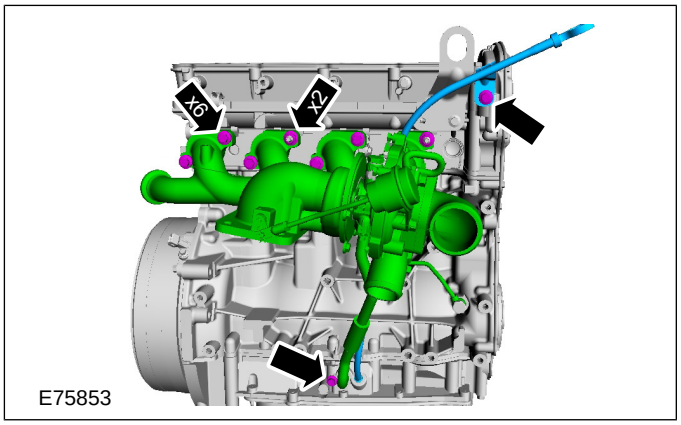


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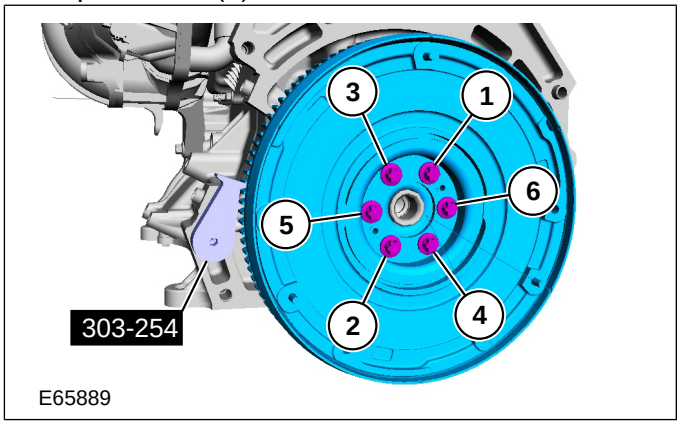


DISASSEMBLY

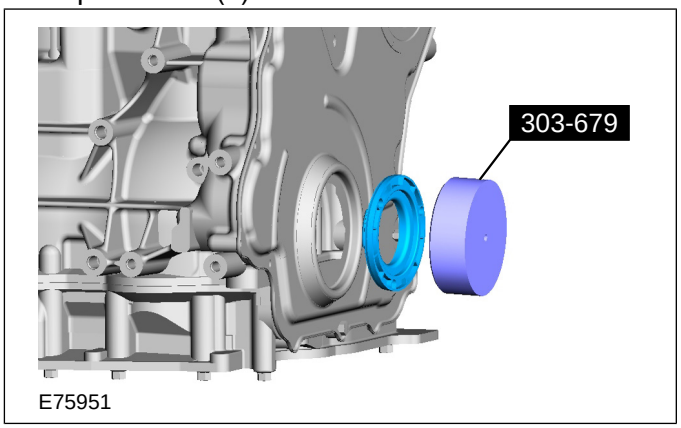
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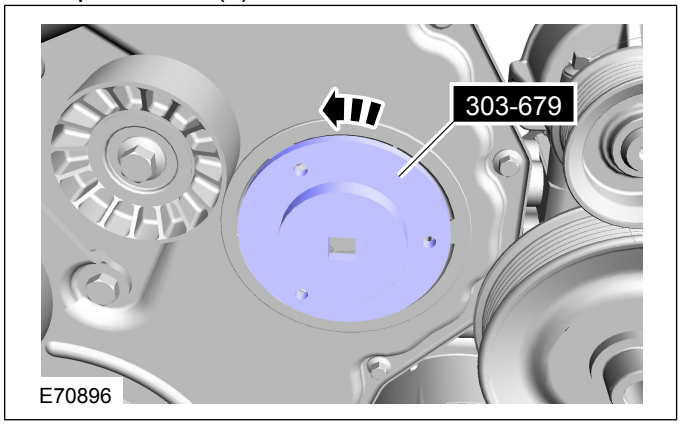
15. Special Tool(s): 303-254



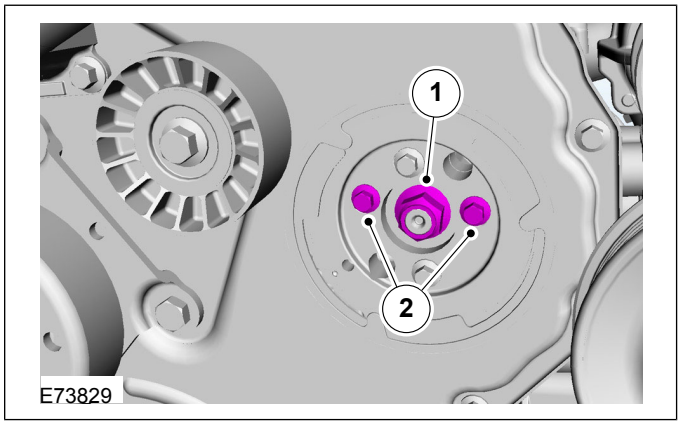
16. Special Tool(s): 303-679



17. Special Tool(s): 303-679

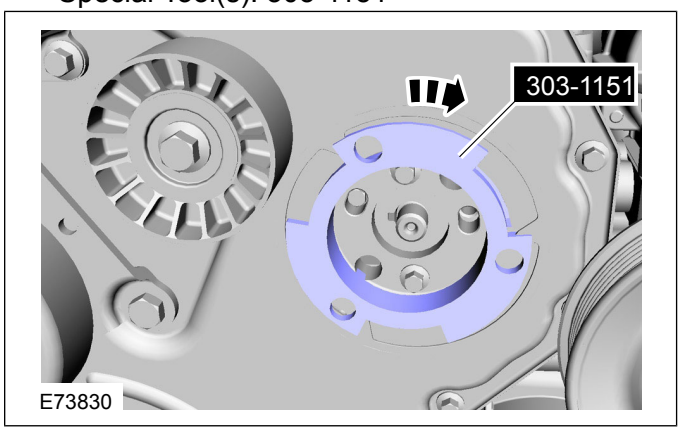


18.



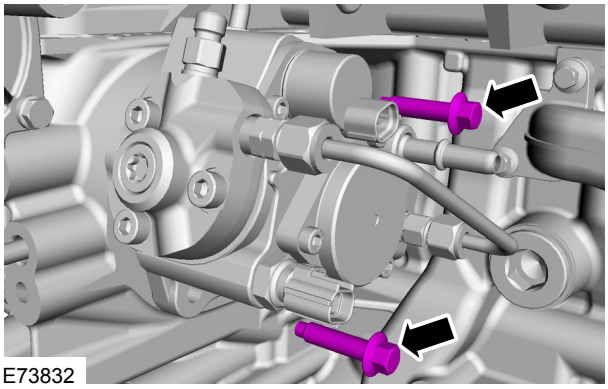
19. Using the special tool, support the fuel pump sprocket.

Special Tool(s): 303-1151



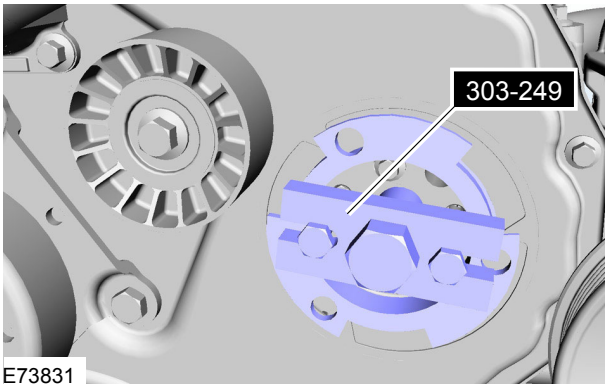
DISASSEMBLY

20.

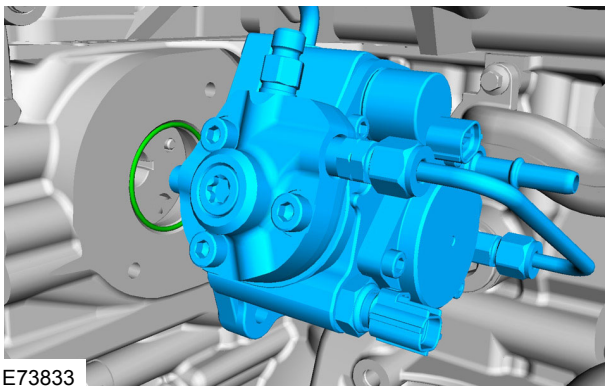


21. While supporting the fuel pump, operate the special tool.

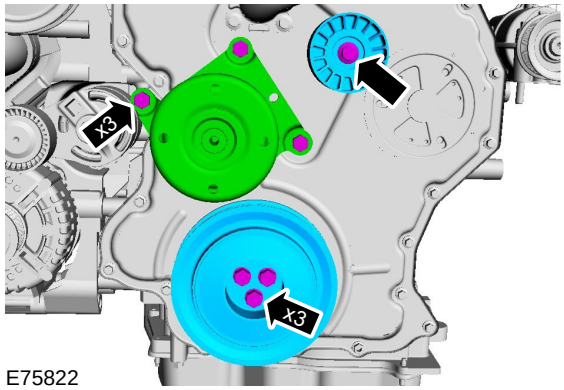
Special Tool(s): 303-249



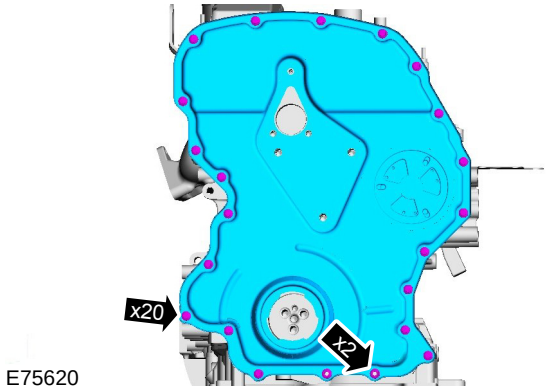
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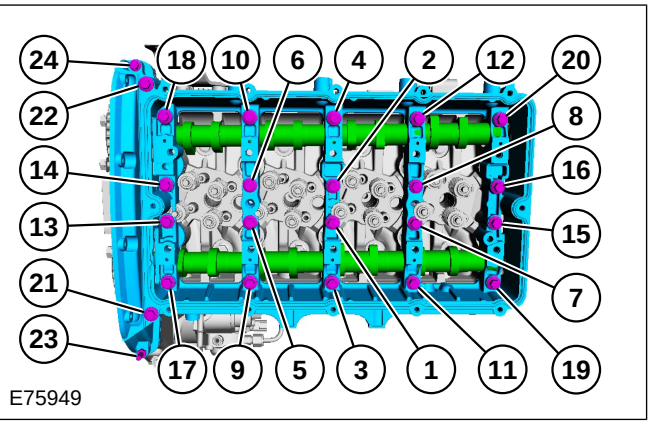
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24.

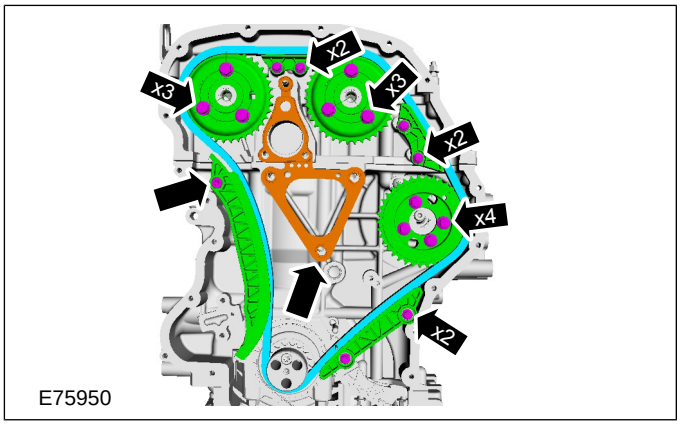


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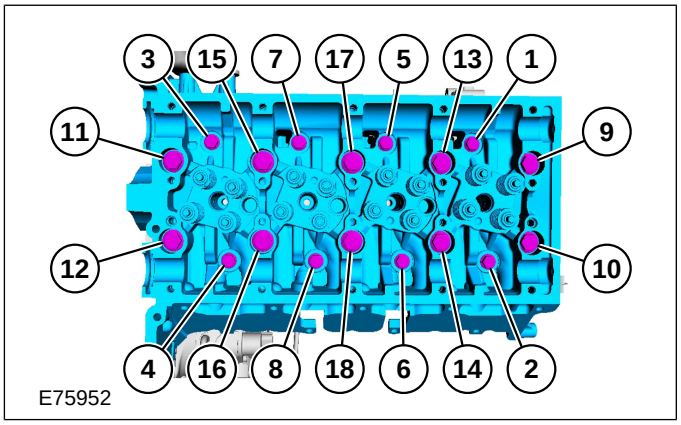


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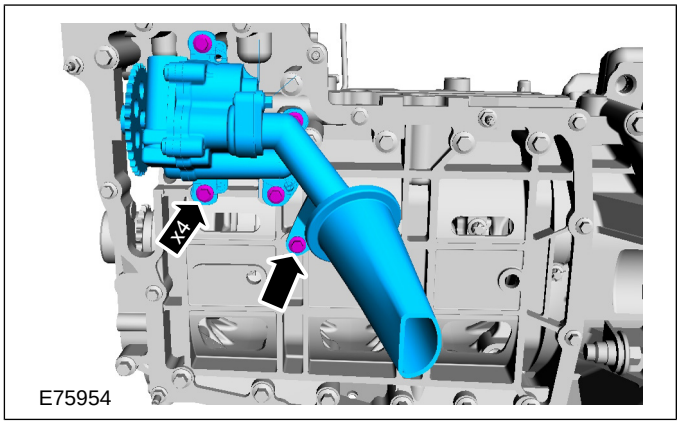
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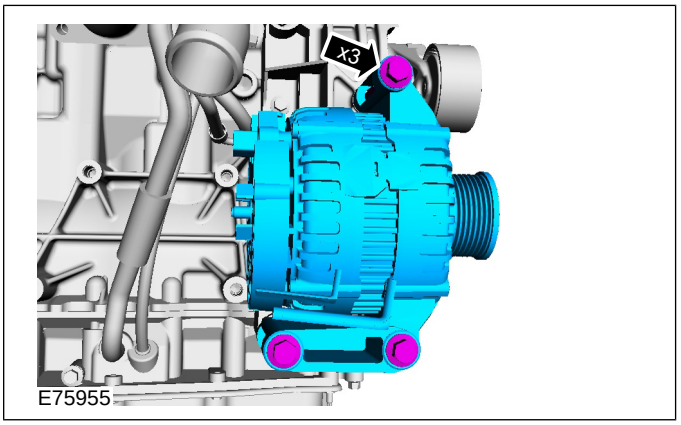
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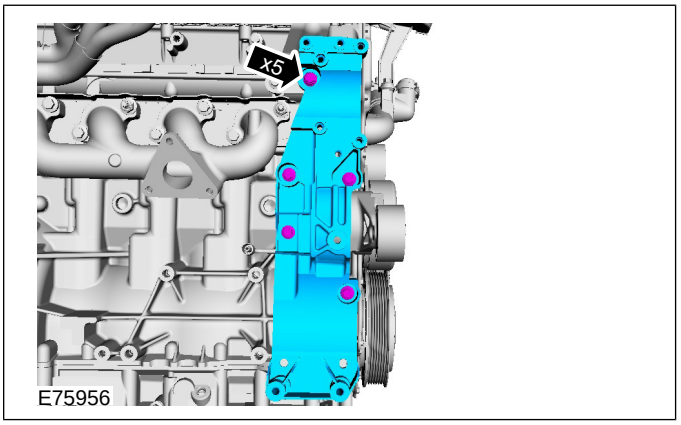
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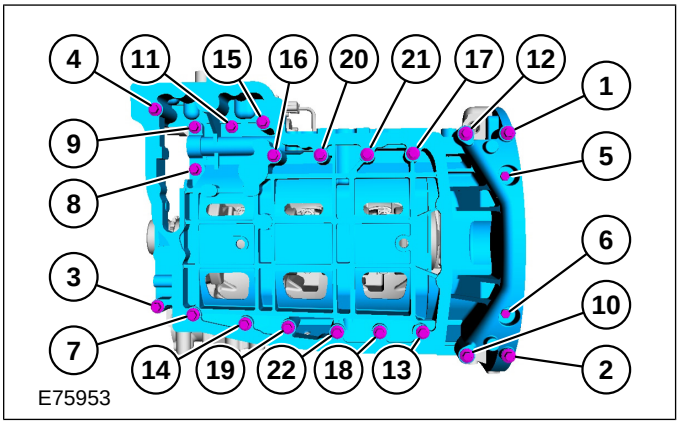
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30.

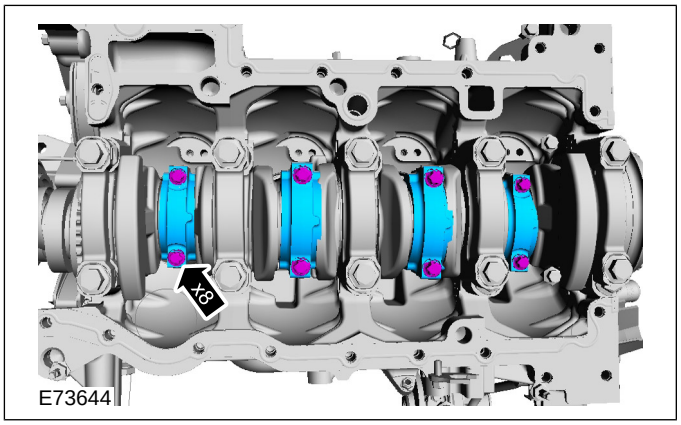


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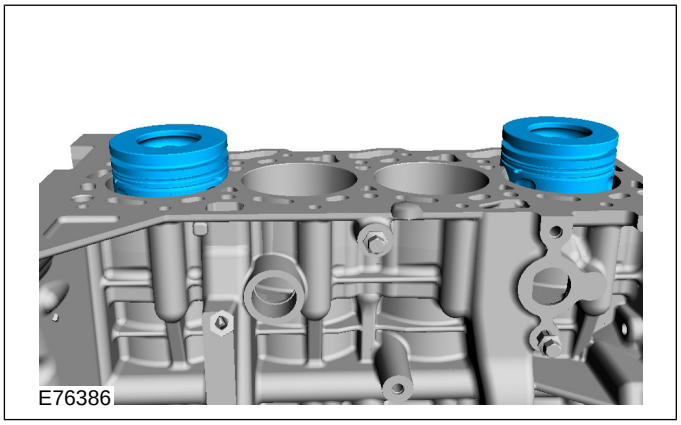


DISASSEMBLY

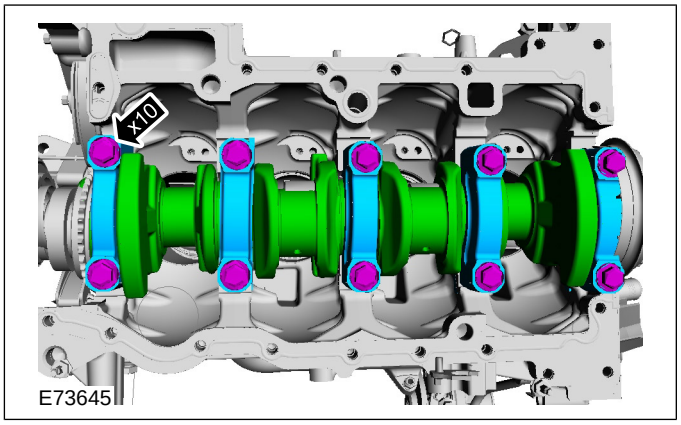
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33.



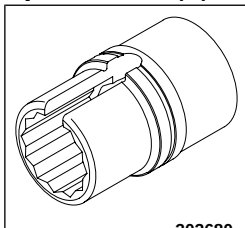
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DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

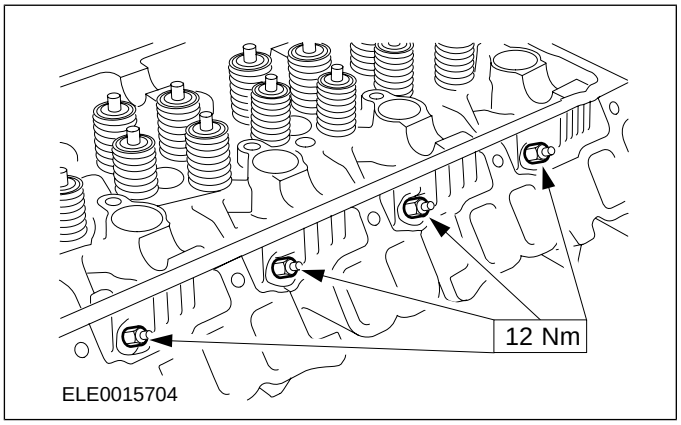
Cylinder Head (21 165 6)

Special Tool(s)

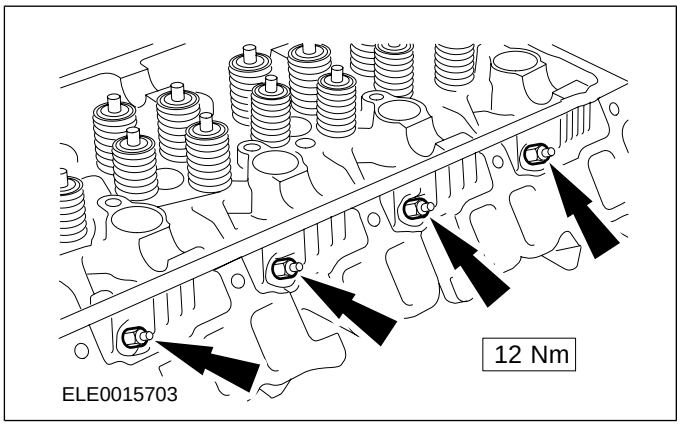
 303680	Socket Wrench, Cylinder Head Temperature (CHT) Sensor 303-680 (21-239)

Disassembly

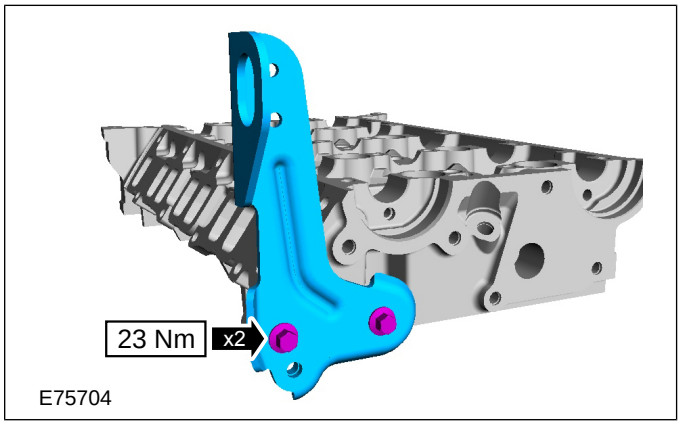
1. **Disconnect the glow plug electrical connectors.**



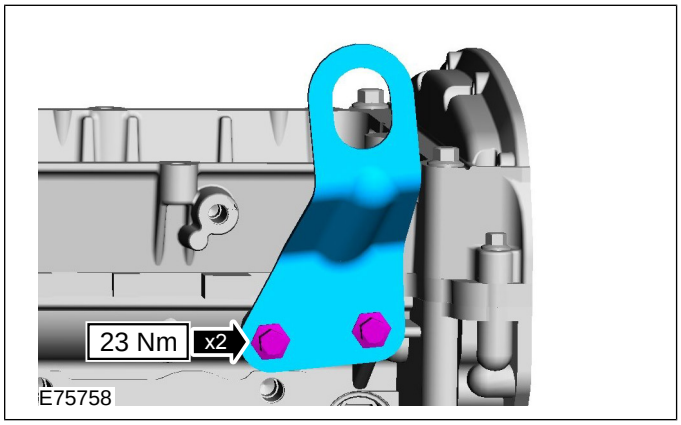
2. **Remove the glow plugs.**



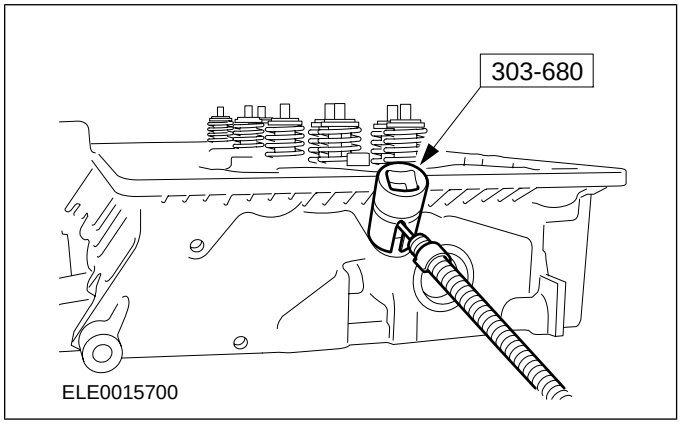
3. **Remove the engine front lifting eye.**



4. **Remove the engine rear lifting eye.**



5. **Using the special tool, remove the cylinder head temperature (CHT) sensor.**
   - Discard the CHT sensor.

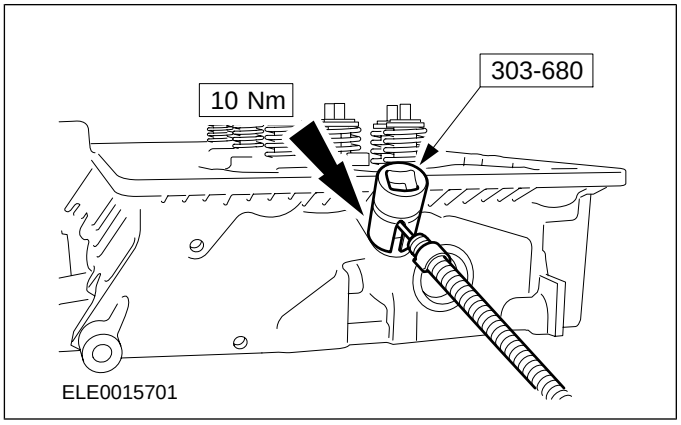


Assembly

1. **To assemble, reverse the disassembly procedure.**

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

2. **⚠CAUTION:Install a new cylinder head temperature (CHT) sensor.**

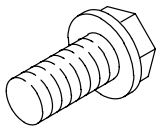
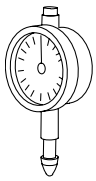
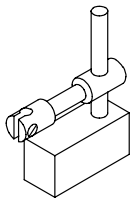
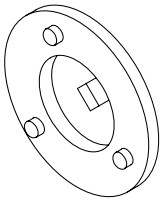
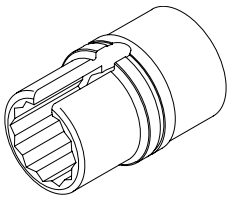
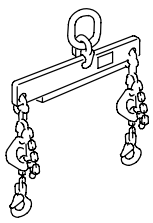


ASSEMBLY

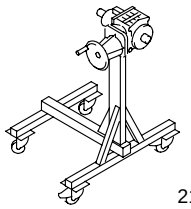
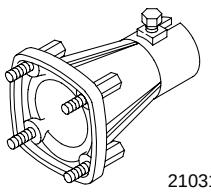
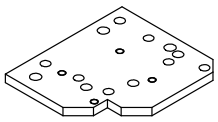
Engine

Assembly

Special Tool(s)

 21182	Bolt, Cylinder Liner 303-431
 15046	Dial Indicator Gauge (Metric) 205-069
 15008	Holding Fixture, Dial Indicator Gauge 205-044
 303679	Remover/Installer, Engine Front Cover Inspection Plate 303-679
 303680	Socket, Cylinder Head Temperature Sensor 303-680
 21068A	Lifting Bracket, Engine 303-122

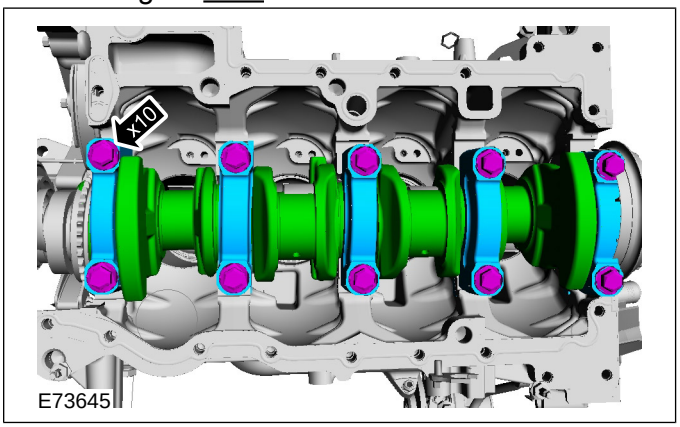
Special Tool(s)

 21187	Mounting Stand 303-435
 21031B	Mounting Bracket for 303-435 303-435-06
 E68386	Mounting Plate for 303-435-06 303-435-11B

General Equipment

Piston ring compressor
Round-ended steel rule

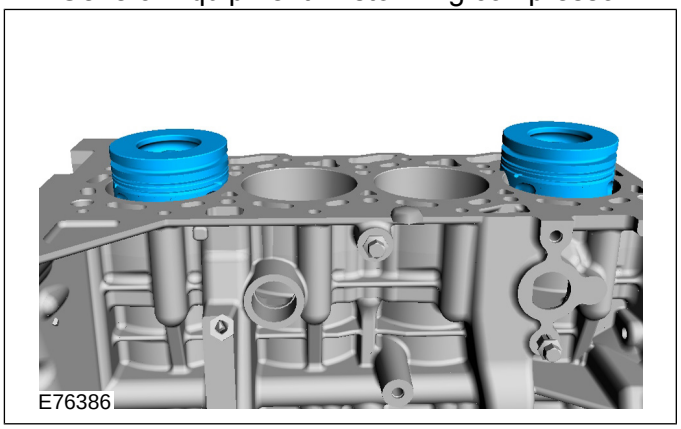
1. Torque:
   - Stage1: 45 Nm
   - Stage2: 80 Nm
   - Stage3: 105°



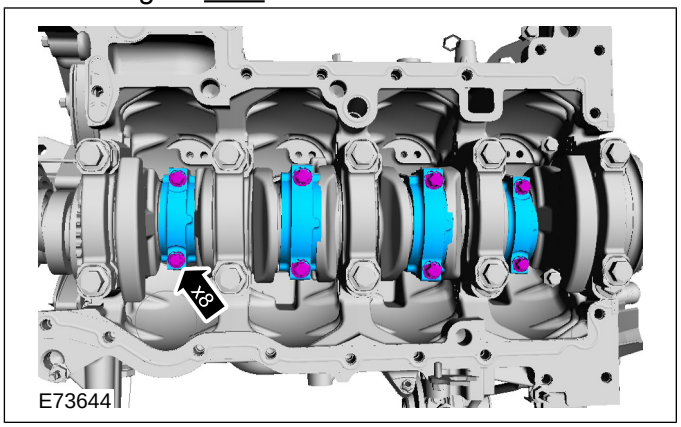
ASSEMBLY

2. The piston ring gaps must be distributed evenly around the circumference of the piston. This also applies to the oil control ring elements. Align the piston ring gaps at 120° to each other.

   General Equipment: Piston ring compressor

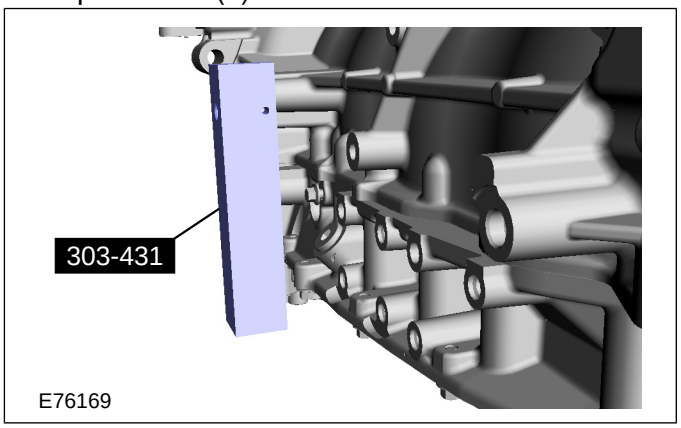


3. Torque:
   - Stage1: 30 Nm
   - Stage2: 100°



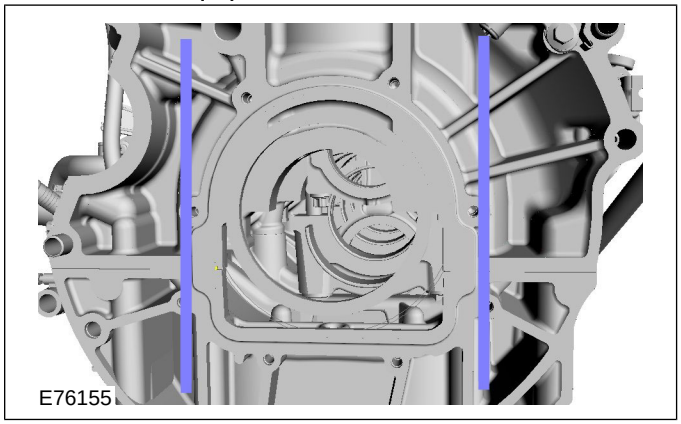
4. The ladder frame and the cylinder block must be aligned so that the side clearance does not exceed 0.05 mm overlap to 0.05 mm gap.

   Special Tool(s): 303-431

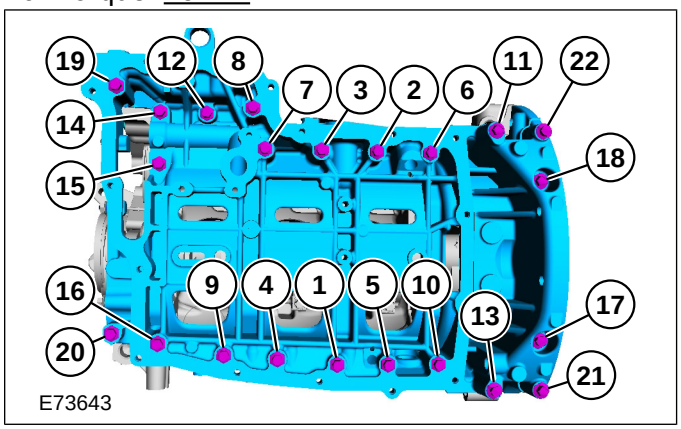


5. The ladder frame and the cylinder block must be aligned so that the rear clearance does not exceed 0.01 mm overlap to 0.2 mm gap.

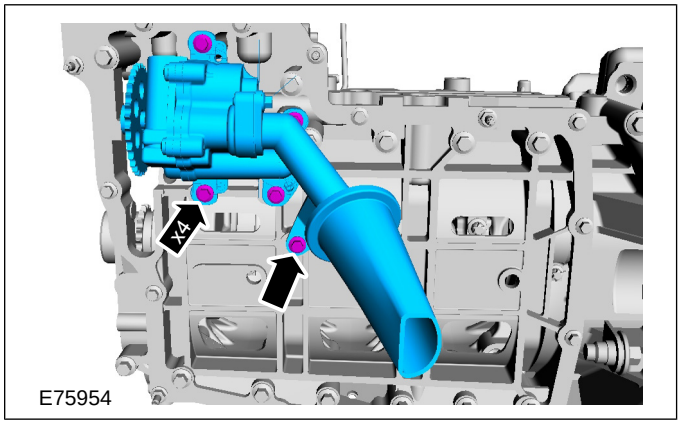
   General Equipment: Round-ended steel rule



6. Torque: 23 Nm



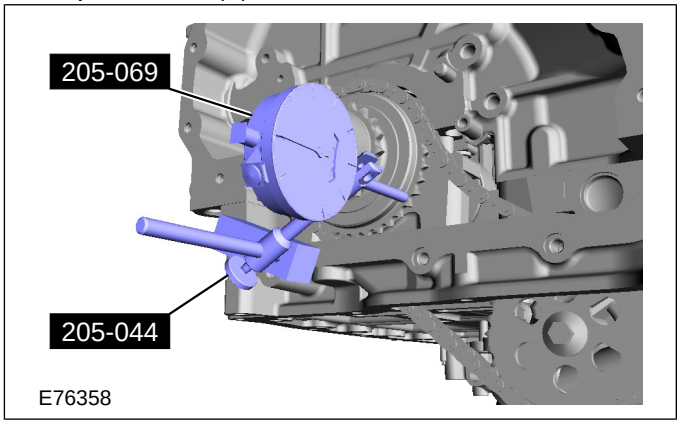
7. **NOTE:** Only tighten the bolts finger tight at this stage.



ASSEMBLY

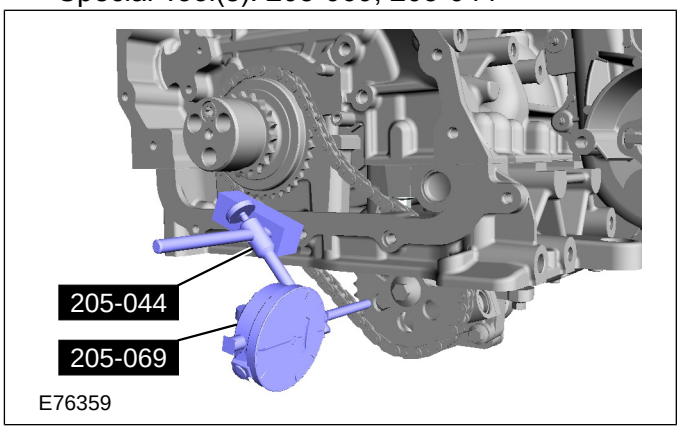
8. Take a reference measurement from the front face of the crankshaft sprocket.

   Special Tool(s): 205-069, 205-044

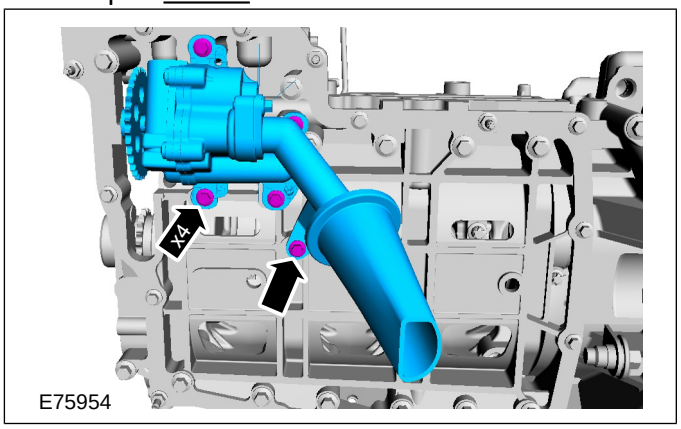


9. Take measurements at two different points on the oil pump sprocket and align the oil pump sprocket.

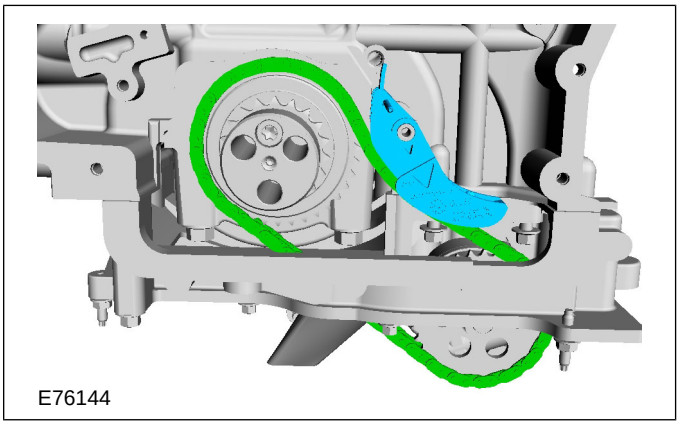
   Special Tool(s): 205-069, 205-044



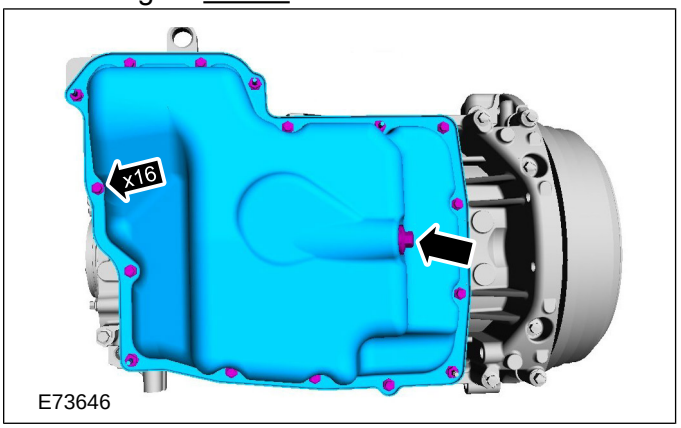
10. Torque: 10 Nm



11.

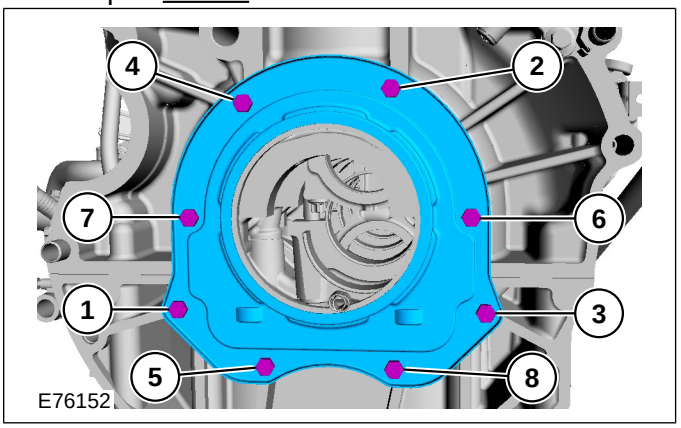


12. Torque:
    - Stage1: 7 Nm
    - Stage2: 14 Nm



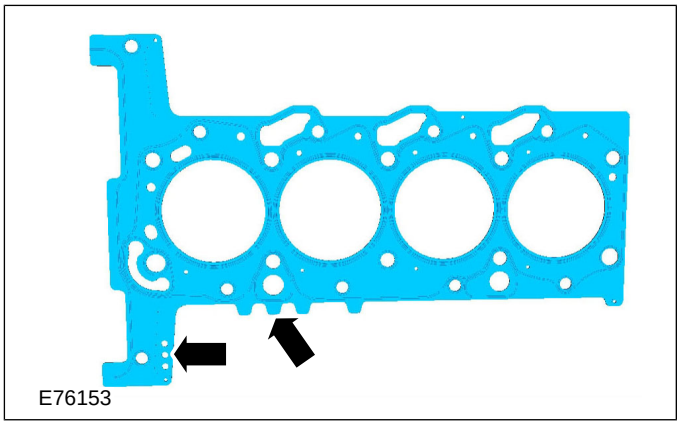
13. **NOTE:** New crankshaft rear seal carriers are supplied with an alignment sleeve which must be removed after installation.

    Torque: 10 Nm



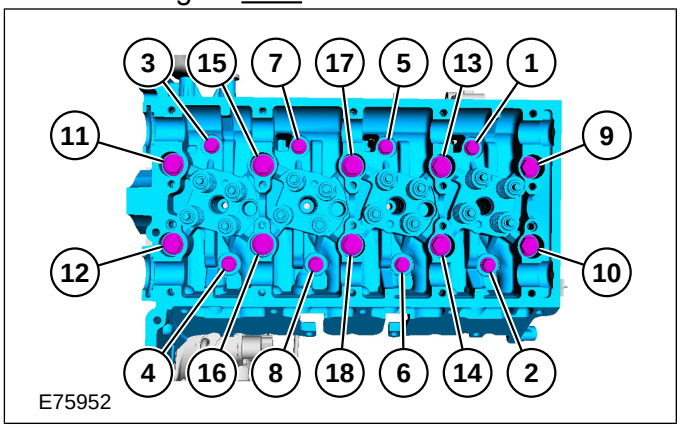
ASSEMBLY

14.

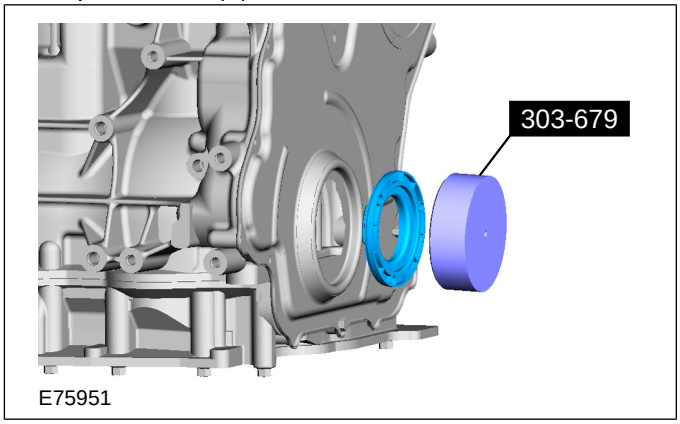


15. Torque:

-
  - Stage1: 20 Nm
  - Stage2: 40 Nm
  - Stage3: 180°
-
  - Stage1: 10 Nm
  - Stage2: 20 Nm
  - Stage3: 180°

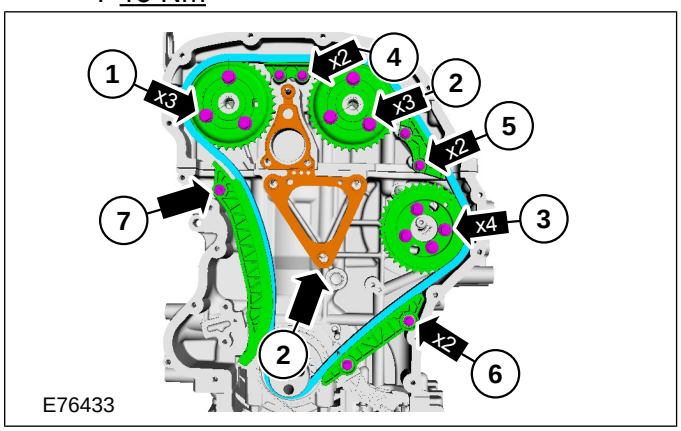


16. Special Tool(s): 303-679



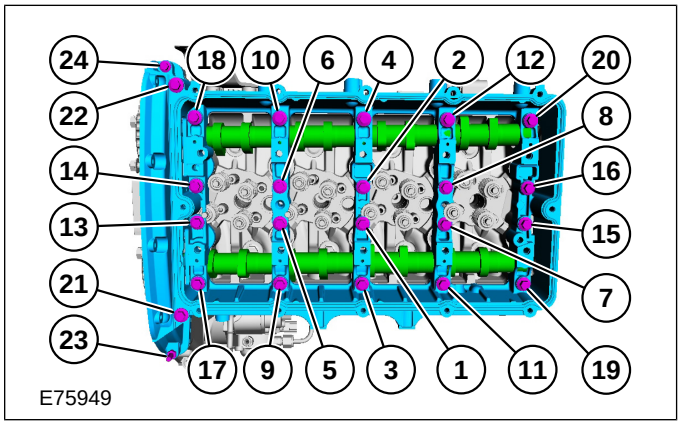
17. Torque:

- 1 33 Nm
- 2 33 Nm
- 3 32 Nm
- 4 15 Nm
- 5 15 Nm
- 6 15 Nm
- 7 15 Nm

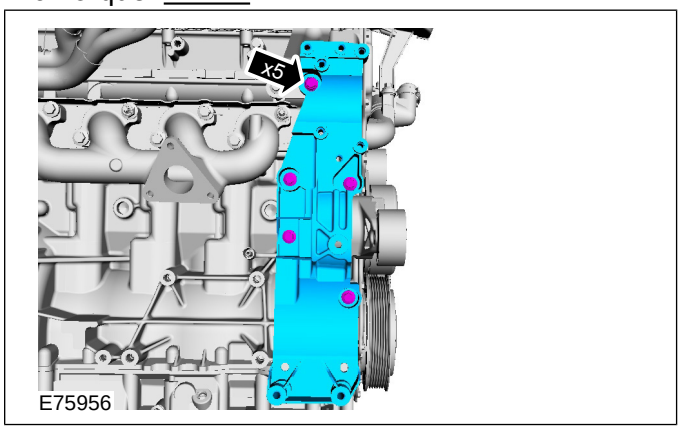


18. Torque:

- Bolts 1 to 22 23 Nm
- Bolts 23 to 24 10 Nm

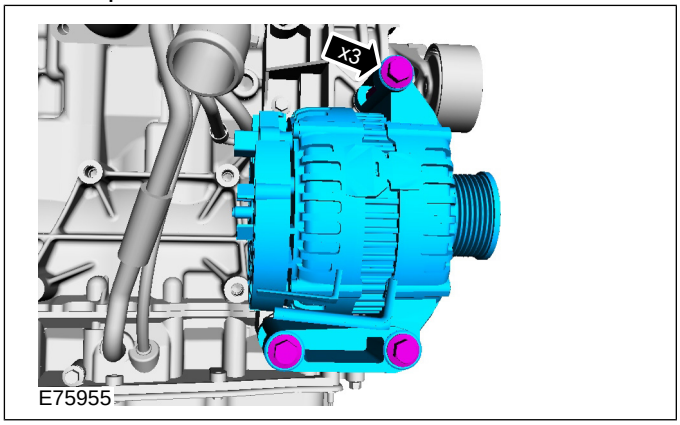


19. Torque: 22 Nm

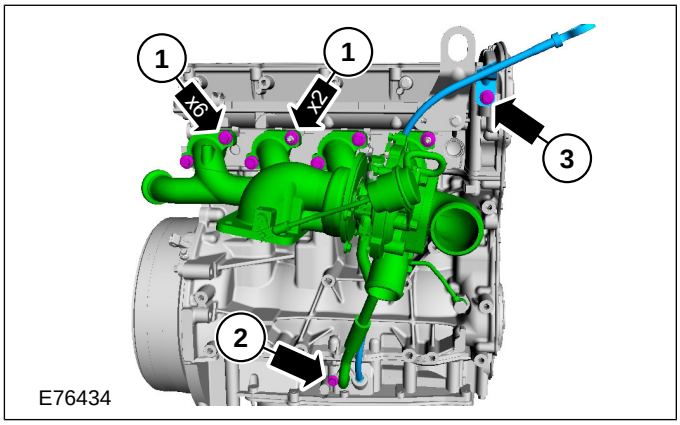


ASSEMBLY

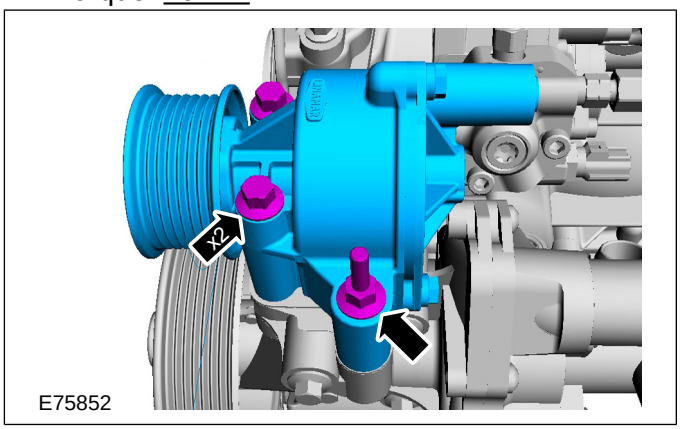
20. Torque: 20 Nm



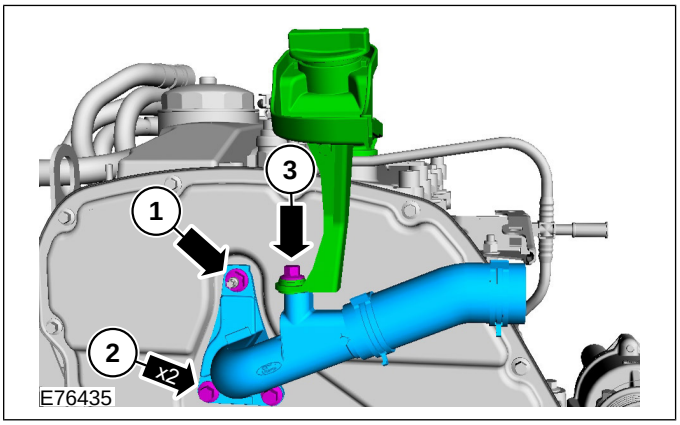
21. Torque:
- 1 40 Nm
- 2 23 Nm
- 3 23 Nm



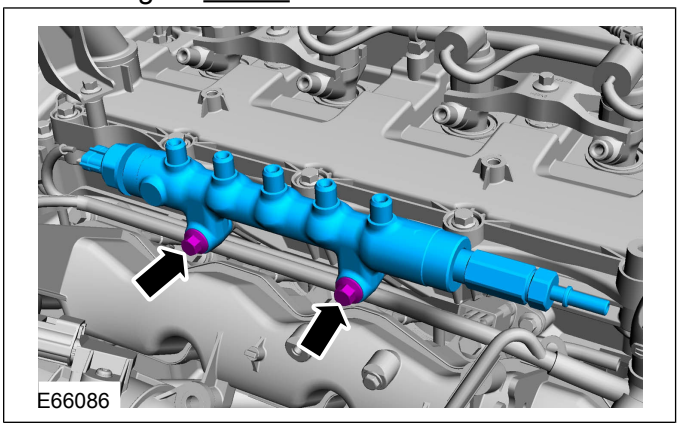
22. Torque: 20 Nm



23. Torque:
- 1 23 Nm
- 2 23 Nm
- 3 10 Nm



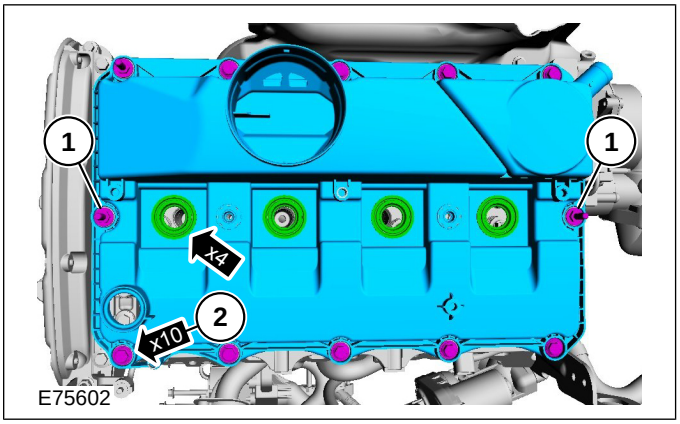
24. Torque:
- Stage1: 6 Nm
- Stage2: 23 Nm



25. 1. **NOTE:**Make sure that a new component is installed.

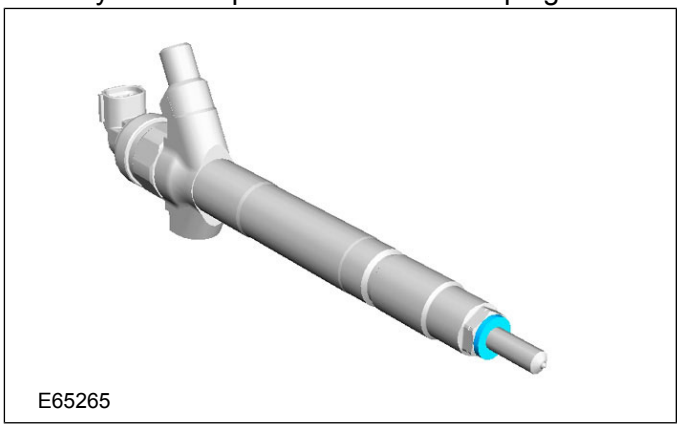
Torque: 10 Nm

2. Torque: 10 Nm



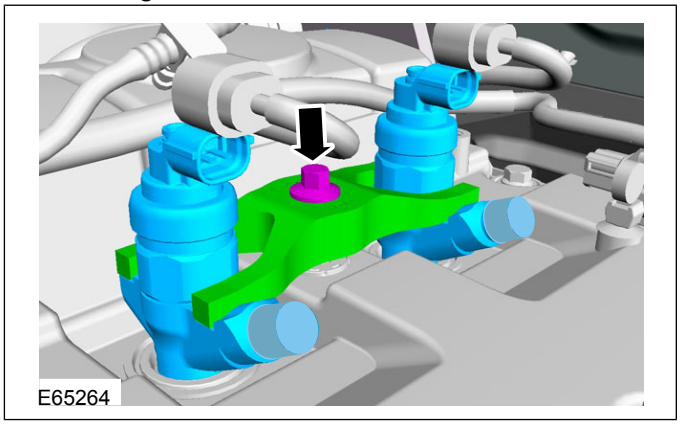
ASSEMBLY

26. Using a socket (or similar), press the new fuel injector copper seals onto the fuel injectors making sure that the copper seals are pushed fully home to prevent uneven clamping.

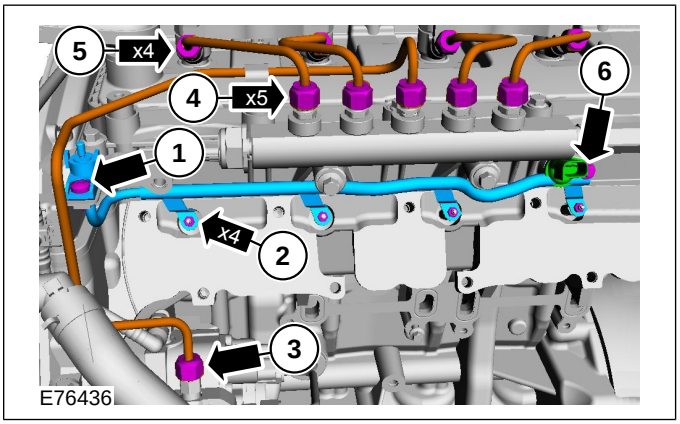


27. **CAUTION:Make sure that new bolts are installed.**

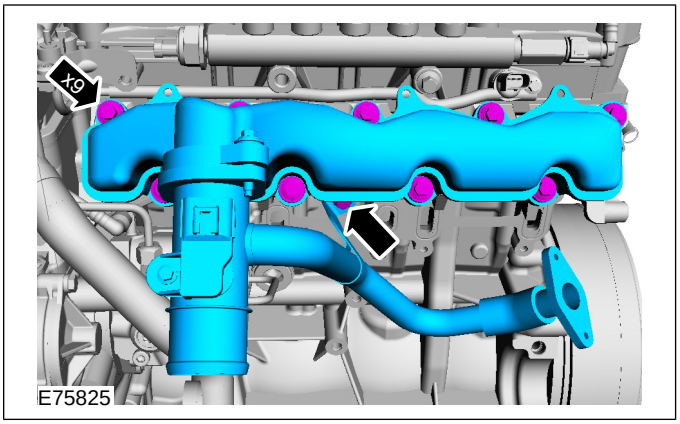
Torque:
- Stage1: 6 Nm
- Stage2: 180°



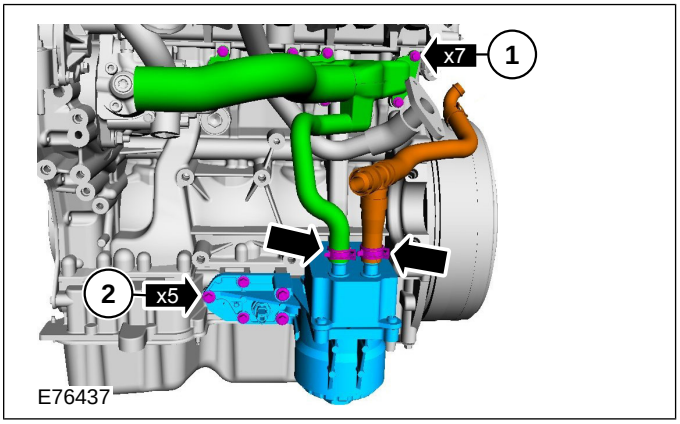
28. Install new fuel injector and fuel rail high-pressure fuel supply lines.
Torque:
- 1 6 Nm
- 2 3 Nm
- 3 35 Nm
- 4 35 Nm
- 5 35 Nm
- 6 10 Nm



29. **NOTE:**Only tighten the bolts finger tight at this stage.

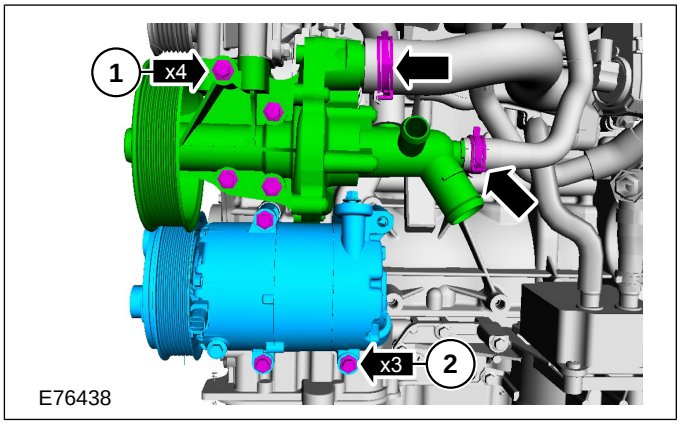


30. Torque:
- 1 10 Nm
- 2 23 Nm

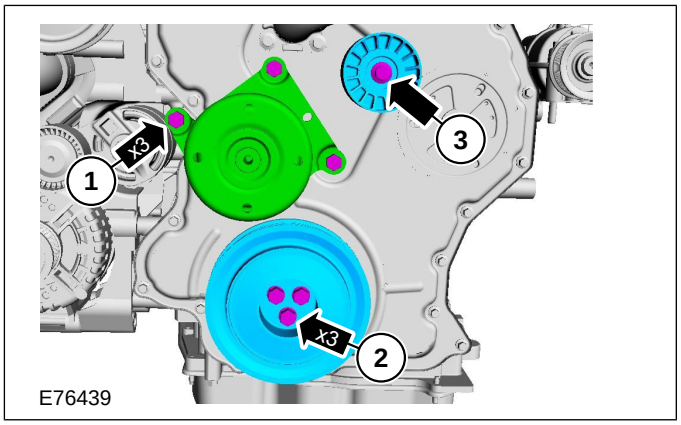


ASSEMBLY

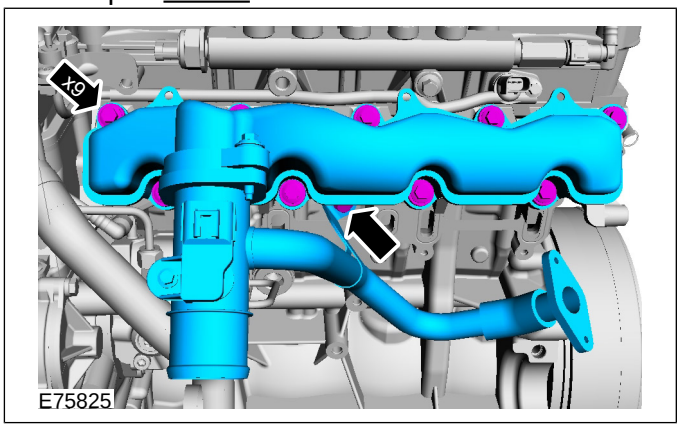
31. Torque:
- 1 23 Nm
- 2 25 Nm



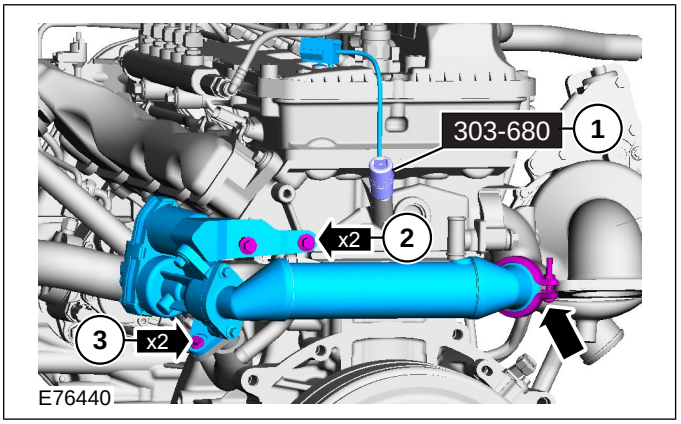
32. 1. Torque: 48 Nm
2. Torque:
   - Stage1: 45 Nm
   - Stage2: 90°
3. Torque: 48 Nm



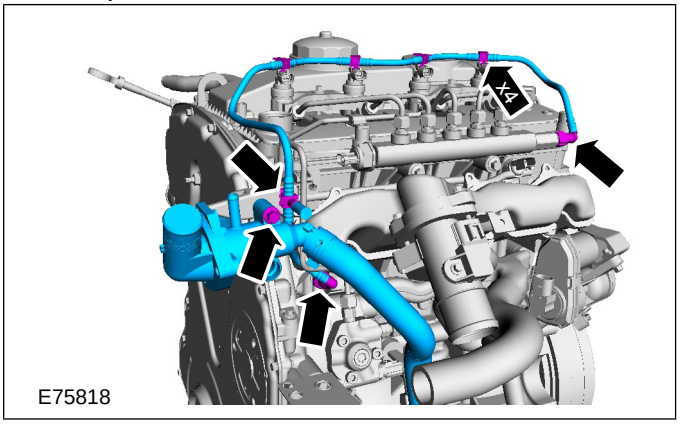
33. Torque: 10 Nm



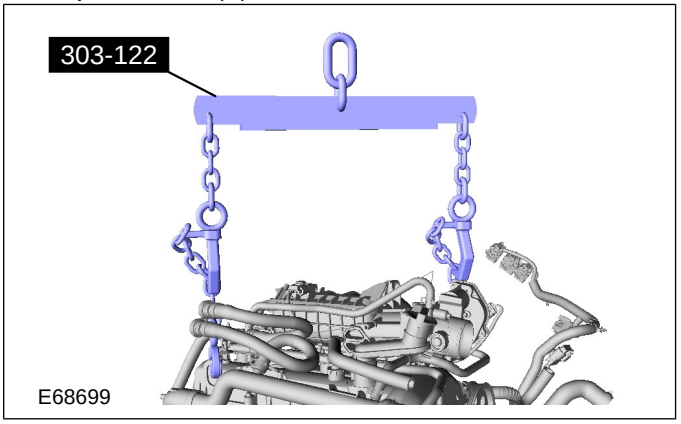
34. Special Tool(s): 303-680
Torque:
- 1 10 Nm
- 2 23 Nm
- 3 23 Nm



35. Torque: 10 Nm

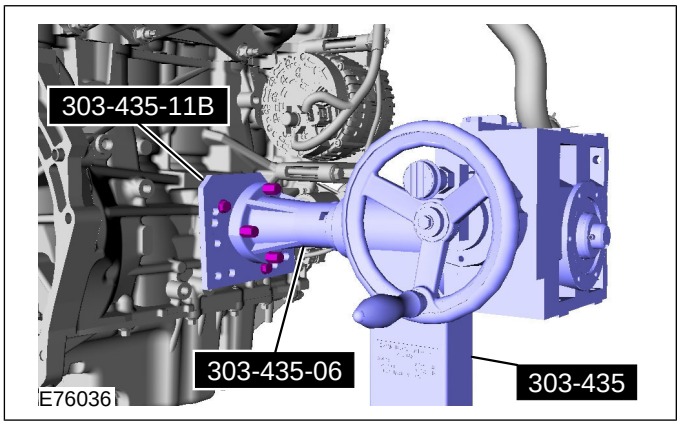


36. Special Tool(s): 303-122



ASSEMBLY

37. Special Tool(s): 303-435, 303-435-06, 303-435-11B

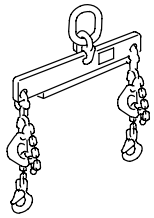


INSTALLATION

Engine

Installation

Special Tool(s)

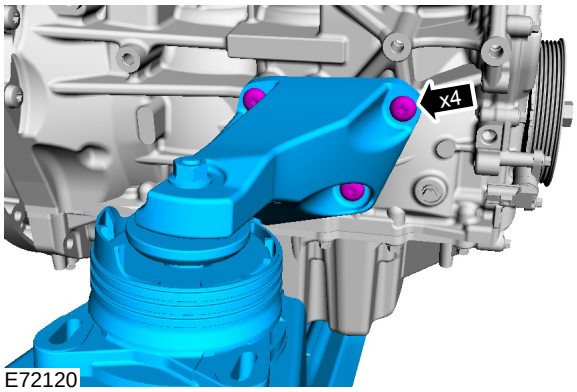
 21068A	Lifting Bracket, Engine 303-122

Materials	
Name	**Specification**
High-Temperature Grease	ESD-M1C220-A

General Equipment

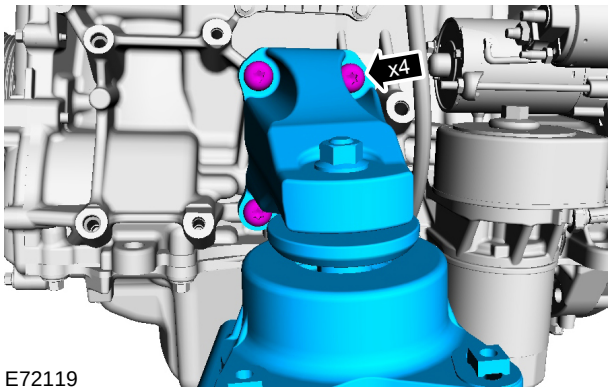
Vehicle/axle stands
Hydraulic jib crane
Trolley jack
Coolant hose clamp remover/installer

1. Torque: 62 Nm



E72120

2. Torque: 62 Nm

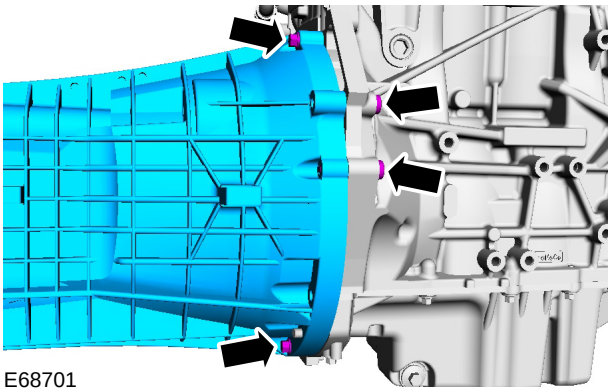


E72119

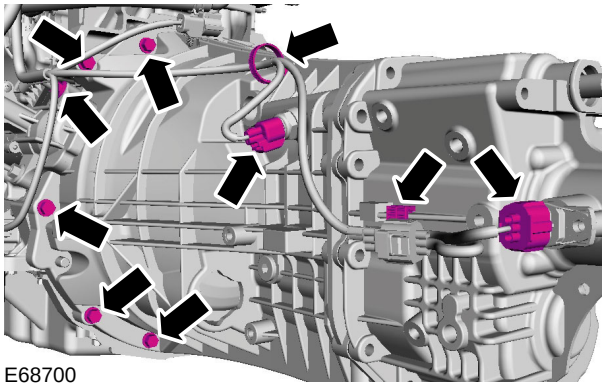
3. ⚠ **CAUTION:Make sure that the transmission is installed straight in relation to the engine to prevent damage to the pilot bearing.**

Apply a thin film of grease to the input shaft guide sleeve.

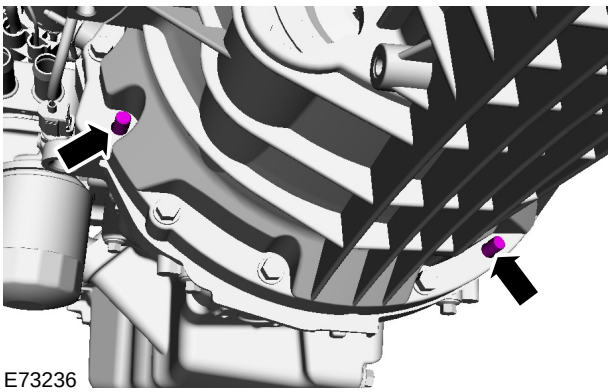
Material: High-Temperature Grease
Torque: 40 Nm


E68701

4. Torque: 40 Nm

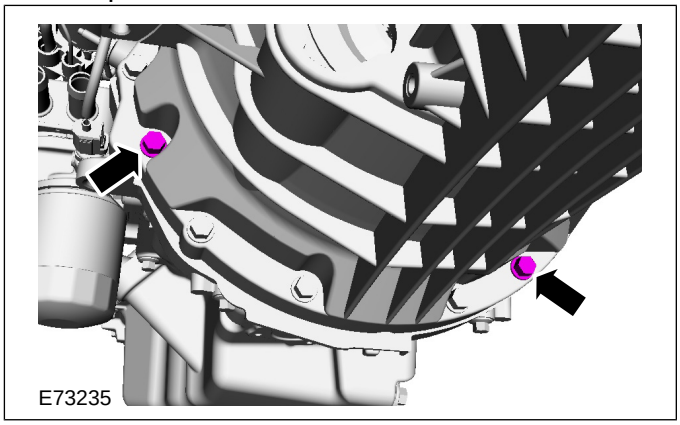

E68700

5.


E73236

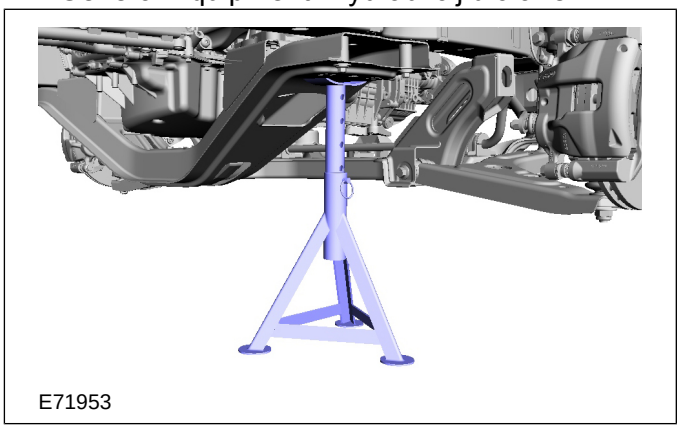
INSTALLATION

6. Torque: 40 Nm

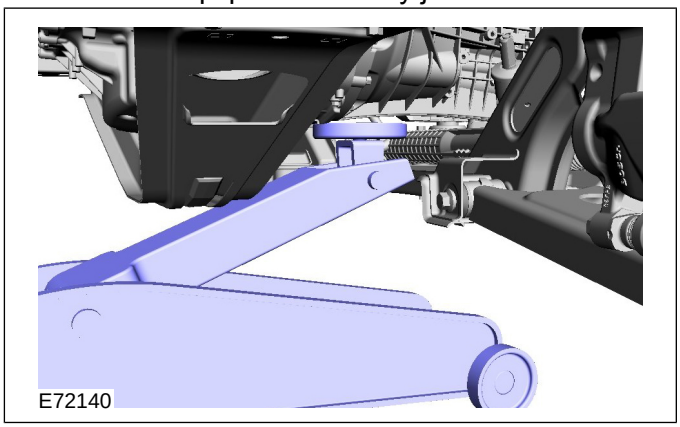


7. Lower the hydraulic jib crane and support the engine crossmember on suitable axle stands on both sides.

   General Equipment: Vehicle/axle stands
   General Equipment: Hydraulic jib crane

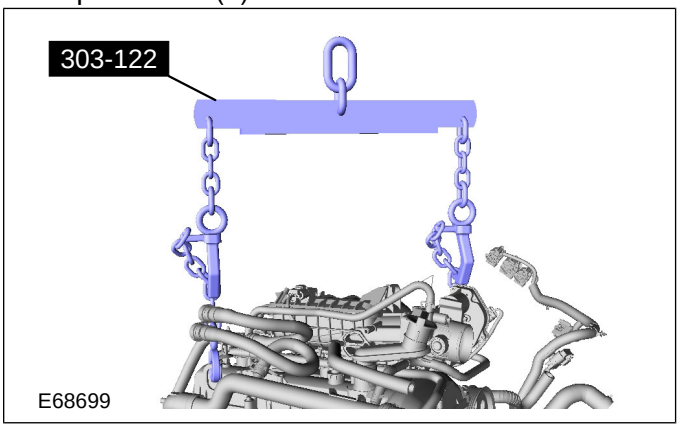


8. General Equipment: Trolley jack



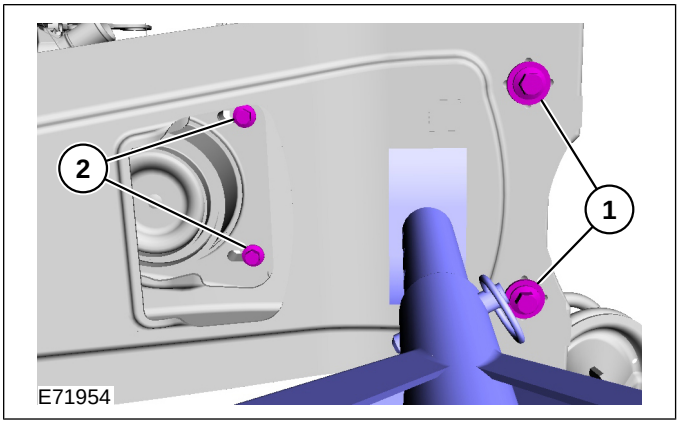
9. Remove the special tool.

   Special Tool(s): 303-122

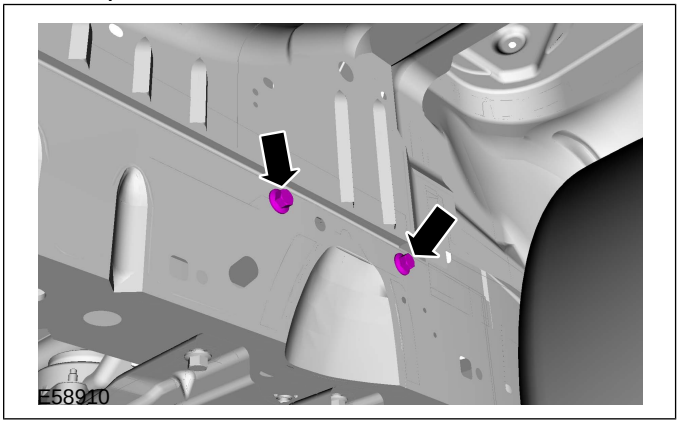


10. Push the vehicle forward until the engine and transmission assembly is in place of the engine compartment.

11. • On both sides.
    Torque:
    - 1 70 Nm
    - 2 40 Nm

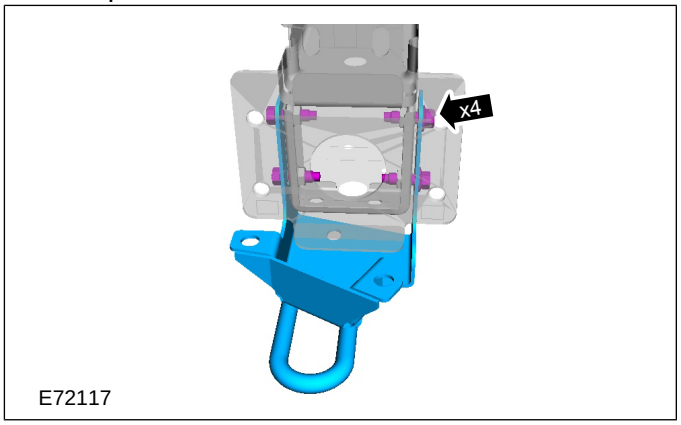


12. Torque: 70 Nm



INSTALLATION

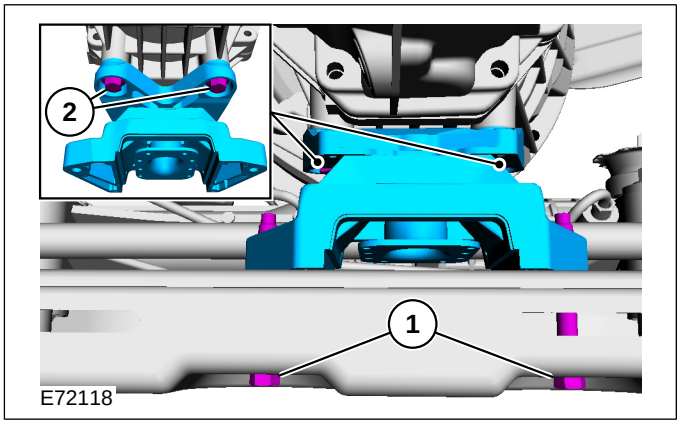
13. Torque: 48 Nm



14. Raise and support the vehicle.

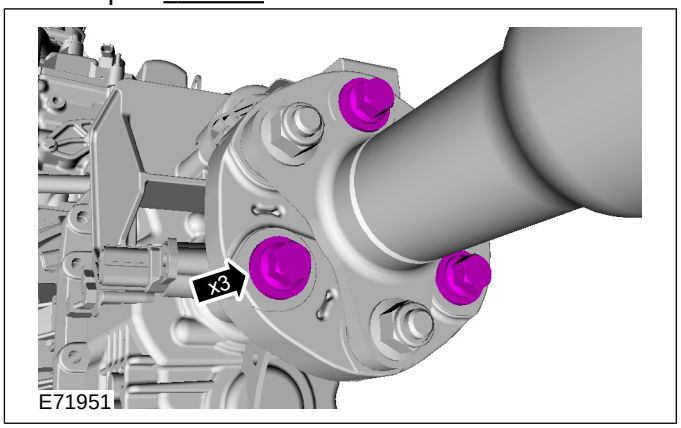
Refer to:Jacking (100-02 Jacking and Lifting, Description and Operation).
Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

15. Torque:
- 1 40 Nm
- 2 55 Nm

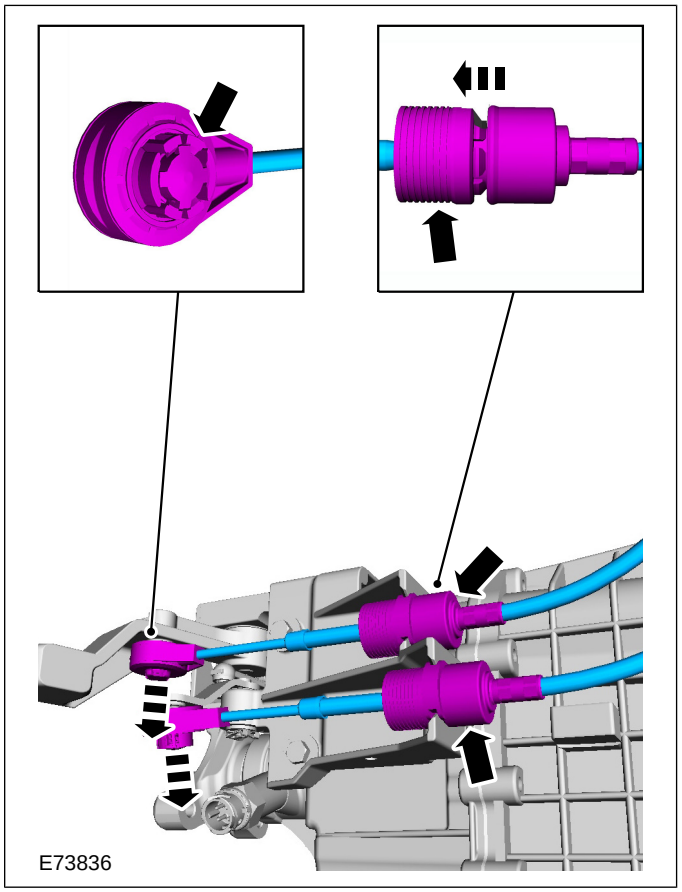


16. ⚠ **CAUTION:Make sure that new bolts are installed.**

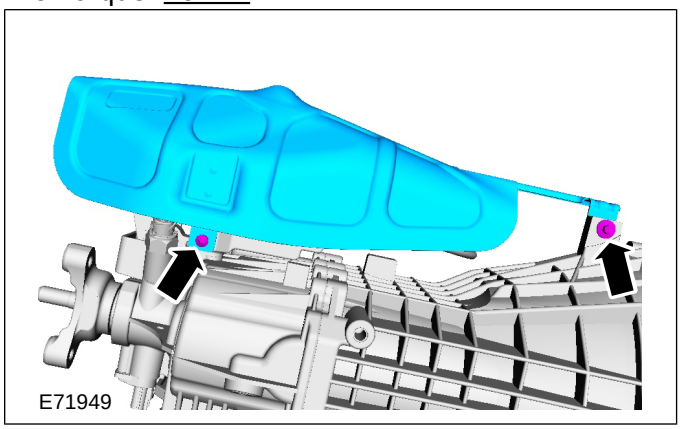
Torque: 115 Nm



17.

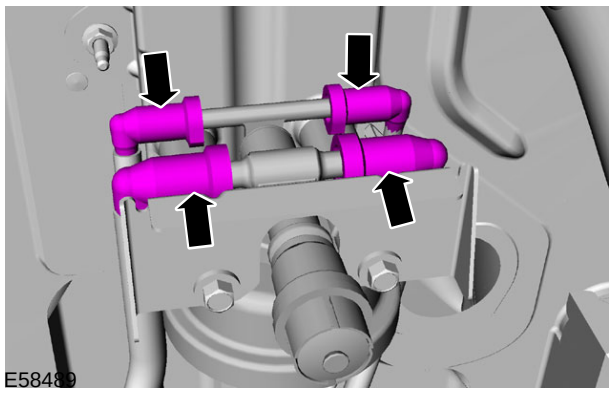


18. Torque: 10 Nm

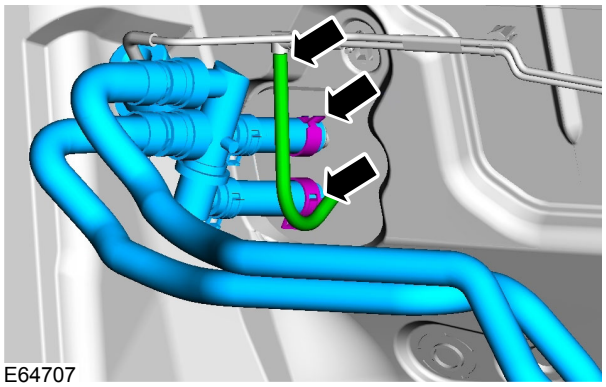


INSTALLATION

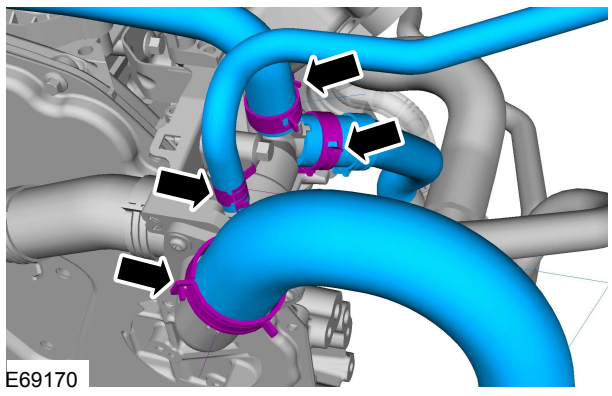
19.



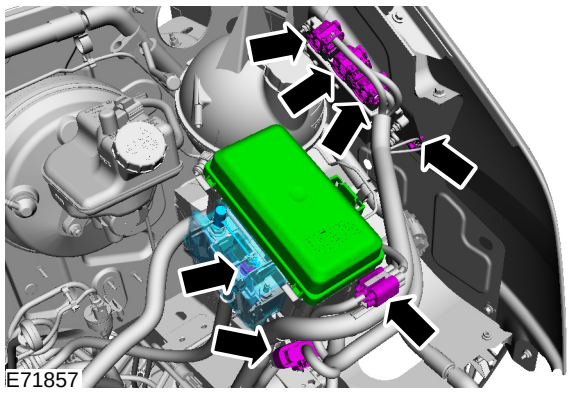
20. General Equipment: Coolant hose clamp remover/installer



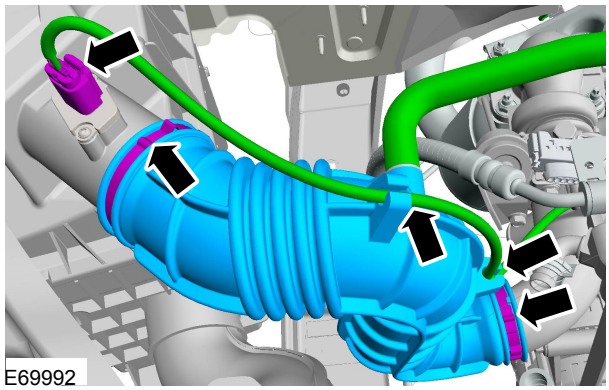
21. General Equipment: Coolant hose clamp remover/installer



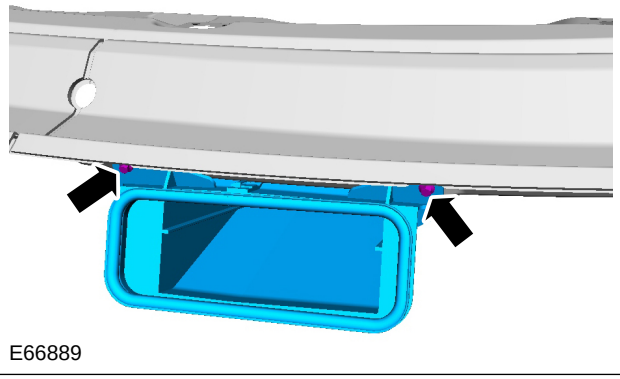
22.



23.



24.



25. Connect the battery ground cable.

Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

INSTALLATION

26. Install the following items:
    1. Catalytic Converter

       Refer to:Catalytic Converter - 2.4L Duratorq-TDCi (Puma) Diesel (309-00 Exhaust System, Removal and Installation).
    2. Accessory Drive Belt

       Refer to:Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).
    3. Power Steering Pump

       Refer to:Power Steering Pump - 2.4L Duratorq-TDCi (Puma) Diesel (211-02 Power Steering, Removal and Installation).
    4. Radiator

       Refer to:Radiator (303-03 Engine Cooling, Removal and Installation).
    5. Condenser Core

       Refer to:Condenser Core (412-03 Air Conditioning, Removal and Installation).
    6. Front Bumper

       Refer to:Front Bumper (501-19 Bumpers, Removal and Installation).
    7. Air Cleaner

       Refer to:Air Cleaner - 2.3L Duratec-HE (MI4)/2.4L Duratorq-TDCi (Puma) Diesel (303-12 Intake Air Distribution and Filtering, Removal and Installation).

SECTION 303-01B Engine — 2.3L Duratec-HE (MI4)

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 303-01B-2
Engine Oil 303-01B-2
Engine Oil Capacity 303-01B-2
Valve Clearance 303-01B-3

DESCRIPTION AND OPERATION

Engine 303-01B-4

DIAGNOSIS AND TESTING

Engine 303-01B-6

REMOVAL AND INSTALLATION

Intake Manifold 303-01B-7
Crankshaft Pulley 303-01B-9
Engine Front Cover 303-01B-15
Camshafts 303-01B-17
Exhaust Manifold 303-01B-24
Cylinder Head 303-01B-26
Oil Pan 303-01B-31
Crankshaft Front Seal 303-01B-34
Valve Stem Seals 303-01B-35
Timing Chain 303-01B-37
Oil Pump 303-01B-39
Crankshaft Rear Seal 303-01B-40

REMOVAL

Engine 303-01B-41

DISASSEMBLY

Engine 303-01B-46

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

Cylinder Head 303-01B-54

ASSEMBLY

Engine 303-01B-56

INSTALLATION

Engine 303-01B-69

SPECIFICATIONS

Engine Data

Description		
Engine code	GZFA	GZFB
Firing order	1-3-4-2	1-3-4-2
Emission level	Stage IV	Stage III
Bore	87,5 mm	87,5 mm
Stroke	94 mm	94 mm
Cubic capacity	2261 cm³	2261 cm³
Compression ratio	9.7 : 1	9.7 : 1
Maximum Power output at 5250 rpm	107 kW (145 PS)	107 kW (145 PS)
Maximum torque at 3850 rpm	210 Nm	210 Nm
Maximum engine speed (intermittent)	6500 rpm	6500 rpm
Maximum engine speed (continous)	6500 rpm	6500 rpm
Idle speed	750 rpm	750 rpm
Number of main bearings	5	5
Camshaft drive	Chain	Chain
Oil consumption	0.5 l/1000 Km	0.5 l/1000 Km

Engine Oil

Viscosity /ambient temperature	Type	Specification
Recommended engine oil		
SAE 5W-30 /below -20°C to over +40°C	Ford Formula E	WSS-M2C913-B
Alternative engine oils (for top-up only)		
SAE 10W-40 /-20°C to over +40°C	Ford Formula XR+	ACEA A3/B3
SAE 5W-40 /below -20°C to over +40°C	Ford Formula S/SD	ACEA A3/B3

Engine Oil Capacity

Description	Liters
Service fill including filter	4,3
Service fill excluding filter	3,9

Lubricants, Fluids, Sealers and Adhesives

	Specifications
Sealant for oil pan, cylinder block and front cover mating faces	WSE-M4G 323-A4

	Specifications
Sealant front cover plugs	WSK-M2G 349-A7

SPECIFICATIONS

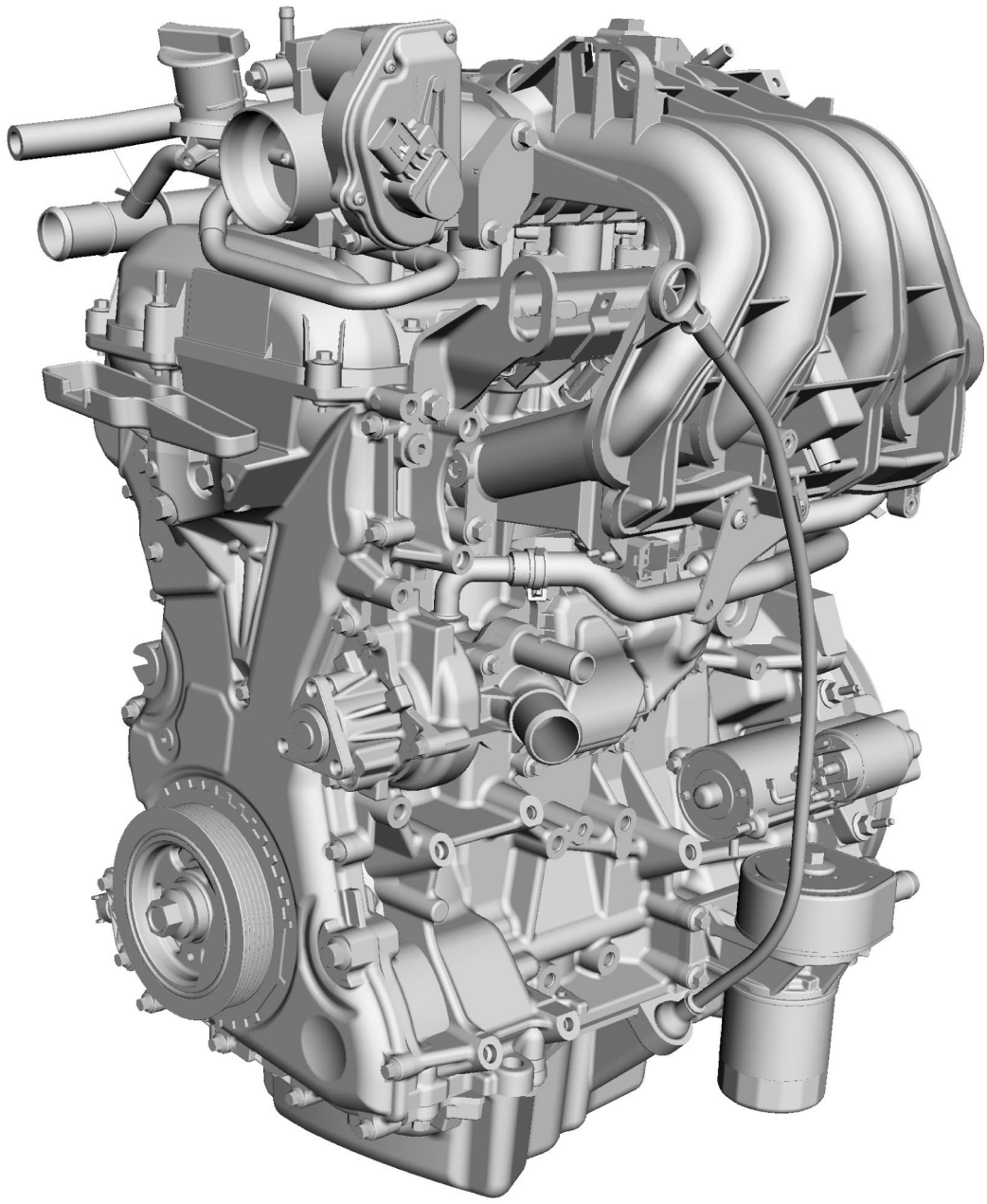
Valve Clearance

Description	mm
Valve clearance (engine cold), intake	0.22 - 0.32
Valve clearance (engine cold), exhaust	0.25 - 0.35
For vehicles converted to CNG or LPG, check the valve clearance at 60,000 km (40,000 miles) intervals. If the valve clearance is less than 0.2 mm, adjust the valves to the maximum valve clearance.	

DESCRIPTION AND OPERATION

Engine

2.3L Duratec-HE (MI4)



E64753

The 2.3L Duratec-HE (MI4) engine is essentially based on the 2.0L Duratec-HE (MI4) already used in the Focus C-MAX 2003.75 and 2004.75 Focus.

Key features of the engine include:

- Longitudinally installed four-cylinder in-line engine with two chain-driven overhead camshafts and 16 valves
- Aluminum cylinder block with lower crankcase
- Mechanical bucket tappets
- Intake manifold switching system with swirl valves
- Ignition system with ignition coil-on-plug
- Electronic throttle valve
- Balance shafts

Engine management

- Visteon powertrain control module (PCM)
- Knock control with one knock sensor (KS)

DESCRIPTION AND OPERATION

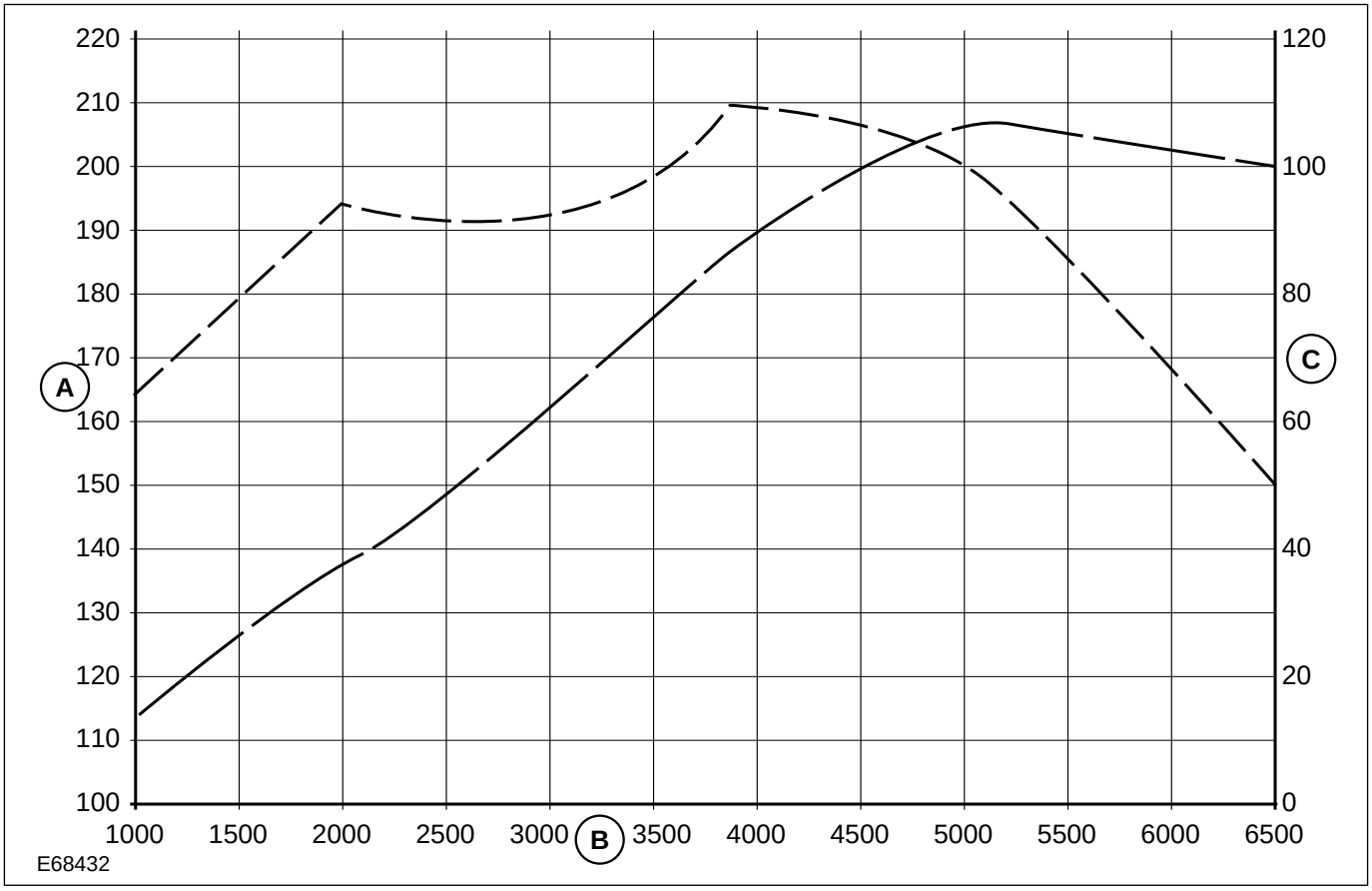
Engine-emission control

- Meets European emission standard IV
- European on-board diagnosis (EOBD) for the monitoring of emissions-relevant components.

Diagnosis

- Diagnosis is performed via the data link connector (DLC) by means of the Worldwide Diagnosis System (WDS).

Power and torque curve (when using 95 RON fuel)



Item	Description
A	Torque (Nm)
B	Engine speed (rpm)
C	Power output (kW)

Service note:

The valve clearance of the engine only needs to be monitored if the engine is converted to operation using alternative fuel (every 60,000 km).

Conversion of the engine to operation with alternative fuel requires no modification to the engine as the valve seats are reinforced as standard. All that is required is an adaptation of the fuel system.

The service interval is 20,000 km or 1 year.

DIAGNOSIS AND TESTING

Engine

REFER to Section 303-00 [Engine System - General Information].

REMOVAL AND INSTALLATION

Intake Manifold

Removal

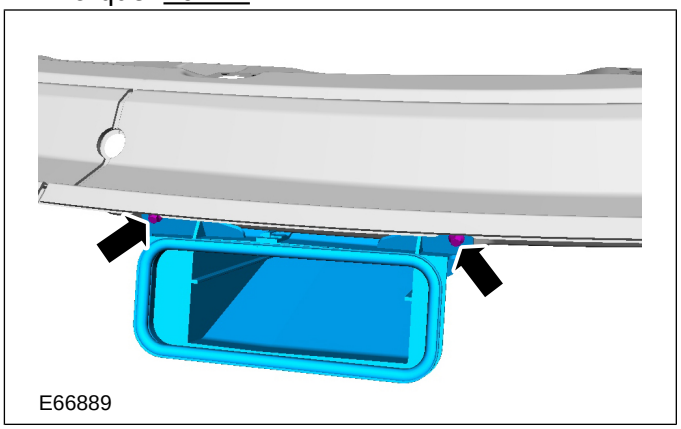
NOTE: Removal steps in this procedure may contain installation details.

1. Disconnect the following items:

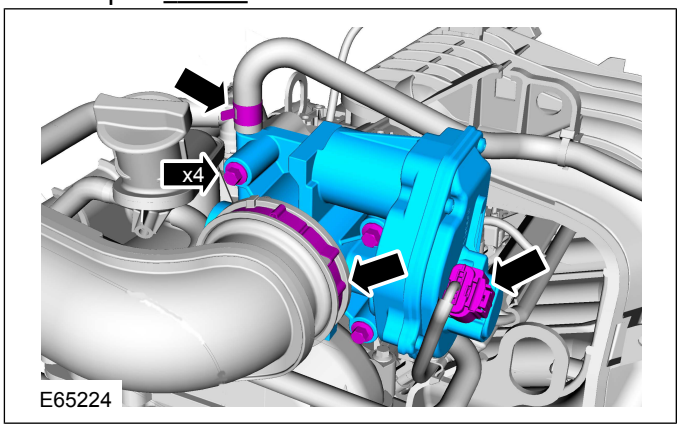
1. Battery

   Refer to: Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

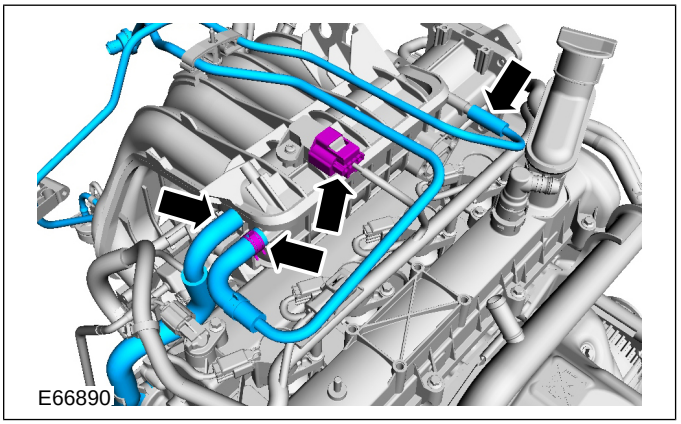
2. Torque: 10 Nm



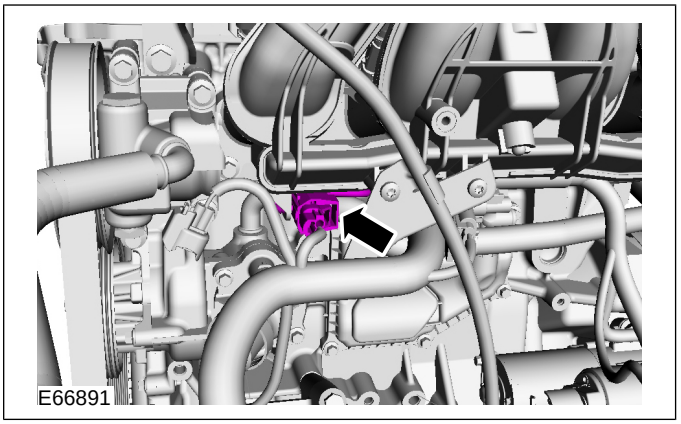
3. Torque: 11 Nm



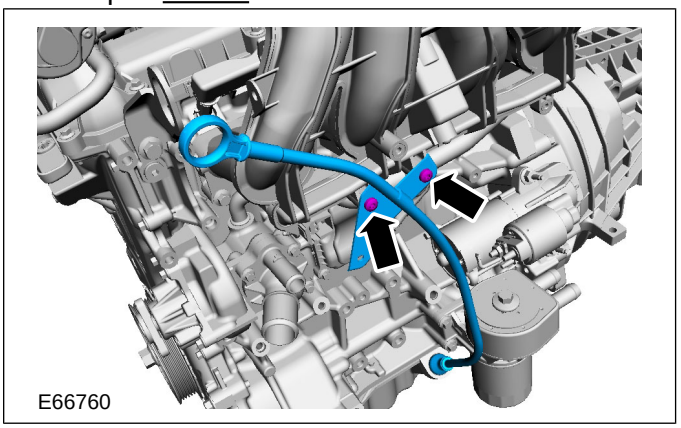
4.



5.



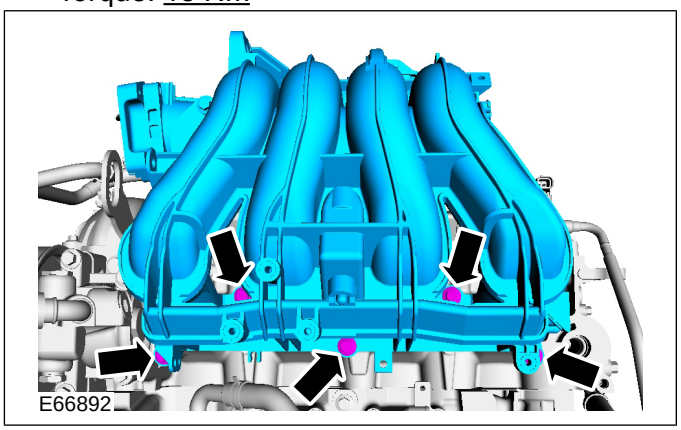
6. Torque: 10 Nm



REMOVAL AND INSTALLATION

7. **NOTE:**The gasket is to be reused unless damage.

   Torque: 18 Nm



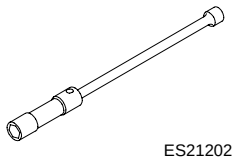
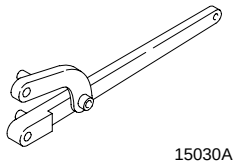
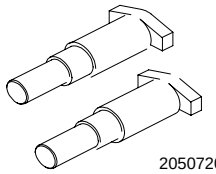
Installation

1. To install, reverse the removal procedure.

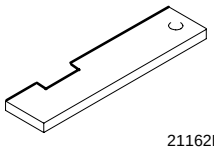
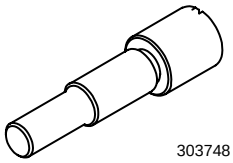
REMOVAL AND INSTALLATION

Crankshaft Pulley

Special Tool(s)

 ES21202	Socket, Spark Plug 303-499
 15030A	Universal Flange Holding Wrench 205-072
 20507202	Adapter for 205-072 205-072-02

Special Tool(s)

 21162B	Alignment Plate, Camshaft 303-376B
 303748	Locking Tool, Crankshaft 303-748

Materials

Name	Specification
Silicone Sealant	WSE-M4G323-A4

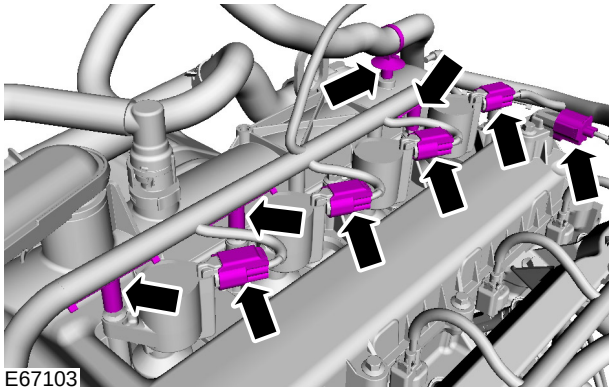
Removal

1. Remove the following items:
   1. Intake manifold

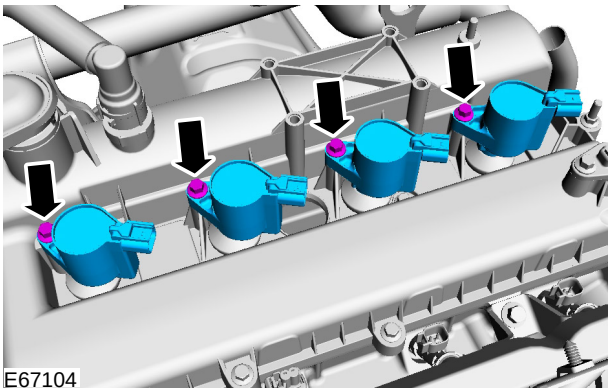
      Refer to: Intake Manifold (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).
   2. Accessory drive belt

      Refer to:Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

2.

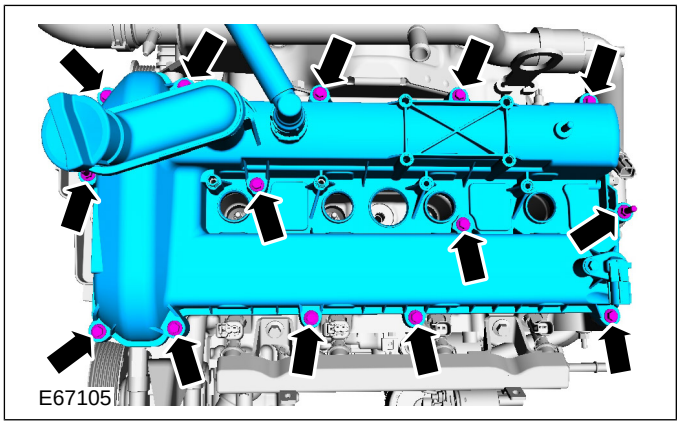


3.

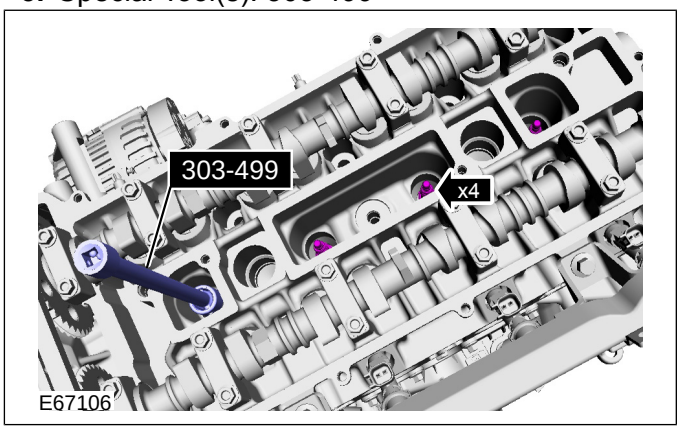


REMOVAL AND INSTALLATION

4. **NOTE:**The gasket is to be reused unless damage.

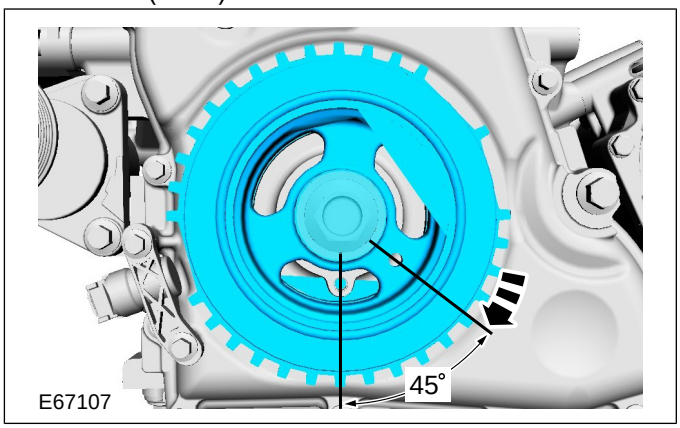


5. Special Tool(s): 303-499

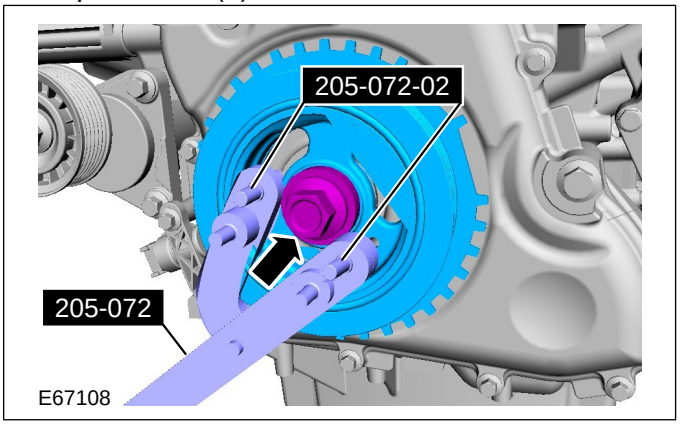


6. **CAUTION:Only rotate the crankshaft clockwise.**

   Rotate the crankshaft until piston No. 1 is approximately 45 degrees before top dead center (TDC).



7. Special Tool(s): 205-072, 205-072-02



Installation

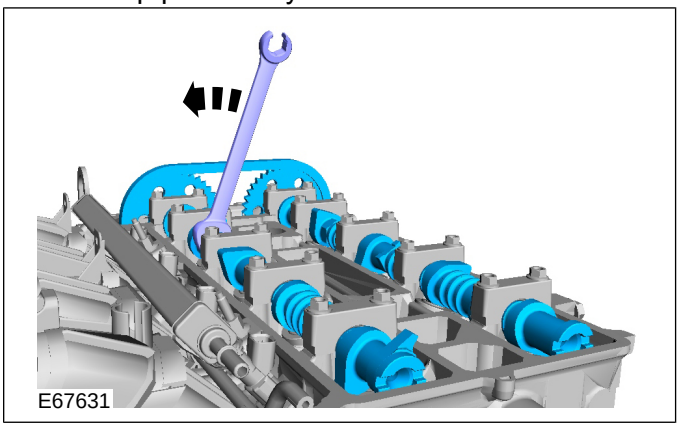
1. Install the following items:
   1. Crankshaft front seal

      Refer to:Crankshaft Front Seal (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).

2. **CAUTION:Only rotate the camshafts clockwise.**

   NOTE: Use an open-ended wrench to rotate the camshafts by the hexagon.

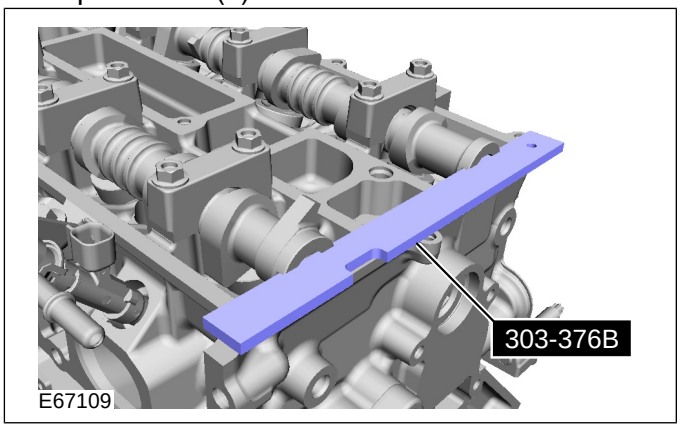
   Rotate the camshafts until they are in a valve overlap position cylinder No. 4.



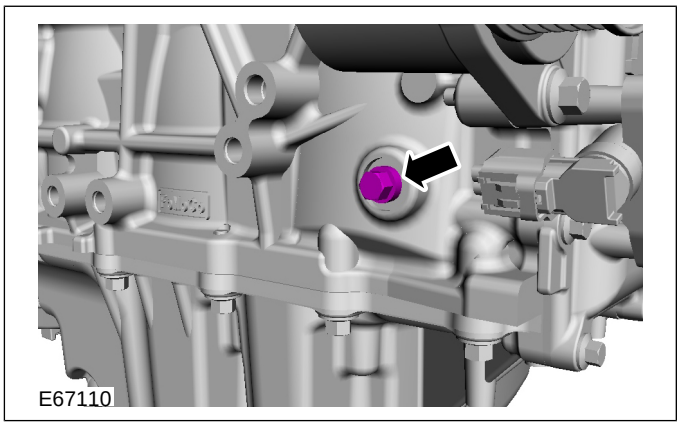
REMOVAL AND INSTALLATION

3. Install the special tool.

   Special Tool(s): 303-376B

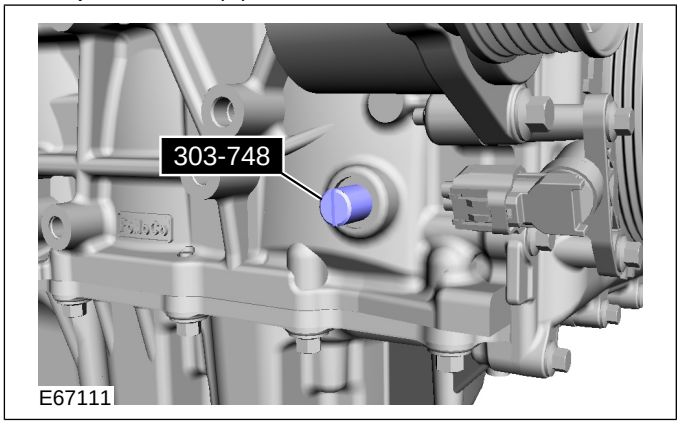


4.



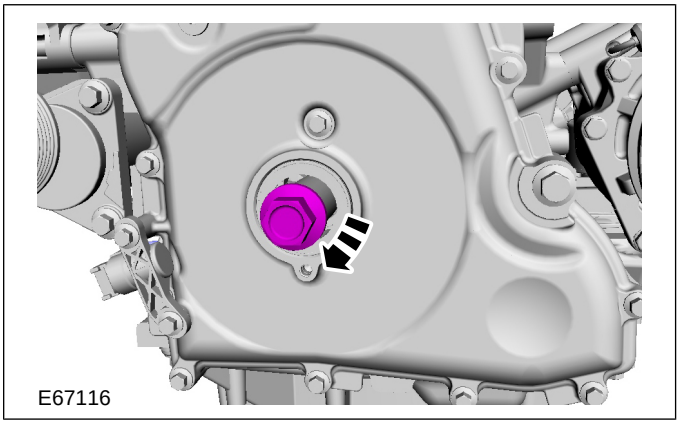
5. Install the special tool.

   Special Tool(s): 303-748

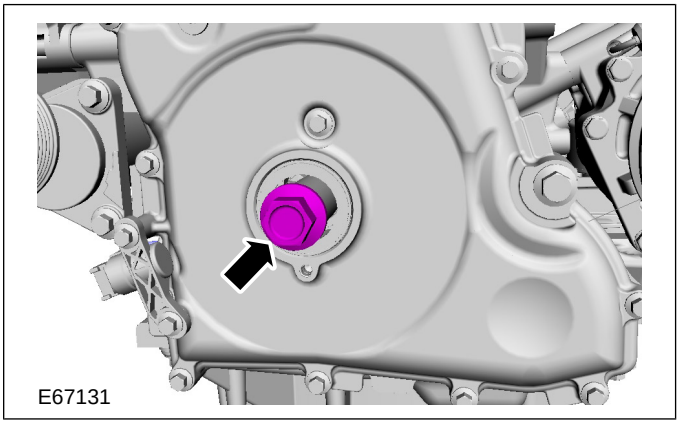


6. ⚠ **CAUTION:Only rotate the crankshaft clockwise.**

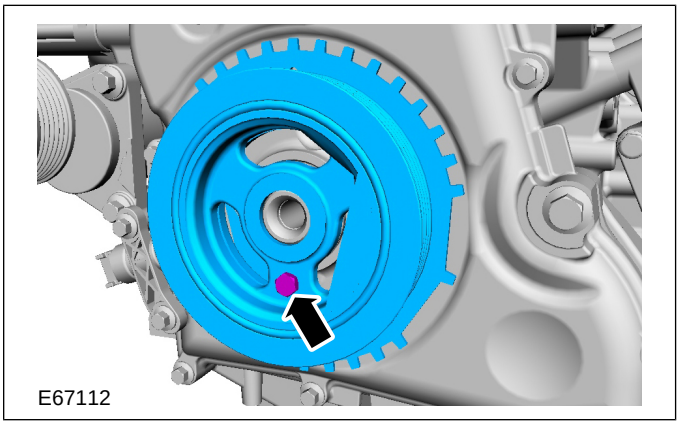
   Rotate the crankshaft until it contacts the special tool.



7.

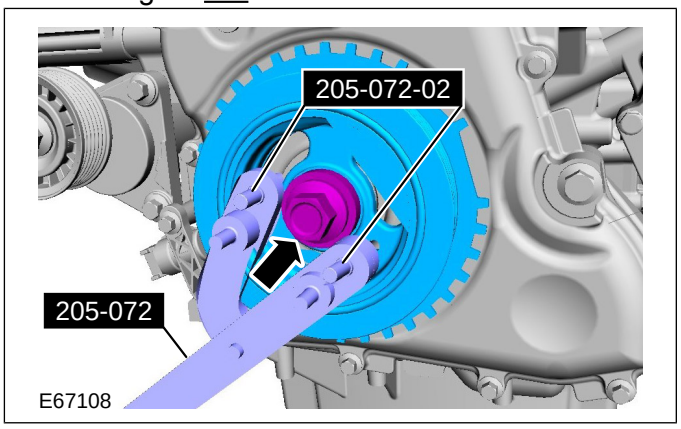


8. **NOTE:**Only tighten the bolt finger tight at this stage.
   - Bolt M6 x 18 mm

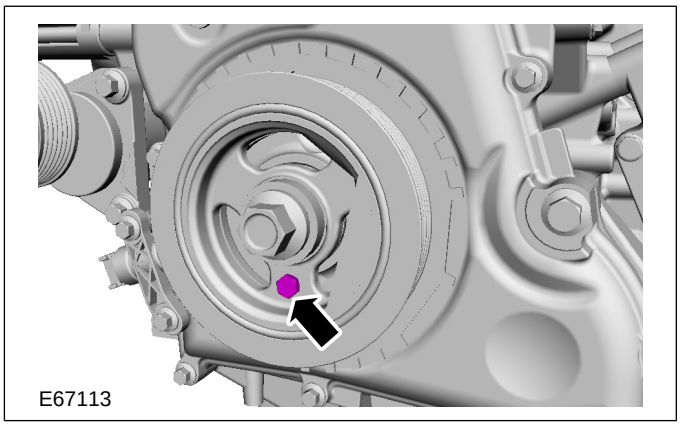


REMOVAL AND INSTALLATION

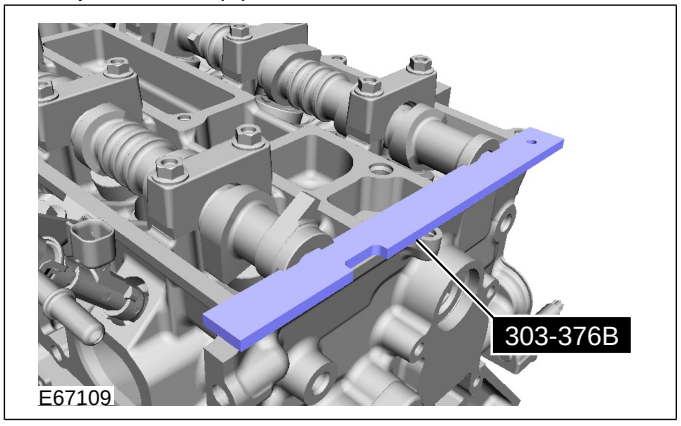
9. Special Tool(s): 205-072, 205-072-02
   Torque:
   - Stage1: 100 Nm
   - Stage2: 90°



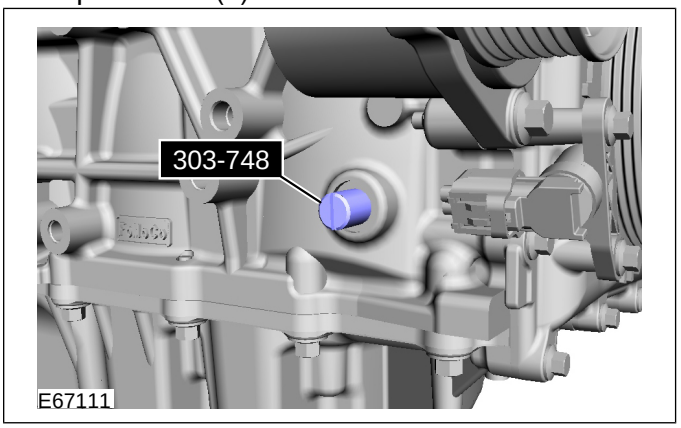
10.



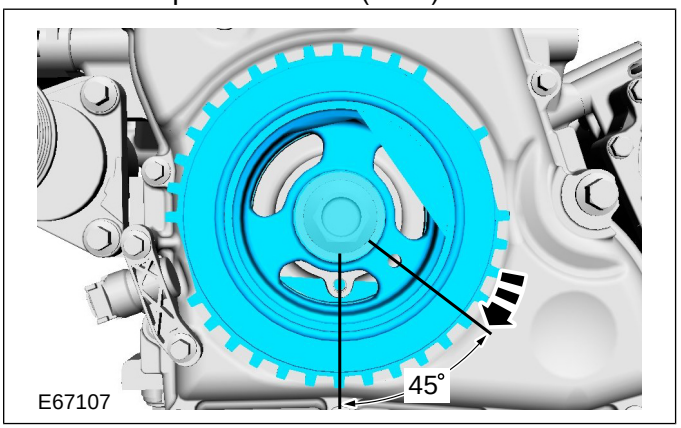
11. Remove the special tool.
    Special Tool(s): 303-376B



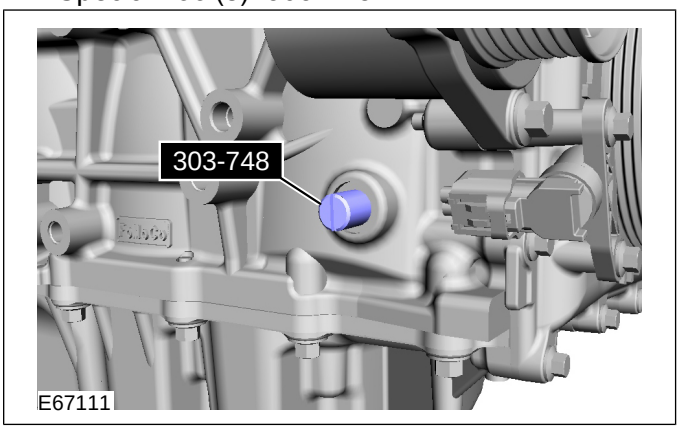
12. Remove the special tool.
    Special Tool(s): 303-748



13. **CAUTION:Only rotate the crankshaft clockwise.**
    Rotate the crankshaft one and three quarters until piston No. 1 is approximately 45 degrees before top dead center (TDC).



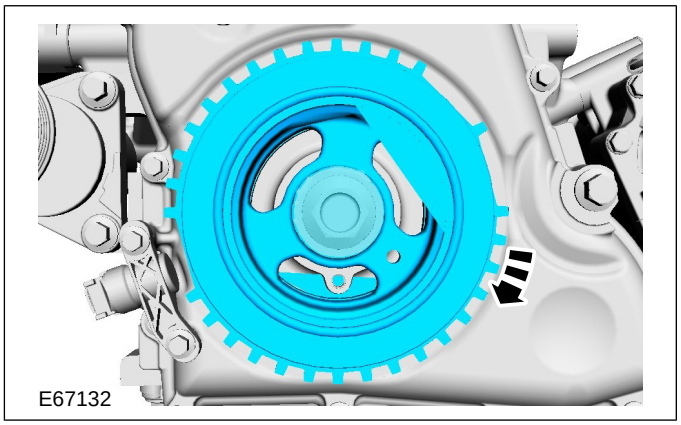
14. Install the special tool.
    Special Tool(s): 303-748



15. **CAUTION:Only rotate the crankshaft clockwise.**

REMOVAL AND INSTALLATION

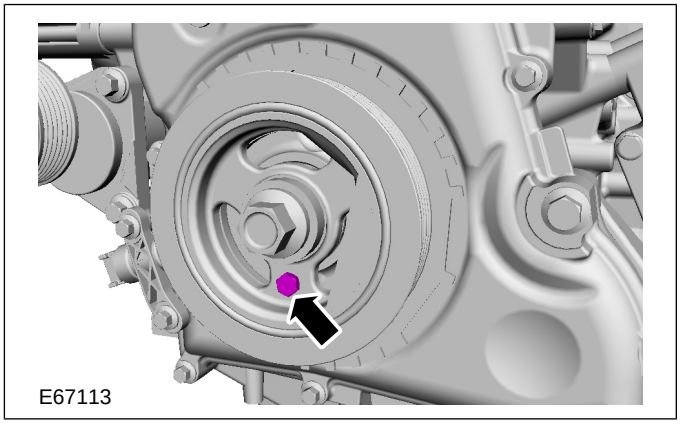
Rotate the crankshaft until it contacts the special tool.



16. **NOTE:** Only tighten the bolt finger tight.

NOTE: The bolt can only be installed if the valve timing is correct.

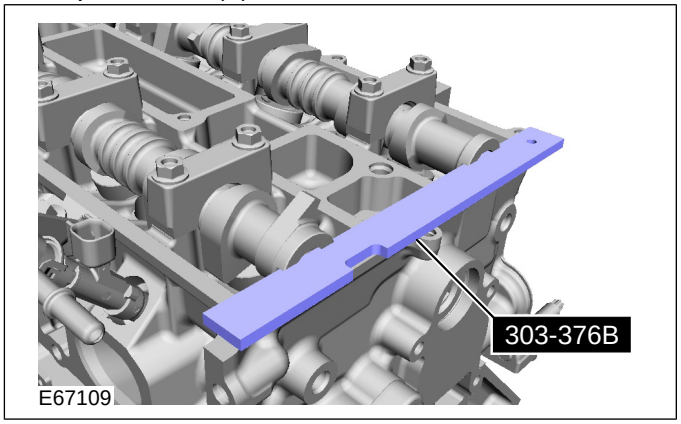
- Bolt M6 x 18 mm



17. **NOTE:** The special tool can only be installed if the valve timing is correct.

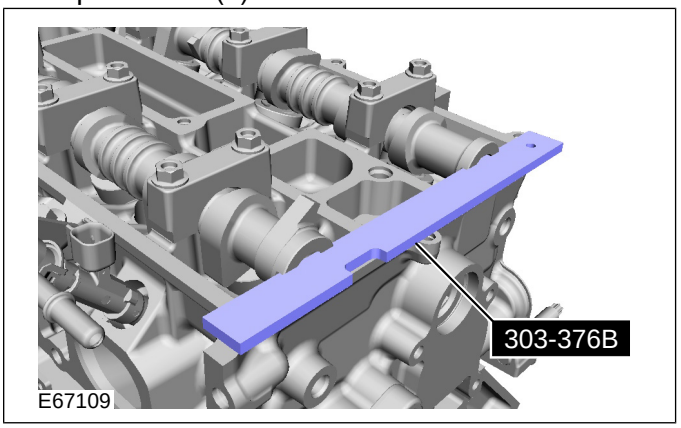
Install the special tool.

Special Tool(s): 303-376B



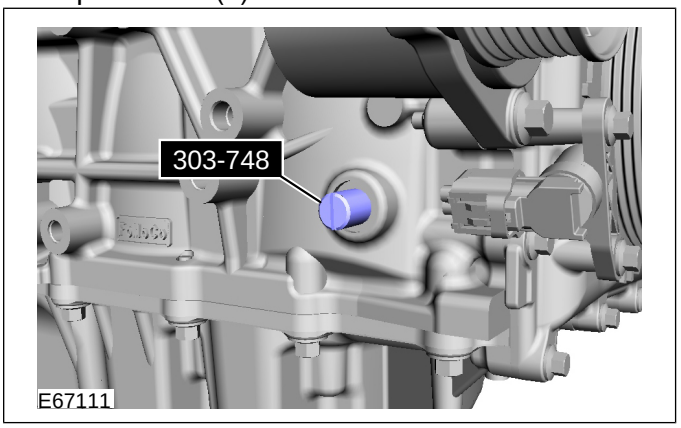
18. Remove the special tool.

Special Tool(s): 303-376B

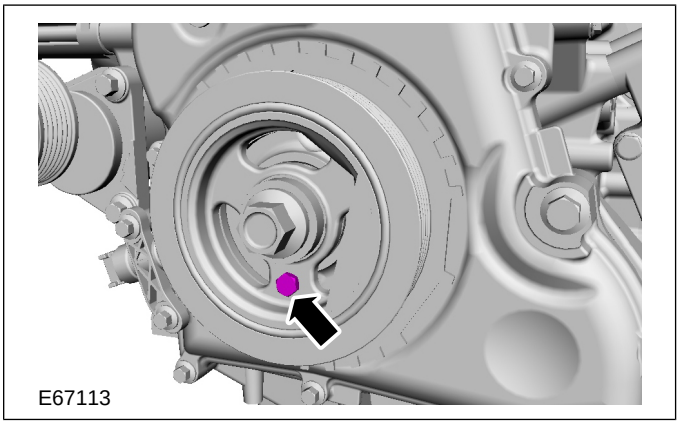


19. Remove the special tool.

Special Tool(s): 303-748

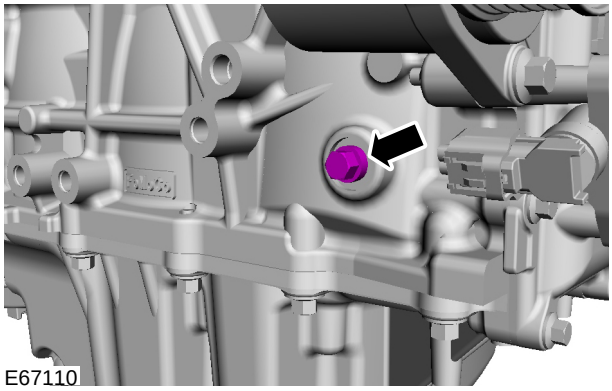


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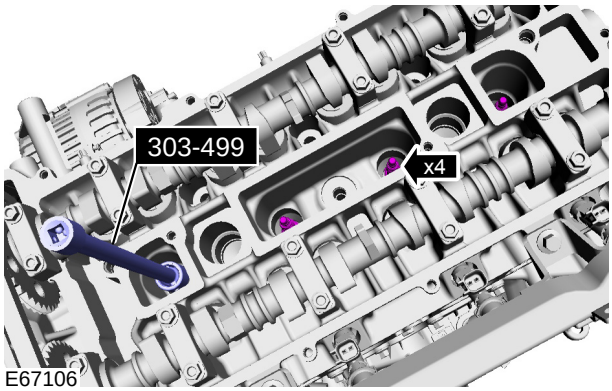


REMOVAL AND INSTALLATION

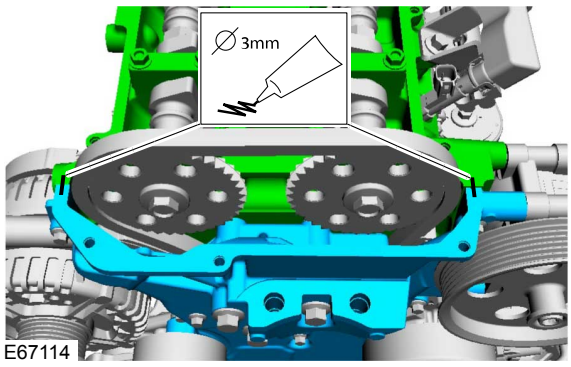
21. Torque: 20 Nm



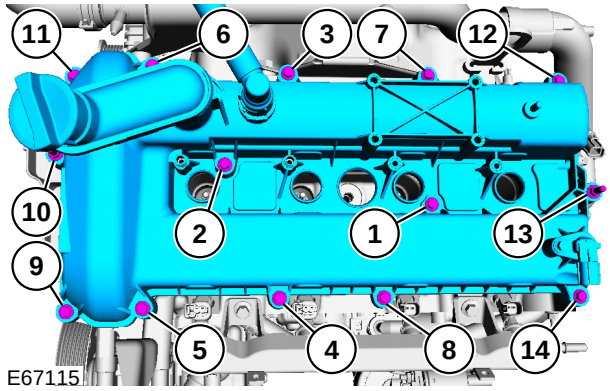
22. Special Tool(s): 303-499
Torque: 12 Nm



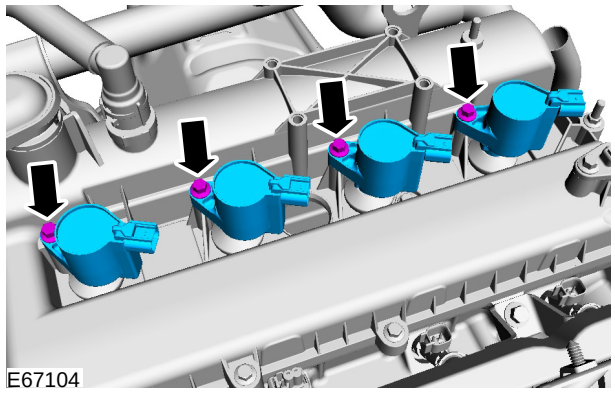
23. Apply a dot of sealant to the areas indicated.
Material: Silicone Sealant



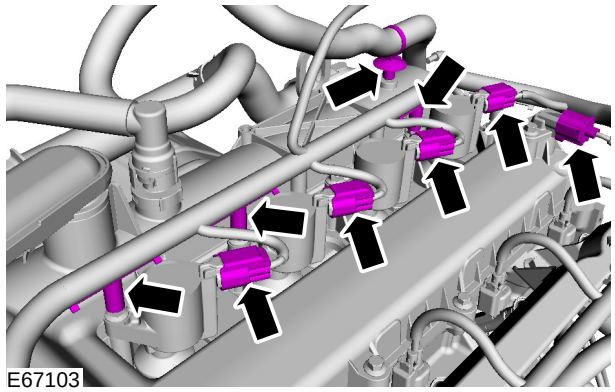
24. Torque: 10 Nm



25. Torque: 10 Nm



26.



27. Install the following items:

1. Accessory drive belt

   Refer to:Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

2. Intake manifold

   Refer to:Intake Manifold (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).

REMOVAL AND INSTALLATION

Engine Front Cover

Materials	
Name	**Specification**
Silicone Sealant	WSE-M4G323-A4

Removal

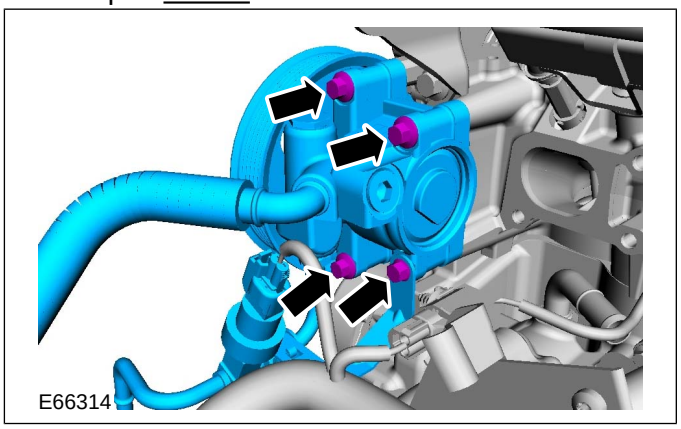
NOTE: Removal steps in this procedure may contain installation details.

1. Remove the following items:
1. Crankshaft pulley

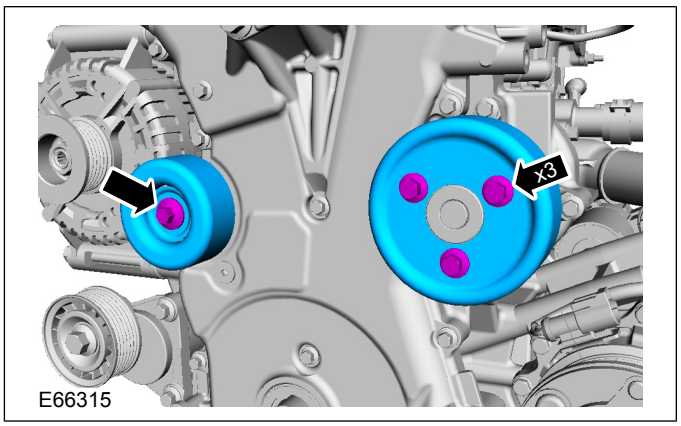
   Refer to:Crankshaft Pulley (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).
2. Crankshaft position (CKP) sensor

   Refer to:Crankshaft Position (CKP) Sensor - 2.3L Duratec-HE (MI4) (303-14 Electronic Engine Controls, Removal and Installation).

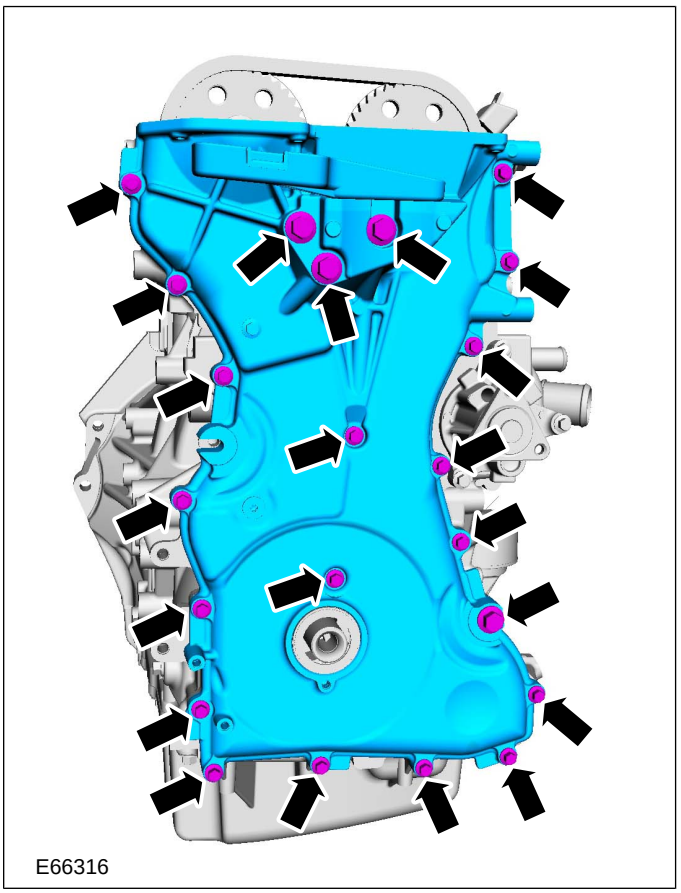
2. Torque: 25 Nm



3. 1. Torque: 25 Nm
2. Torque: 20 Nm



4.



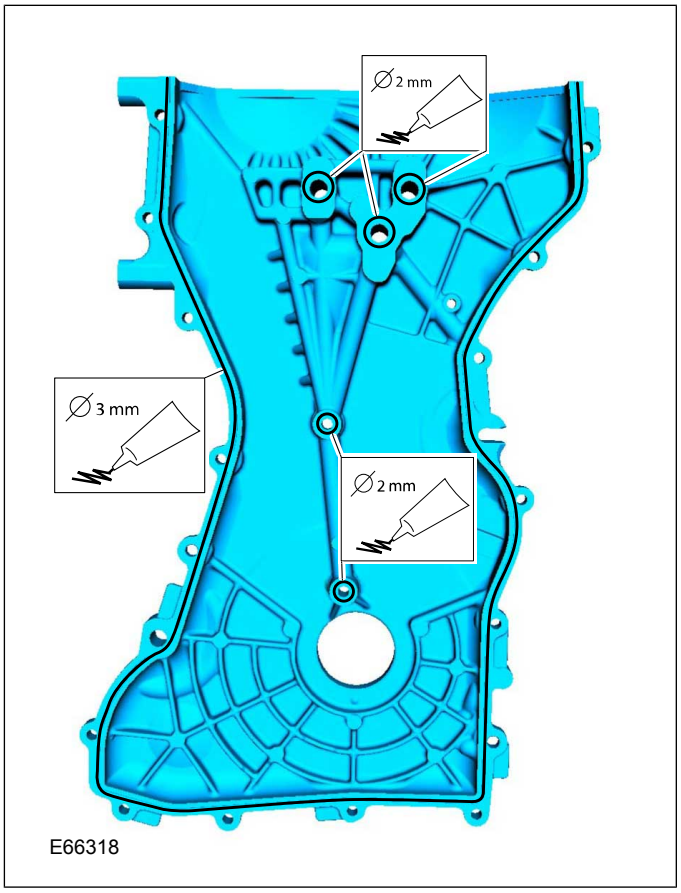
Installation

1. To install, reverse the removal procedure.

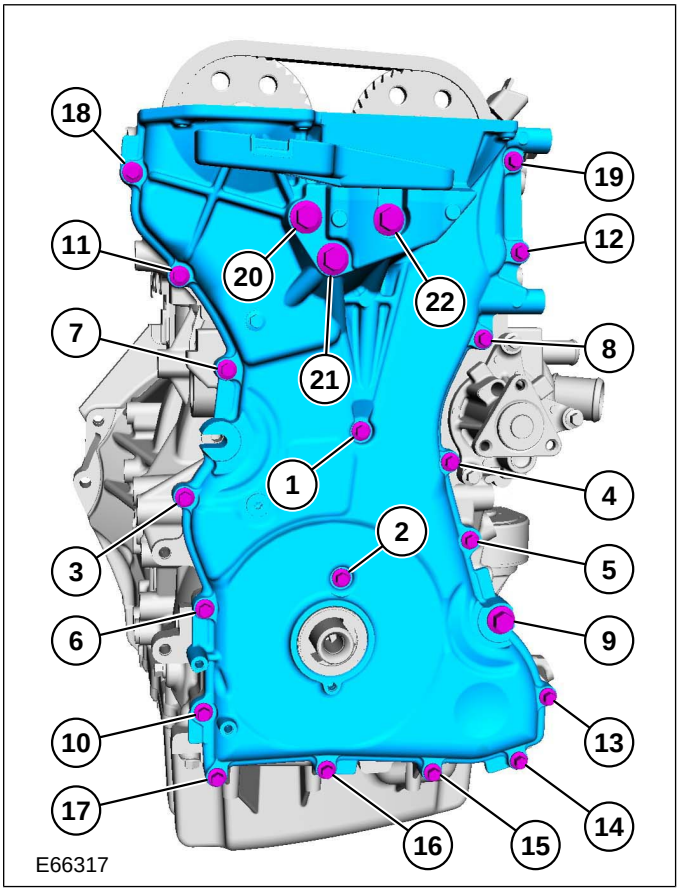
REMOVAL AND INSTALLATION

2. • Apply a 3 mm bead of sealant to the engine front cover.

Material: Silicone Sealant



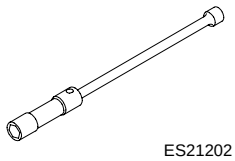
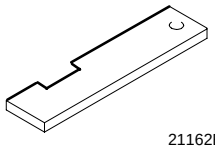
3. Torque:
- 1-8 10 Nm
- 9 48 Nm
- 10-19 10 Nm
- 20-22 48 Nm



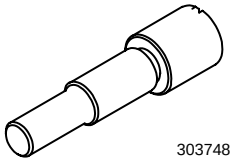
REMOVAL AND INSTALLATION

Camshafts

Special Tool(s)

 ES21202	Socket, Spark Plug 303-499
 21162B	Alignment Plate, Camshaft 303-376B

Special Tool(s)

 303748	Locking Tool, Crankshaft 303-748

Materials

Name	Specification
Hypoid Gear Oil	SQM-2C9002-AA
Adhesive - Loctite 243	WSK-M2G349-A7
Silicone Sealant	WSE-M4G323-A4

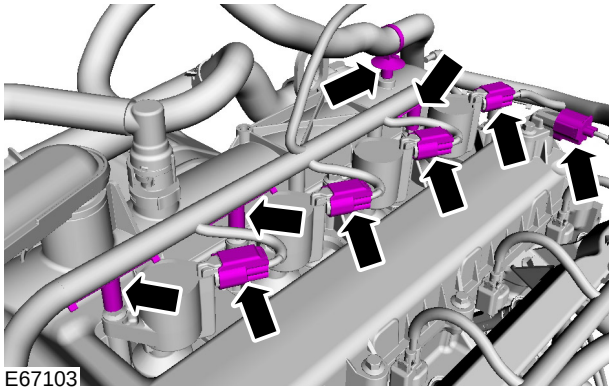
Removal

1. Remove the following items:
   1. Intake manifold

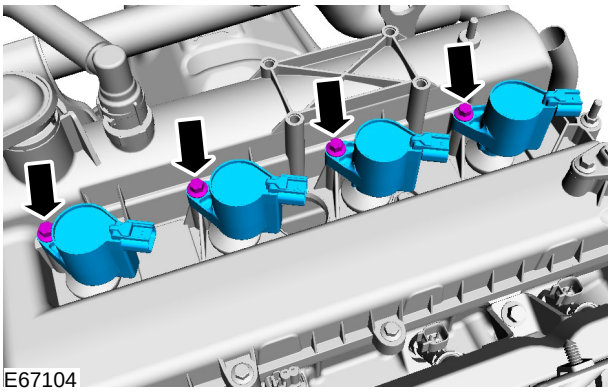
      Refer to:Intake Manifold (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).
   2. Accessory drive belt

      Refer to:Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

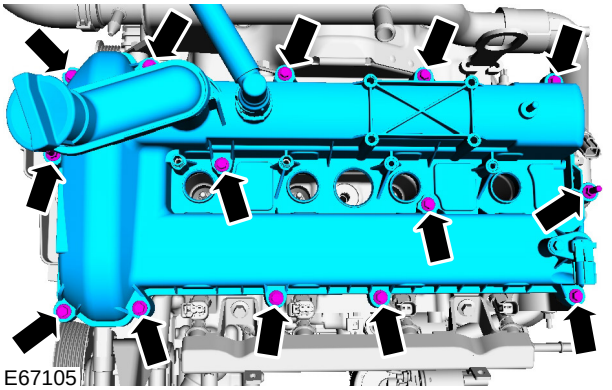
2.



3.

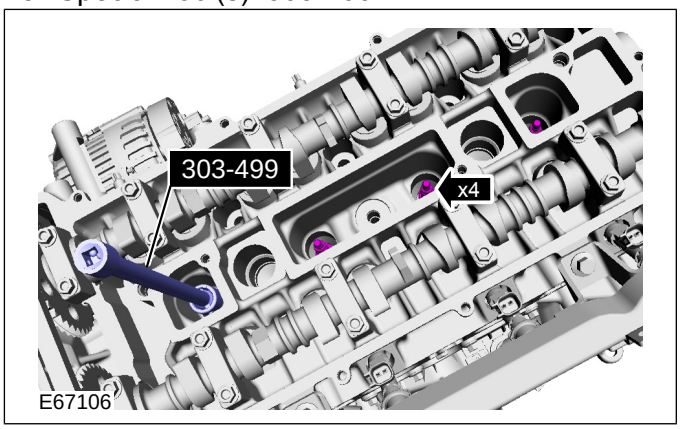


4. **NOTE:**The gasket is to be reused unless damage.



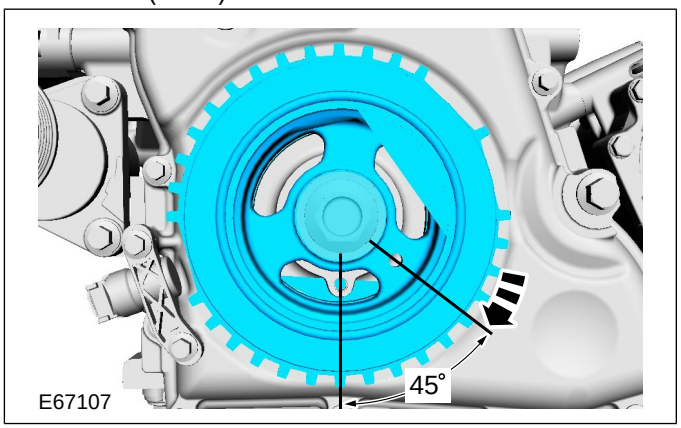
REMOVAL AND INSTALLATION

5. Special Tool(s): 303-499

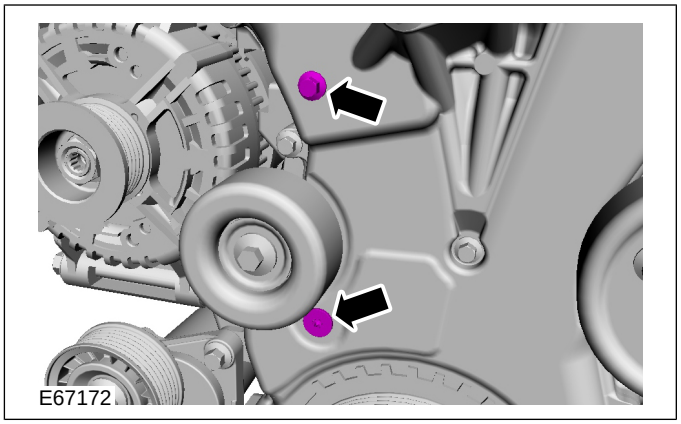


6. ⚠ **CAUTION:Only rotate the crankshaft clockwise.**

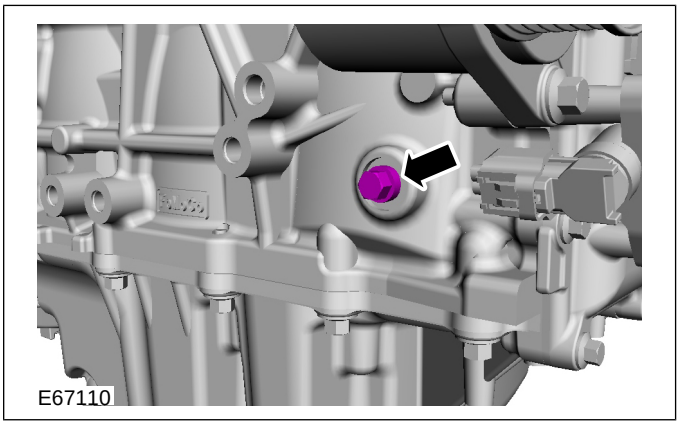
Rotate the crankshaft until piston No. one is approximately 45 degrees before top dead center (TDC).



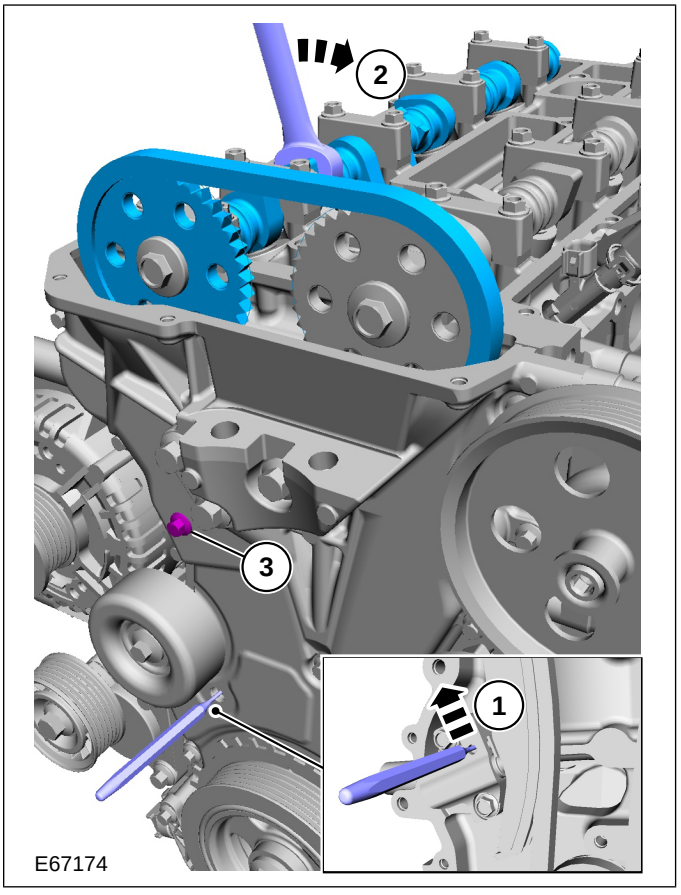
7.



8.

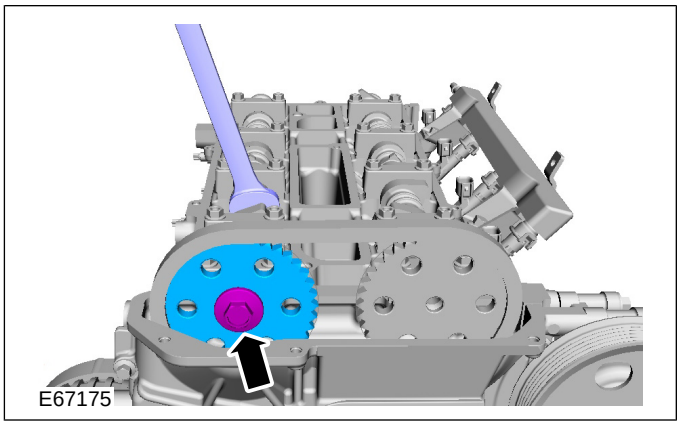


9. 1. Punch 2 mm
2. Open ended wrench
3. Bolt M6 x 25 mm



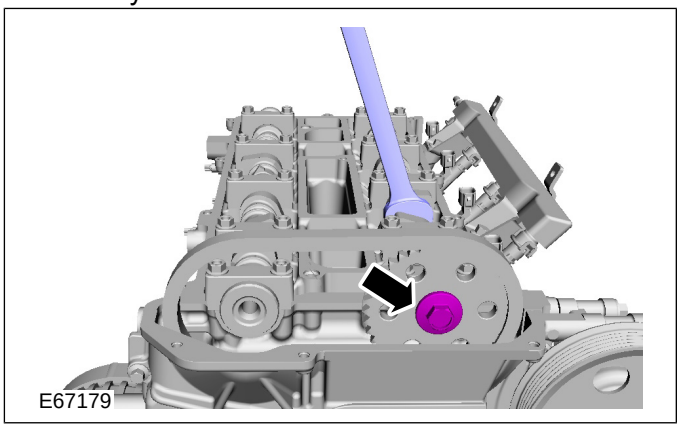
REMOVAL AND INSTALLATION

10. ⚠ **CAUTION:Use an open-ended wrench to hold the camshafts by the hexagon to prevent the camshafts from turning.**

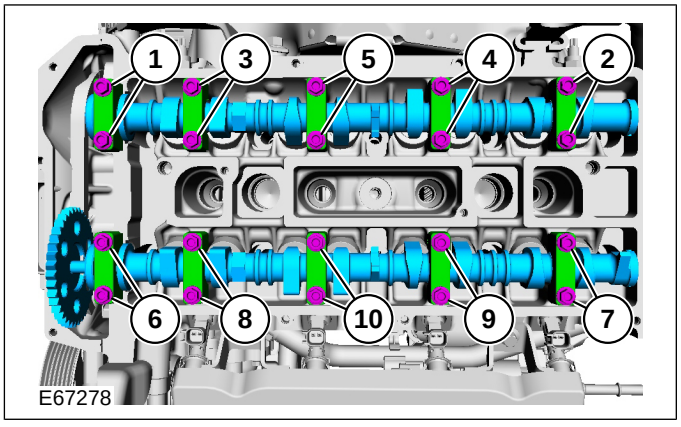


11. ⚠ **CAUTION:Use an open-ended wrench to hold the camshafts by the hexagon to prevent the camshafts from turning.**

Loosen the intake camshaft sprocket retaining bolt by 5 turns.



12 **NOTE:**Note the position of the bearings.



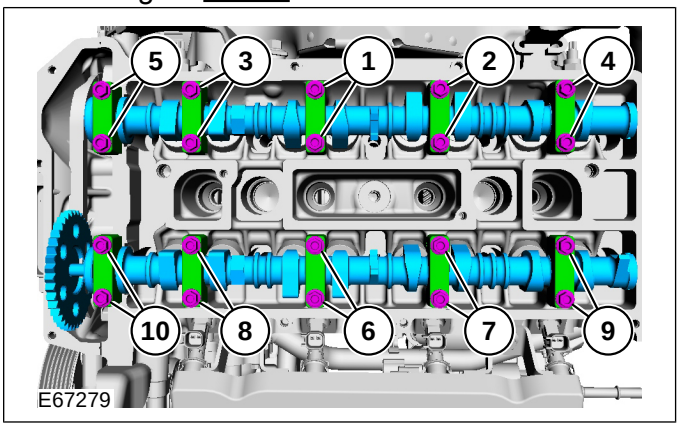
Installation

1. ⚠ **CAUTION:Make sure that the camshafts and camshaft bearing caps are installed in their original locations.**

Coat the camshaft bearing caps with oil.

Material: Hypoid Gear Oil

2. Install the camshafts approximately at valve overlap position cylinder No. 4.
Torque:
   - Stage1: 7 Nm
   - Stage2: 16 Nm

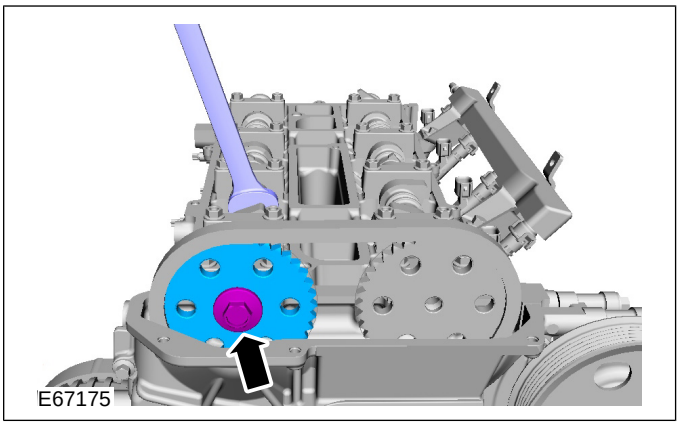


3. **NOTE:**This step is only necessary when installing a new component.

Adjust the valve clearance.

4. **NOTE:**Only tighten the bolt finger tight at this stage.

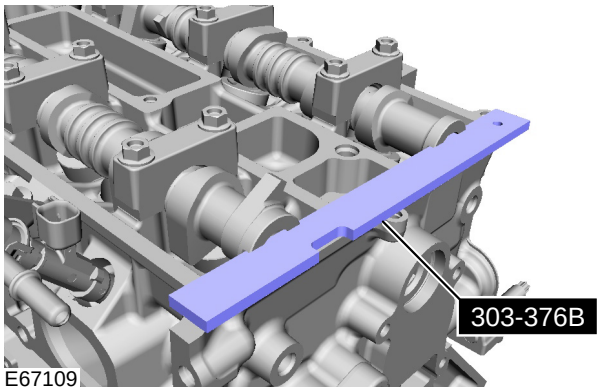
NOTE: Make sure that the camshaft sprockets can rotate on the camshafts.



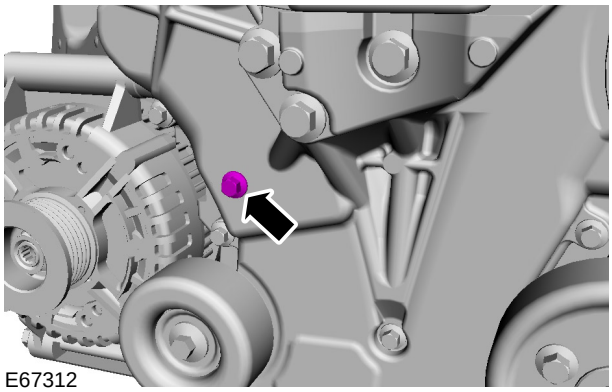
REMOVAL AND INSTALLATION

5. Install the special tool.

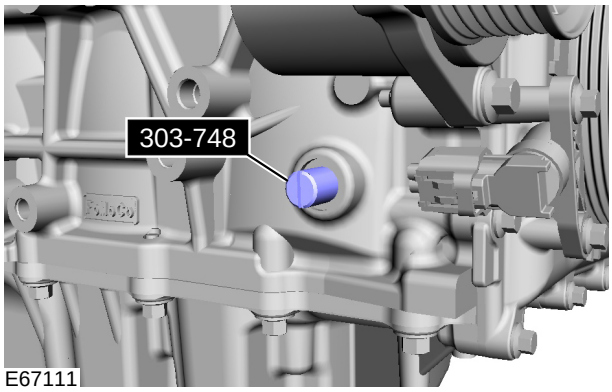
   Special Tool(s): 303-376B



6. • Bolt M6 x 25 mm

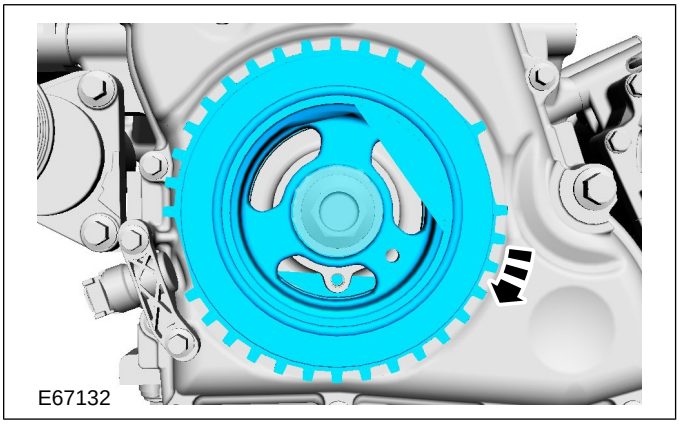


7. Install the special tool.



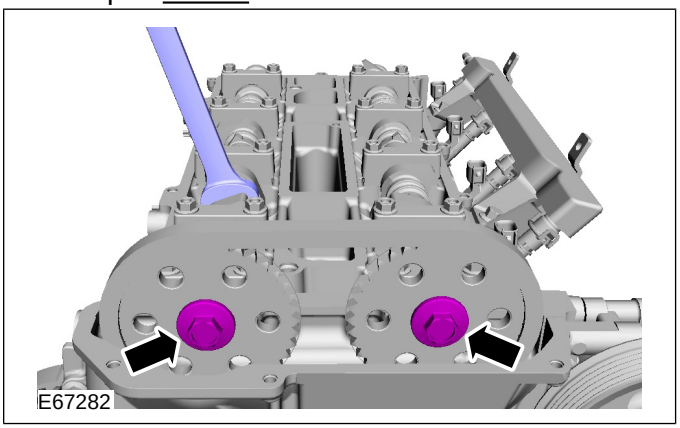
8. ⚠ **CAUTION:Only rotate the crankshaft clockwise.**

   Rotate the crankshaft until it contacts the special tool.



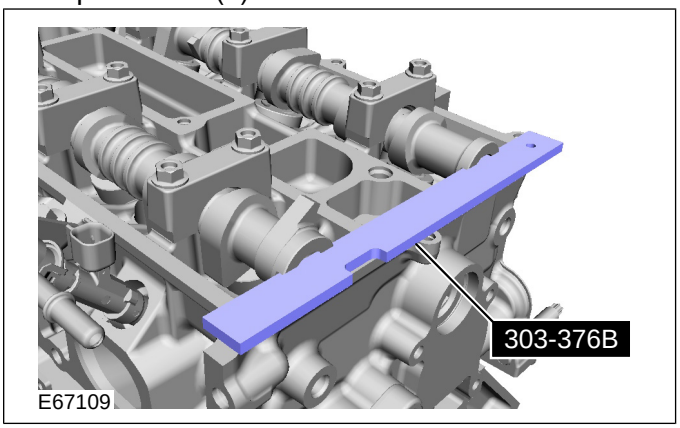
9. ⚠ **CAUTION:Use an open-ended wrench to hold the camshafts by the hexagon to prevent the camshafts from turning.**

   Torque: 72 Nm



10. Remove the special tool.

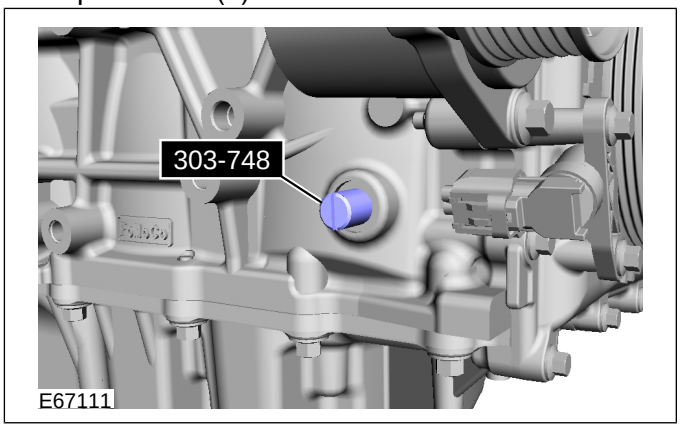
    Special Tool(s): 303-376B



REMOVAL AND INSTALLATION

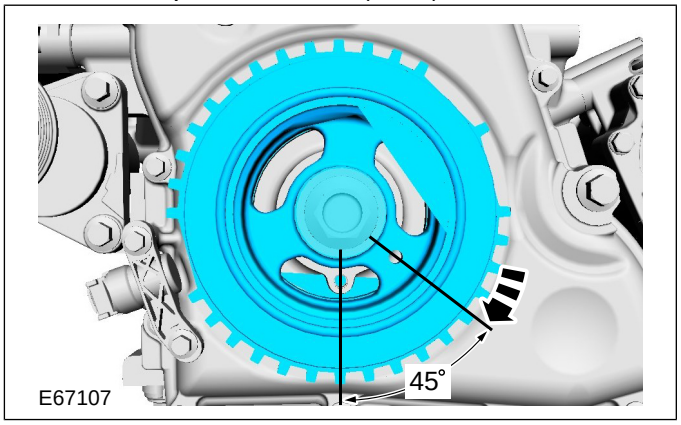
11. Remove the special tool.

Special Tool(s): 303-748



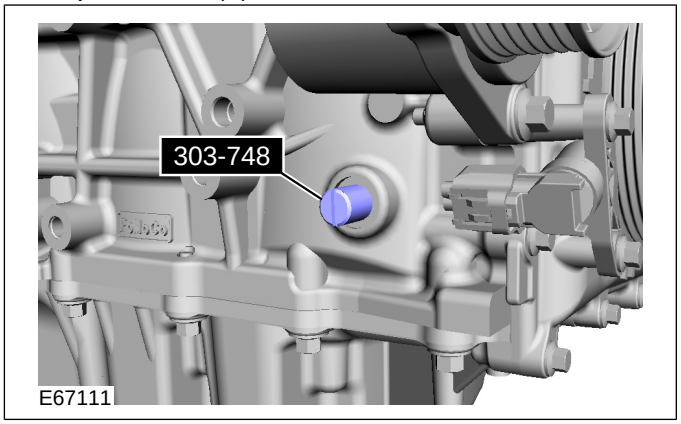
12. ⚠ **CAUTION:Only rotate the crankshaft clockwise.**

Rotate the crankshaft one and three quarters until piston No. 1 is approximately 45 degrees before top dead center (TDC).



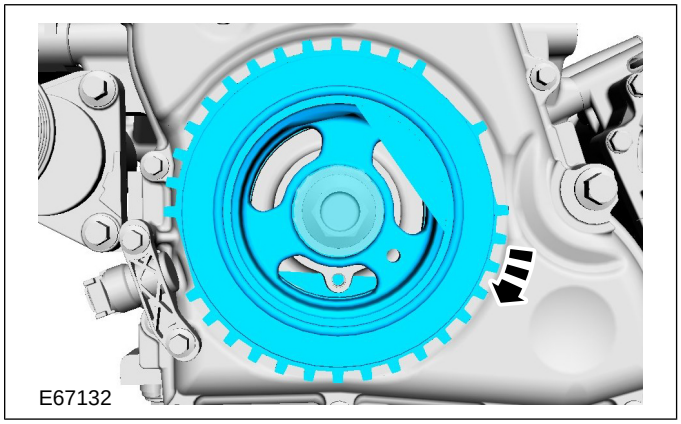
13. Install the special tool.

Special Tool(s): 303-748



14. ⚠ **CAUTION:Only rotate the crankshaft clockwise.**

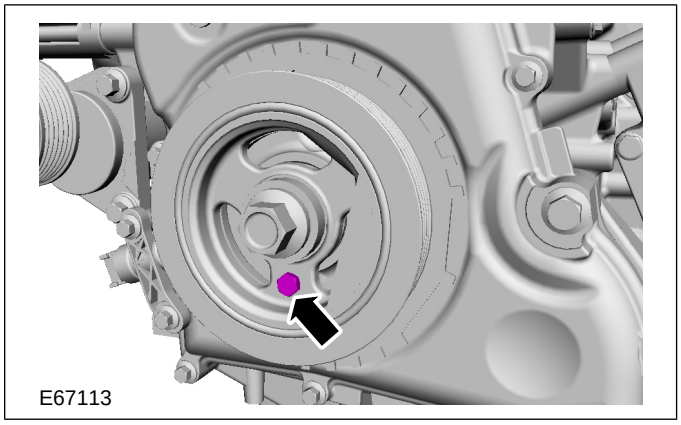
Rotate the crankshaft until it contacts the special tool.



15. **NOTE:**Only tighten the bolt finger tight at this stage.

NOTE: The bolt can only be installed if the valve timing is correct.

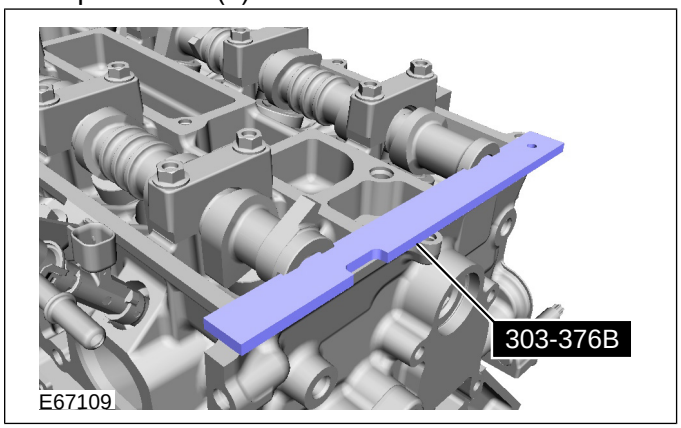
- Bolt M6 x 18 mm



16. **NOTE:**The special tool can only be installed if the valve timing is correct.

Install the special tool.

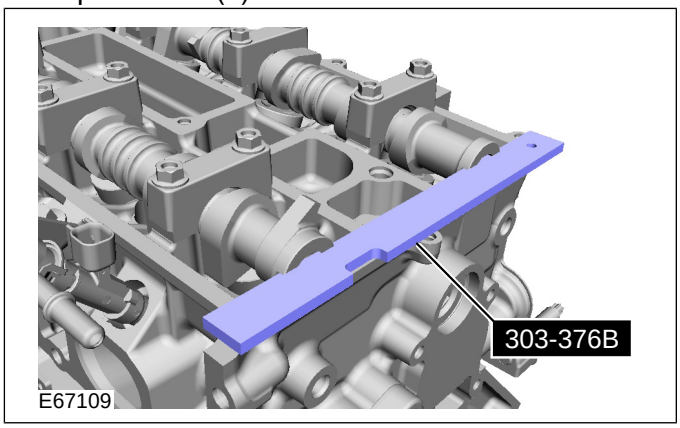
Special Tool(s): 303-376B



REMOVAL AND INSTALLATION

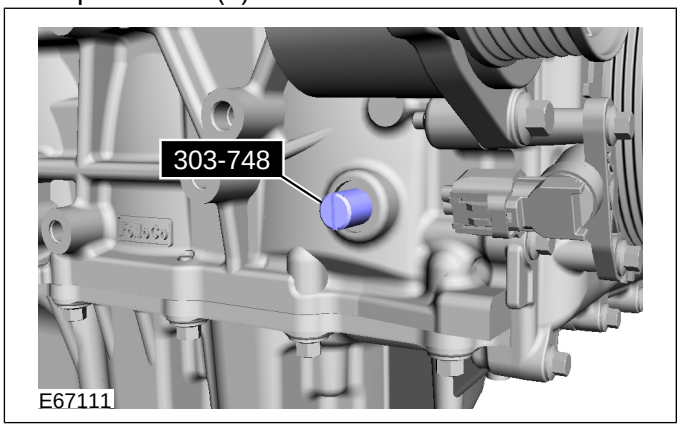
17. Remove the special tool.

Special Tool(s): 303-376B

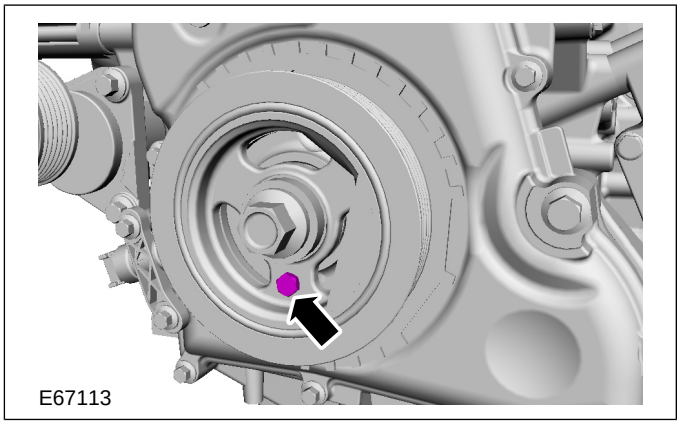


18. Remove the special tool.

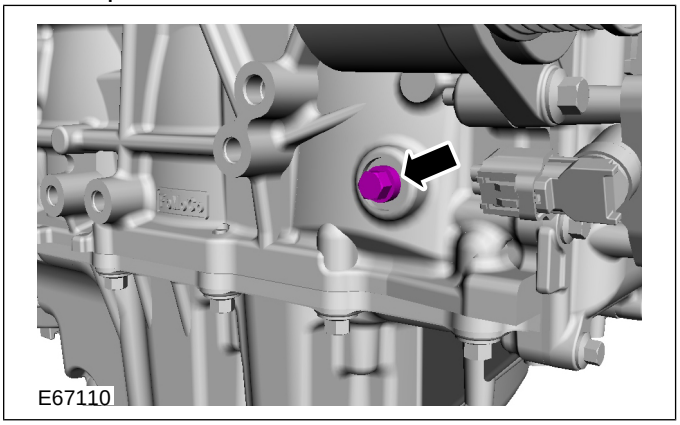
Special Tool(s): 303-748



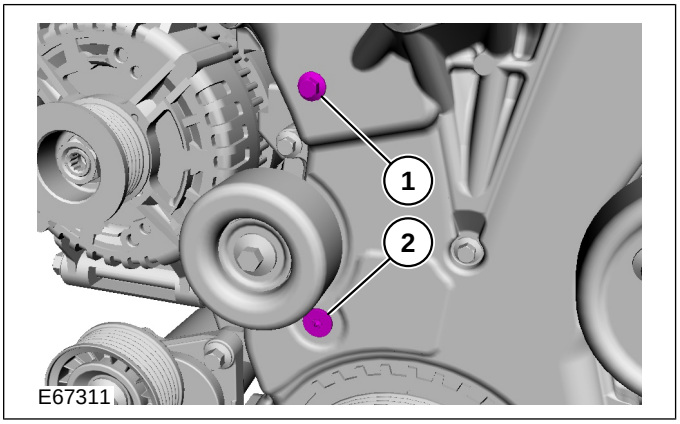
19.



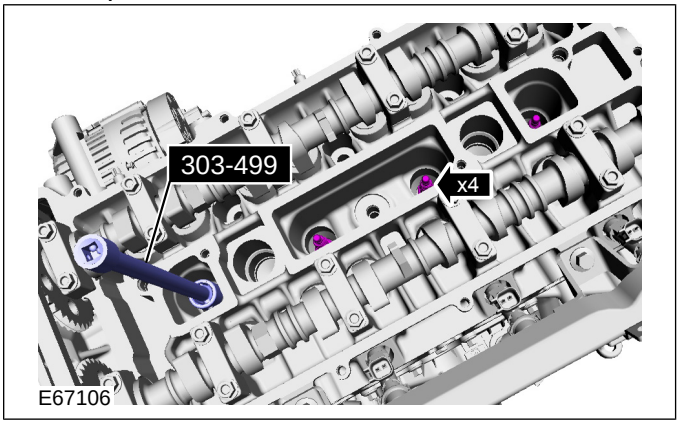
20. Torque: 20 Nm



21. 1. Material: Adhesive - Loctite 243
Torque: 10 Nm
2. Material: Adhesive - Loctite 243
Torque: 12 Nm



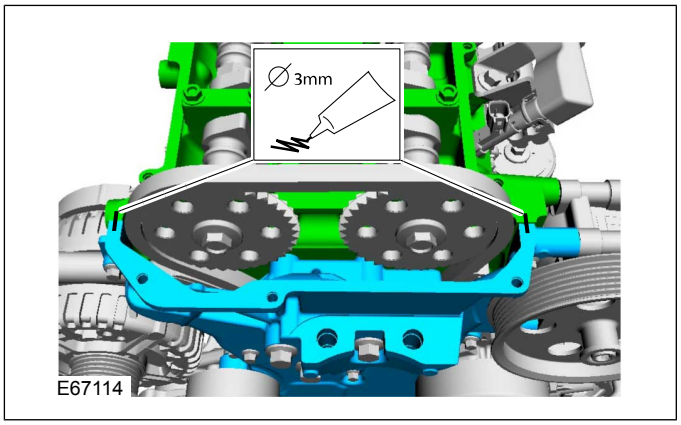
22. Special Tool(s): 303-499
Torque: 12 Nm



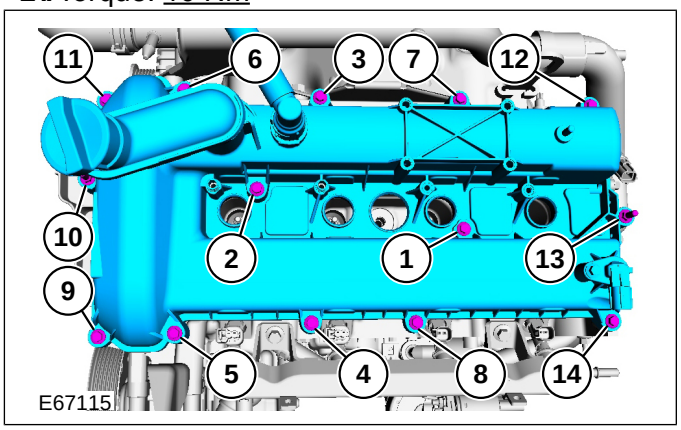
REMOVAL AND INSTALLATION

23. Apply a dot of sealant to the areas indicated.

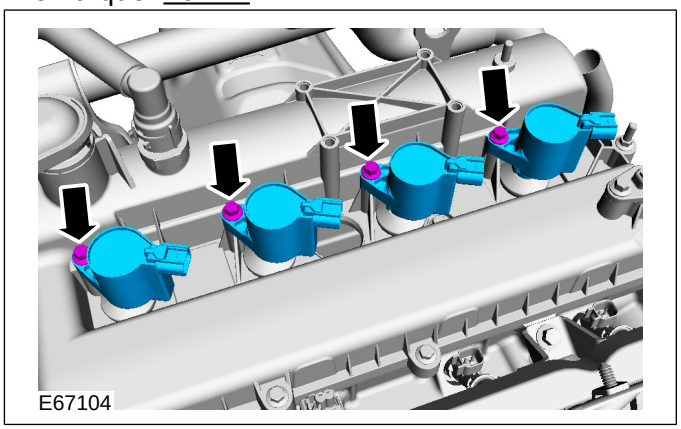
Material: Silicone Sealant



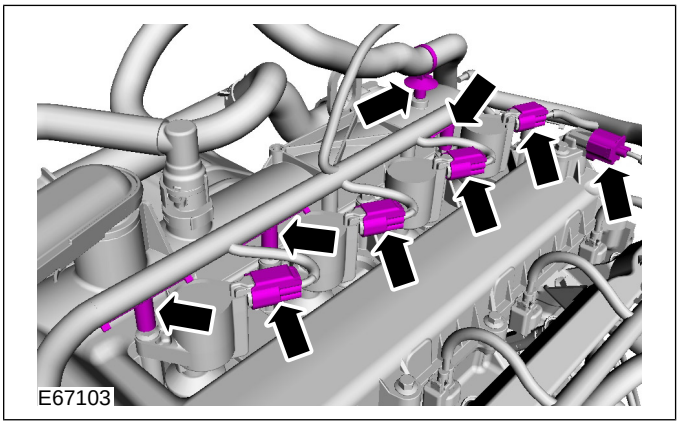
24. Torque: 10 Nm



25. Torque: 10 Nm



26.



27. Install the following items:

1. Accessory drive belt

   Refer to: Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

2. Intake manifold

   Refer to: Intake Manifold (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).

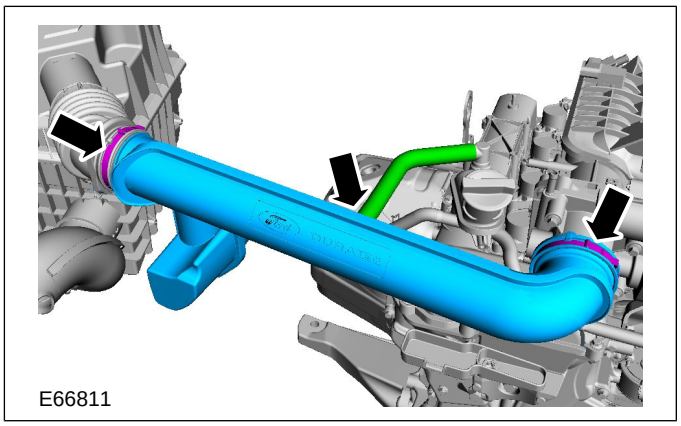
REMOVAL AND INSTALLATION

Exhaust Manifold

Removal

NOTE: Removal steps in this procedure may contain installation details.

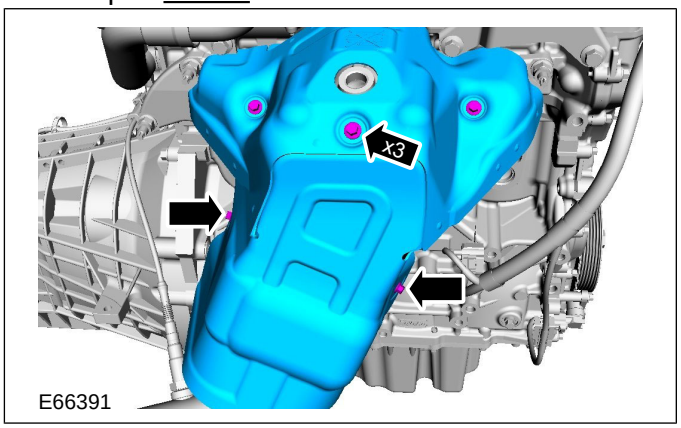
1.



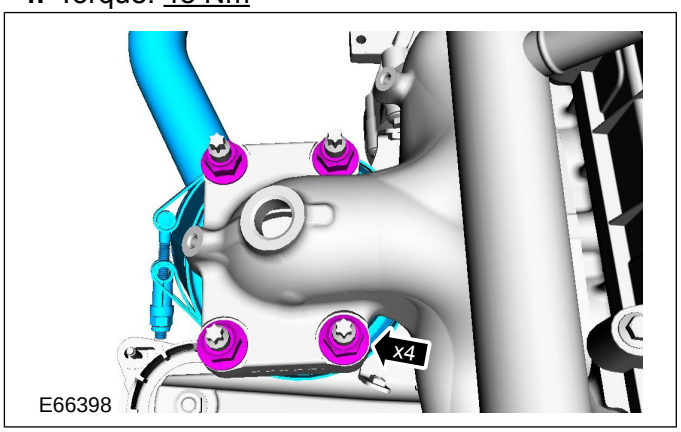
2. Remove the heated oxygen sensor (HO2S).

Refer to:Heated Oxygen Sensor (HO2S) (303-14 Electronic Engine Controls, Removal and Installation).

3. Torque: 10 Nm

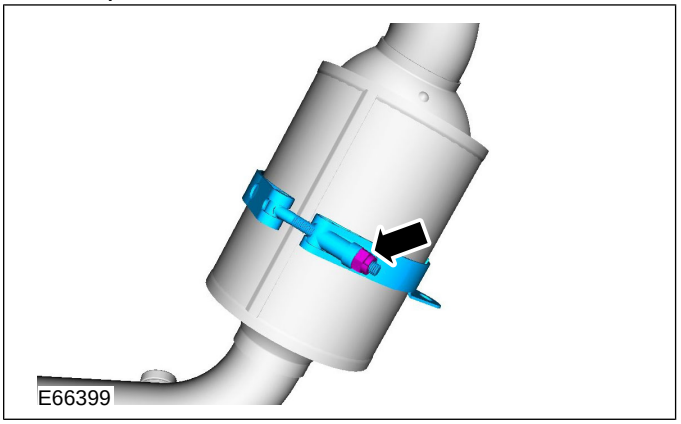


4. Torque: 48 Nm

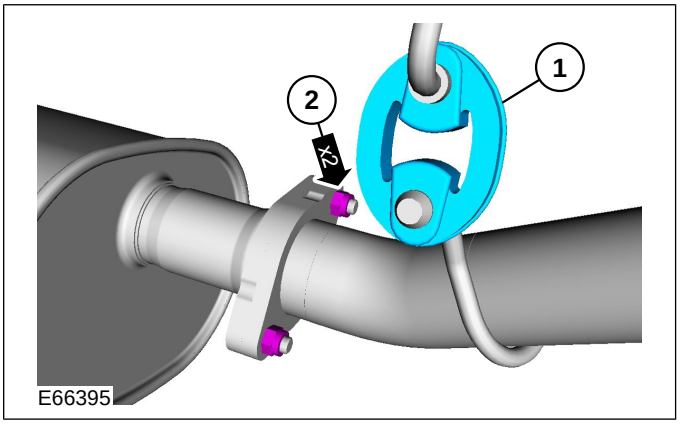


5. ⚠ **CAUTION:To prevent damage to the catalytic converter, do not over tighten the retaining clamp.**

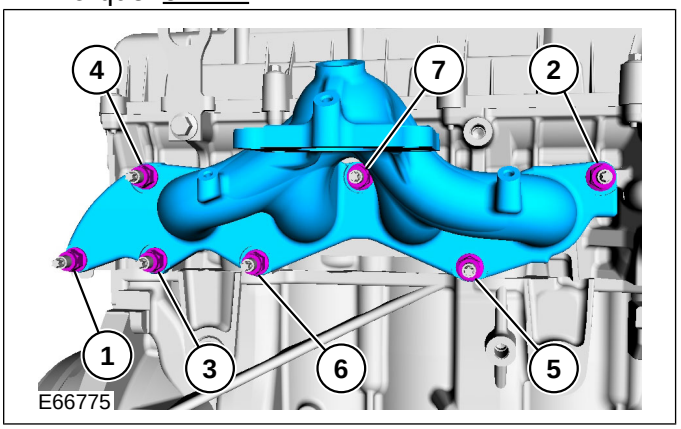
Torque: 11 Nm



6.



7. Torque: 54 Nm



REMOVAL AND INSTALLATION

Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Cylinder Head

Special Tool(s)

 23041	Disconnect Tool, Fuel Line (5/16") 310-040

Special Tool(s)

Materials

Name	Specification
Hypoid Gear Oil	SQM-2C9002-AA

General Equipment

Coolant hose clamp remover/installer

Removal

1. Drain the cooling system.

Refer to:Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
Refer to:Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

2. Remove the following items:

1. Intake manifold

   Refer to:Intake Manifold (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).

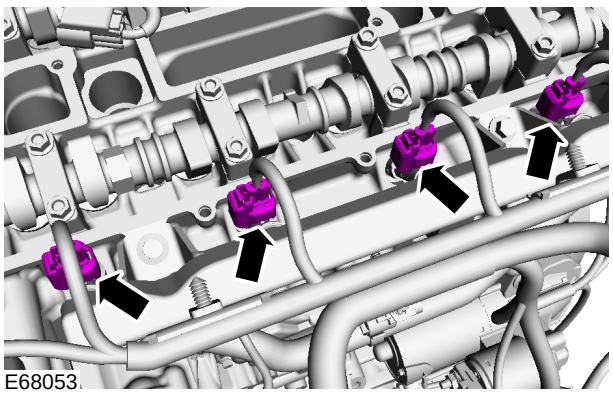
2. Timing chain

   Refer to:Timing Chain (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).

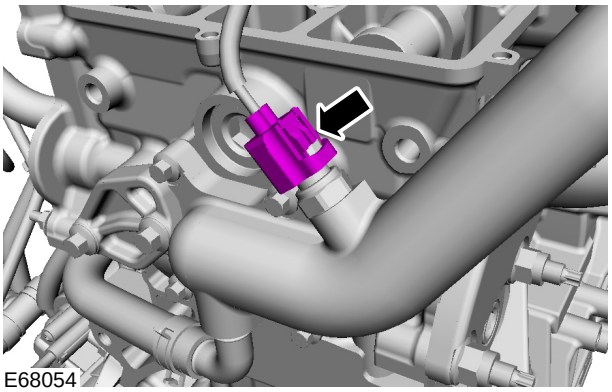
3. Heated oxygen sensor

   Refer to:Heated Oxygen Sensor (HO2S) (303-14 Electronic Engine Controls, Removal and Installation).

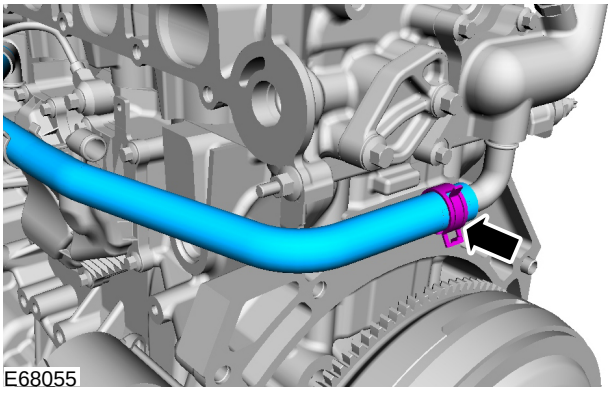
3.



4.

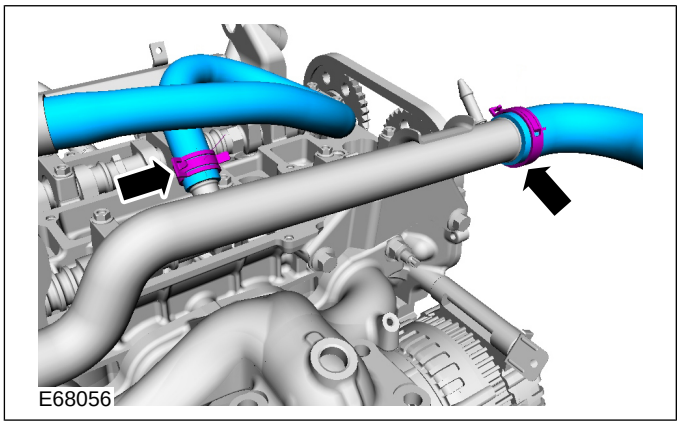


5. General Equipment: Coolant hose clamp remover/installer

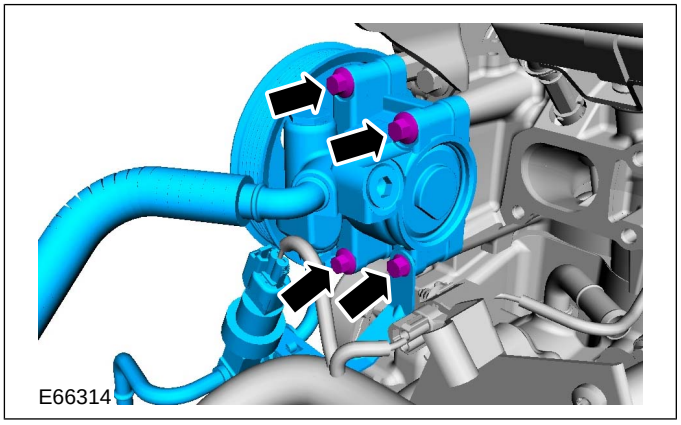


REMOVAL AND INSTALLATION

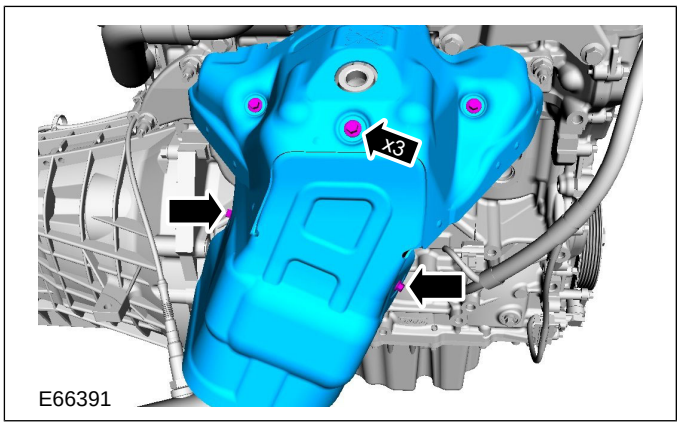
6. General Equipment: Coolant hose clamp remover/installer



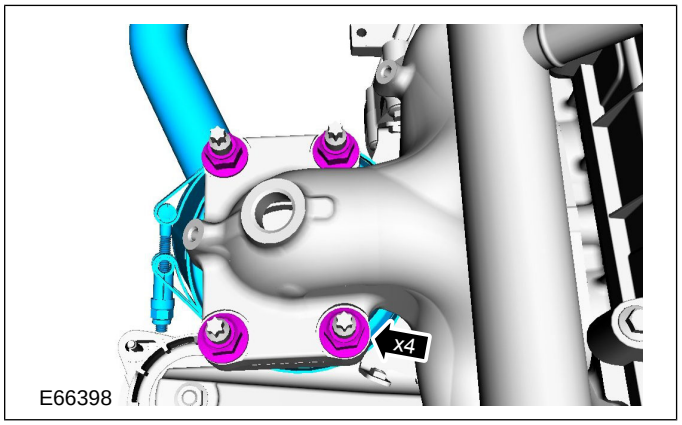
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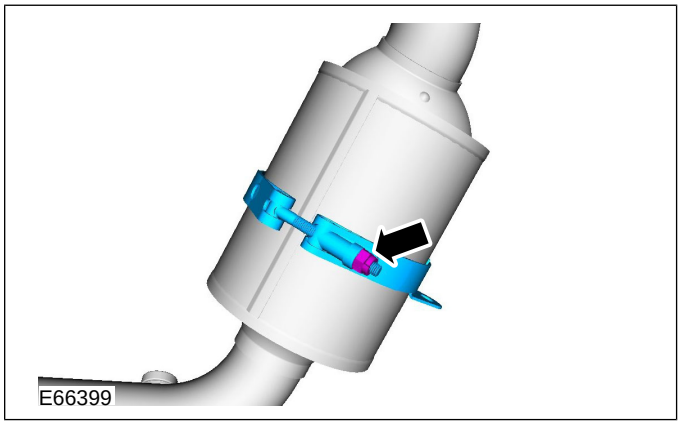
8.



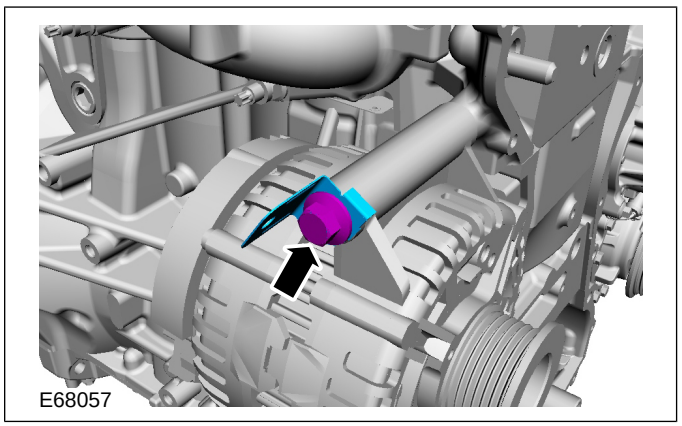
9.



10.

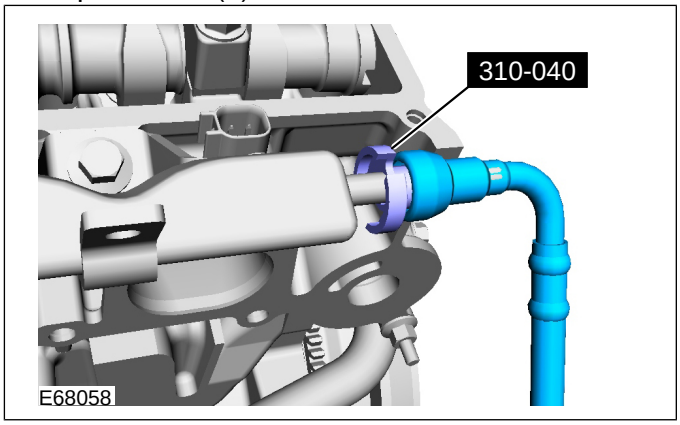


11.

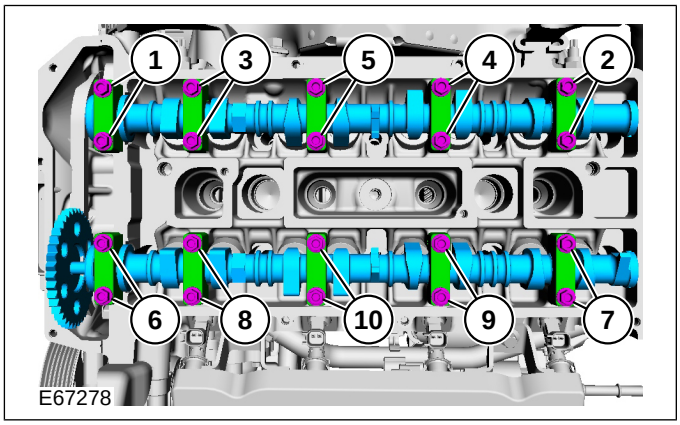


REMOVAL AND INSTALLATION

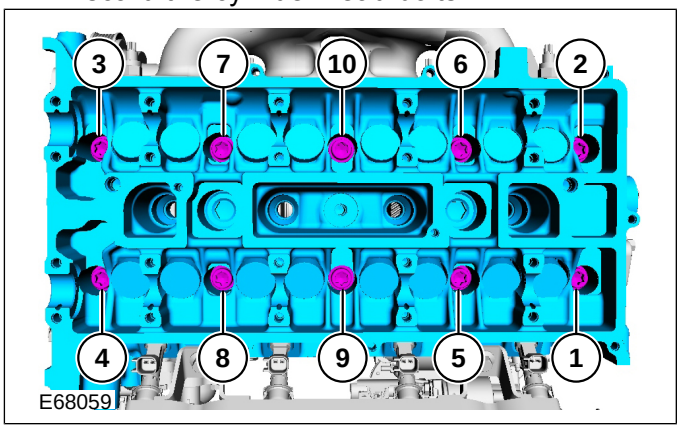
12. Special Tool(s): 310-040



13. **CAUTION:Keep the camshaft bearing caps and the camshafts in order for installation.**



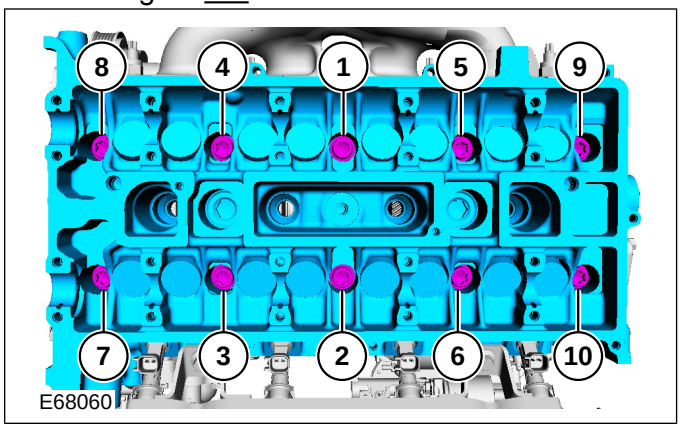
14. Discard the cylinder head bolts.



Installation

1. **CAUTION:Install new cylinder head bolts.**

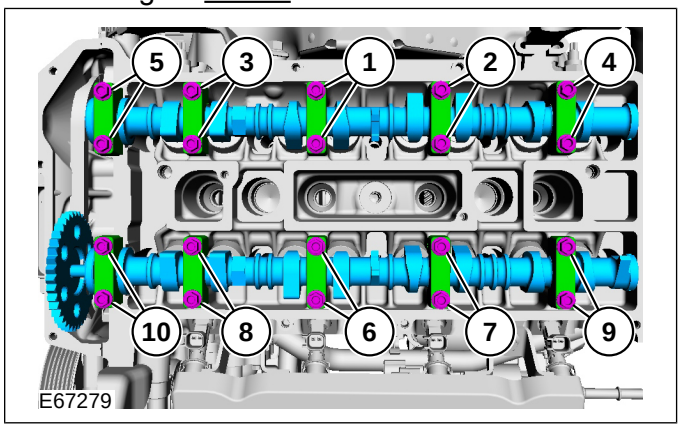
Torque:
- Stage1: 5 Nm
- Stage2: 15 Nm
- Stage3: 45 Nm
- Stage4: 90°
- Stage5: 90°



2. **CAUTION:Make sure that the camshafts and camshaft bearing caps are installed in their original locations.**

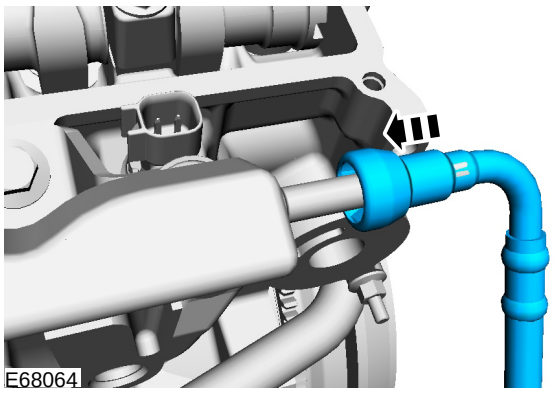
Coat the camshaft bearing caps with oil.

Material: Hypoid Gear Oil
Torque:
- Stage1: 7 Nm
- Stage2: 16 Nm

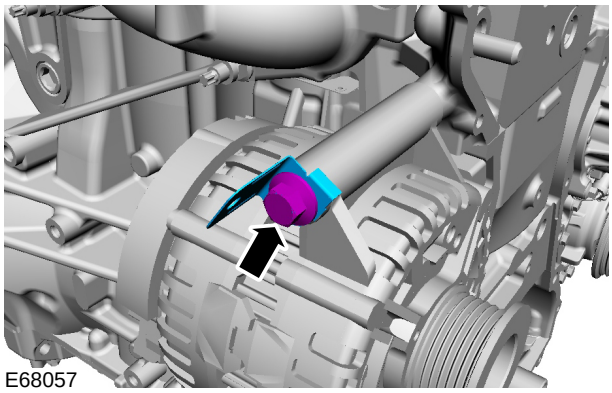


REMOVAL AND INSTALLATION

3.

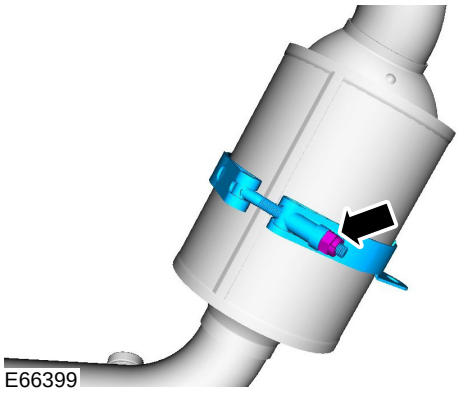


4. Torque: 47 Nm

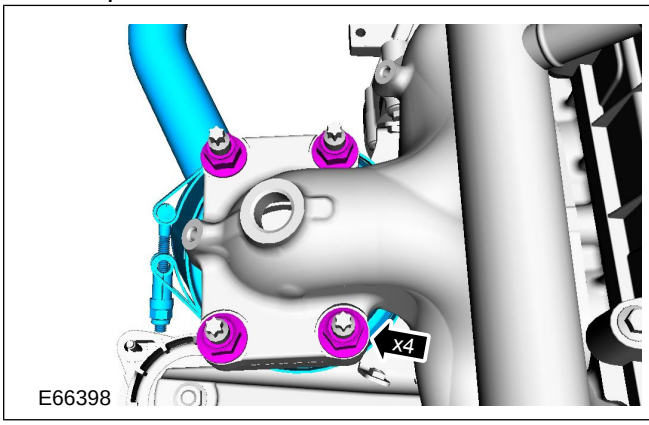


5. ⚠ **CAUTION:To prevent damage to the catalytic converter, do not over tighten the retaining clamp.**

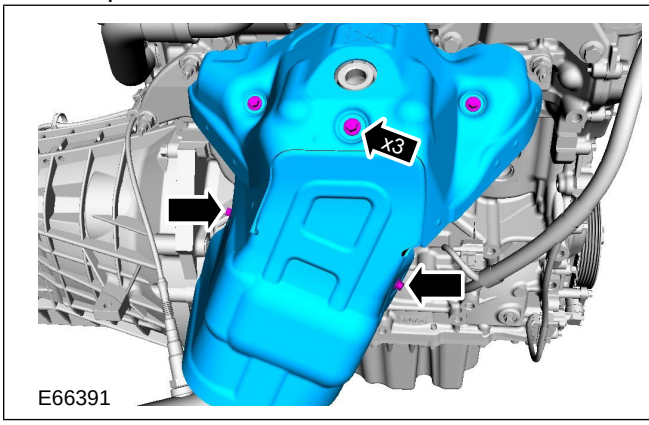
Torque: 11 Nm



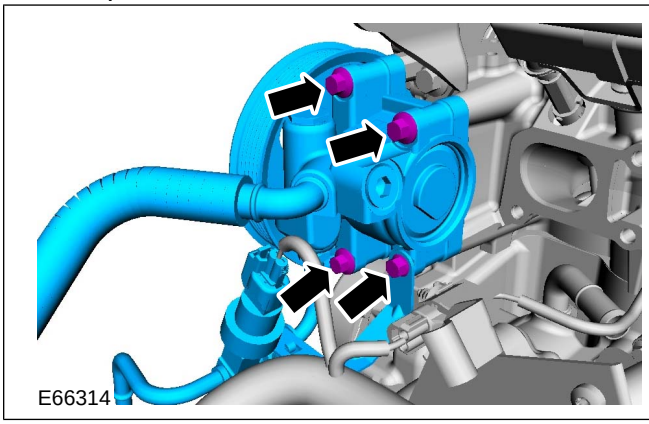
6. Torque: 48 Nm



7. Torque: 10 Nm

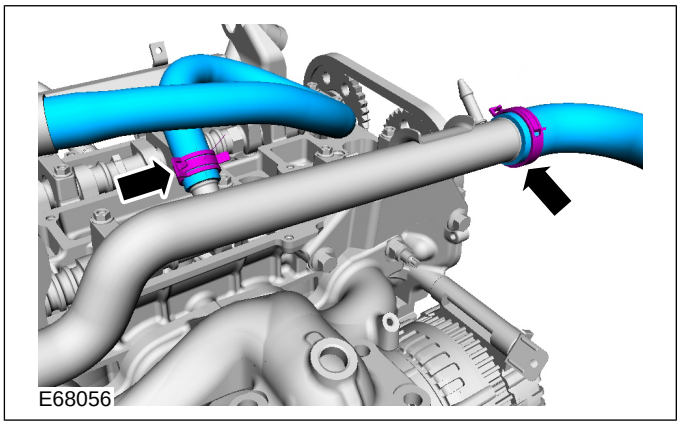


8. Torque: 25 Nm

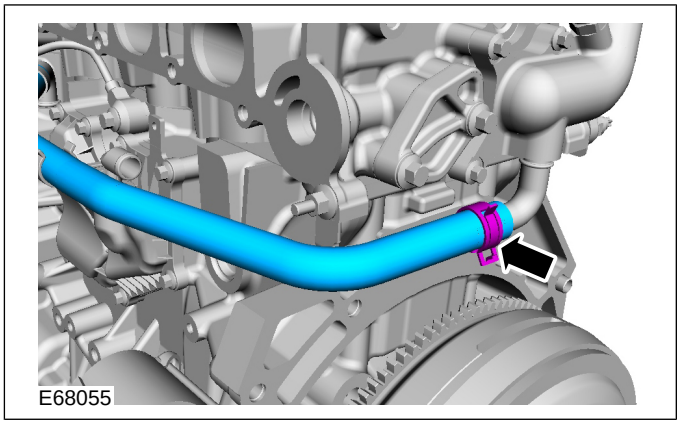


REMOVAL AND INSTALLATION

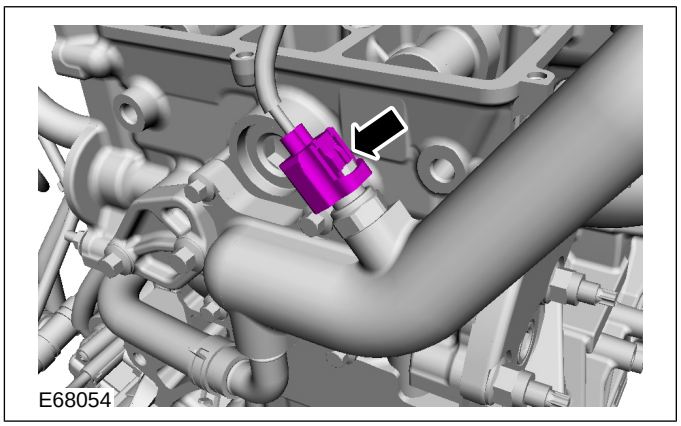
9. General Equipment: Coolant hose clamp remover/installer



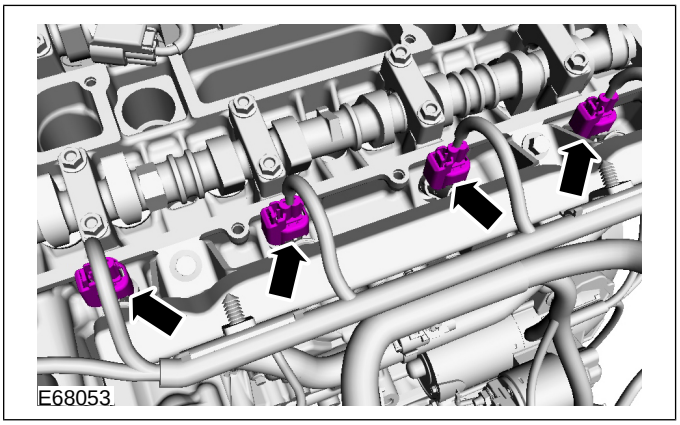
10. General Equipment: Coolant hose clamp remover/installer



11.



12.



13. Install the following items:

1. Heated oxygen sensor

   Refer to:Heated Oxygen Sensor (HO2S) (303-14 Electronic Engine Controls, Removal and Installation).
2. Timing chain

   Refer to:Timing Chain (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).
3. Intake manifold

   Refer to:Intake Manifold (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).

14. Fill the cooling system.

Refer to:Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
Refer to:Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

REMOVAL AND INSTALLATION

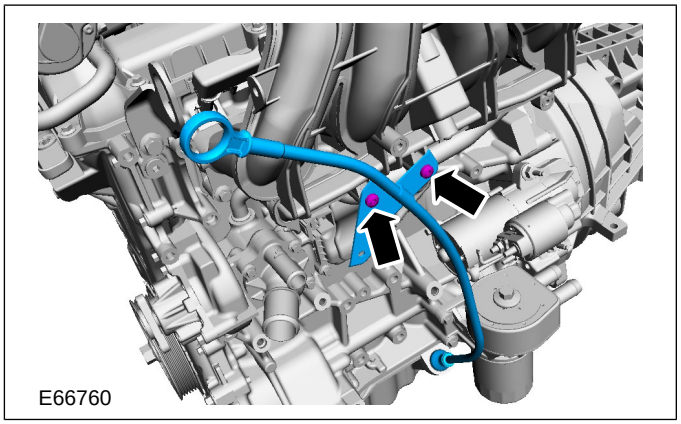
Oil Pan

Materials	
Name	**Specification**
Silicone Sealant	WSE-M4G323-A4

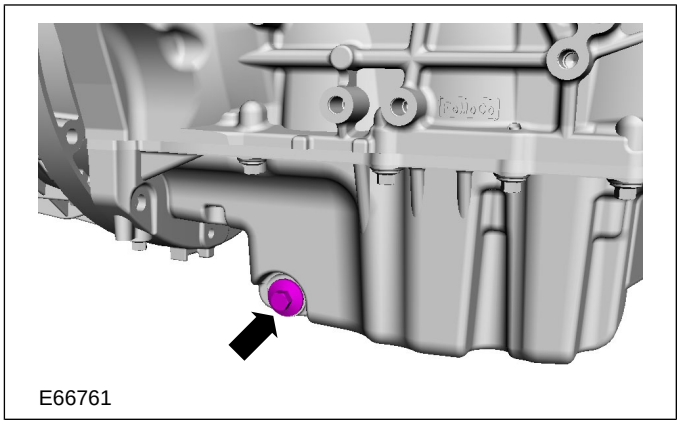
Materials	
Name	**Specification**
Engine Oil - 5W-30	WSS-M2C913-B

Removal

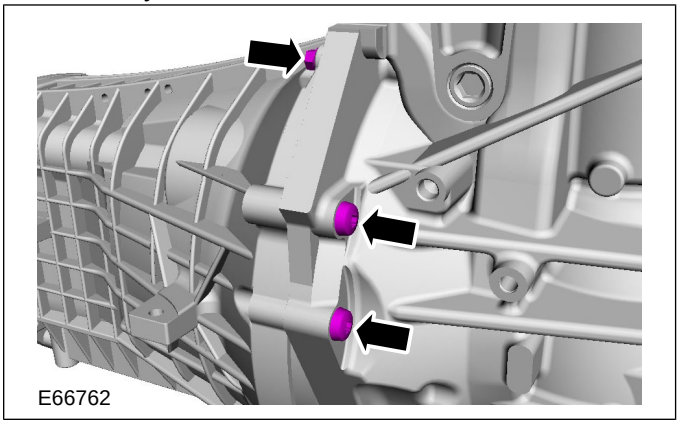
1. **NOTE:** The O-ring seal is to be reused unless damage.



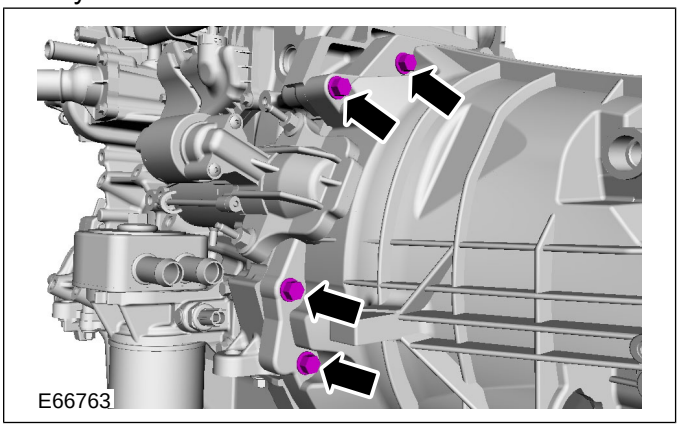
2. **NOTE:** The seal is to be reused unless damaged.



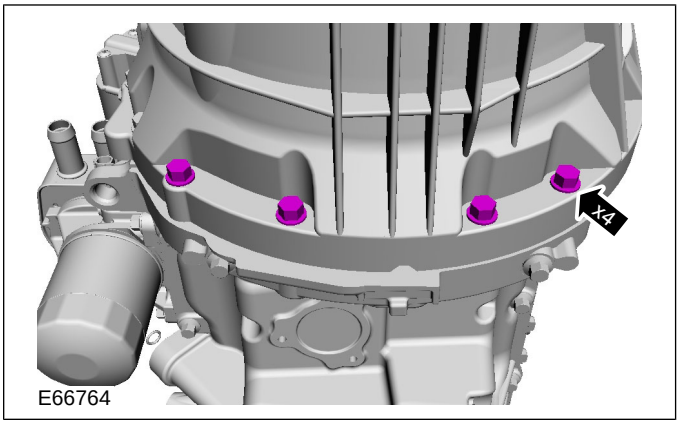
3. Loosen the right-hand transmission retaining bolts by 5 turns.



4. Loosen the left-hand transmission retaining bolts by 5 turns.

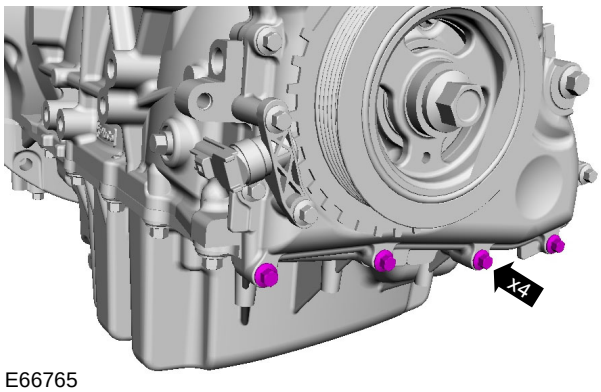


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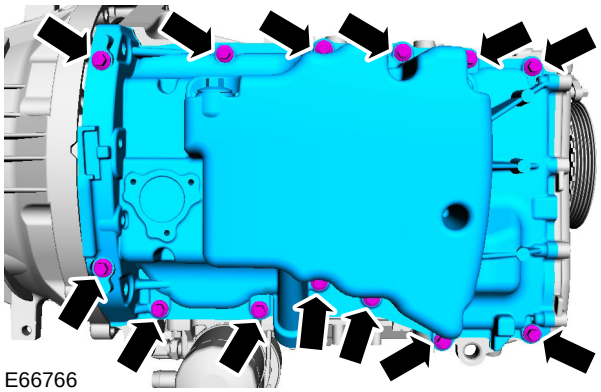


REMOVAL AND INSTALLATION

6.



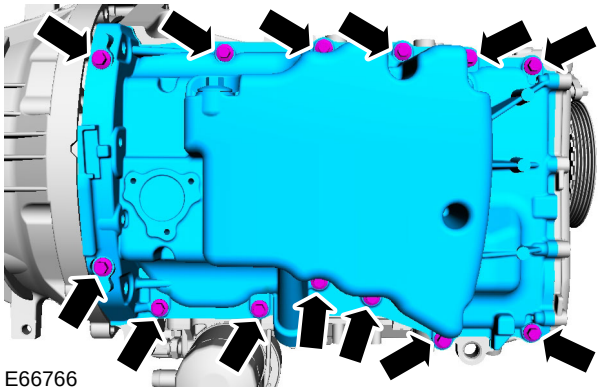
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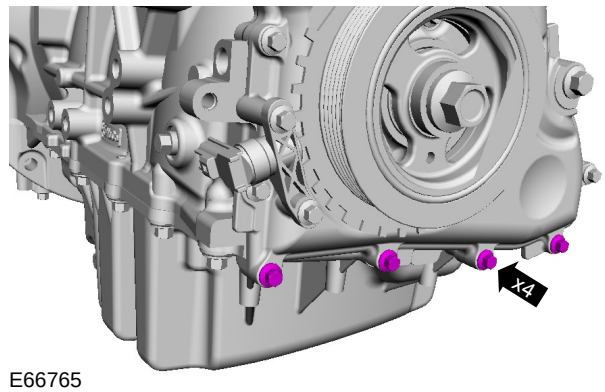
Installation

1. **NOTE:**Only tighten the bolts finger tight at this stage.
   - Apply a 3 mm bead of sealant to the oil pan.

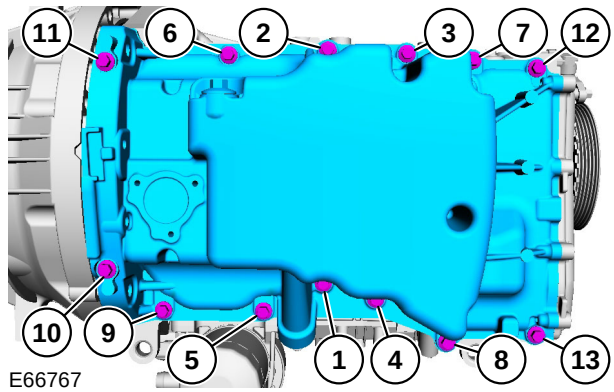
     Material: Silicone Sealant



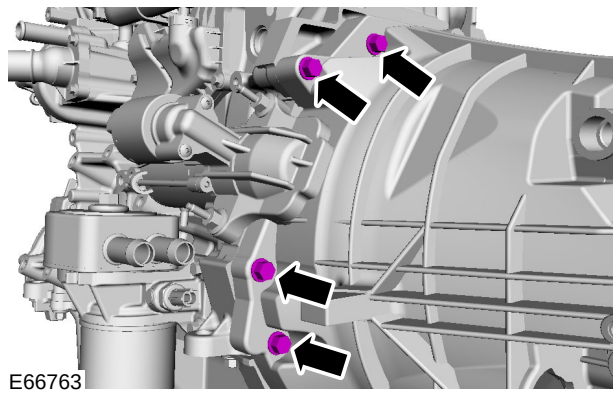
2. Torque: 10 Nm



3. Torque: 25 Nm

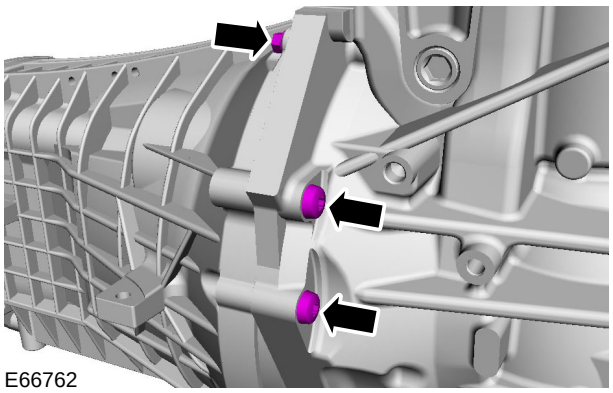


4. Torque: 40 Nm

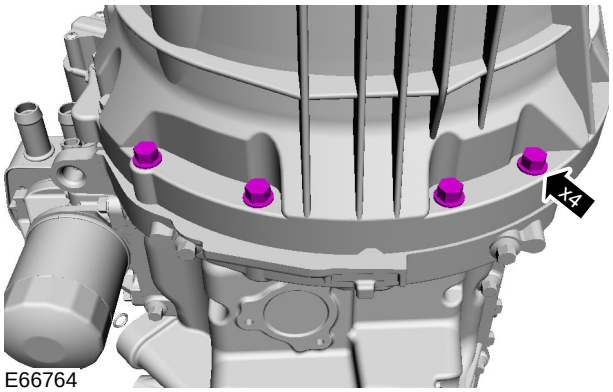


REMOVAL AND INSTALLATION

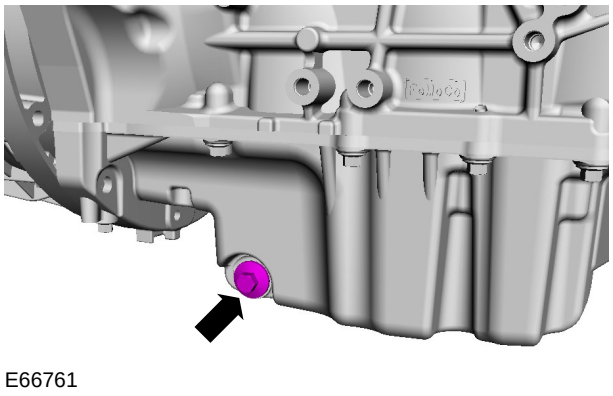
5. Torque: 40 Nm



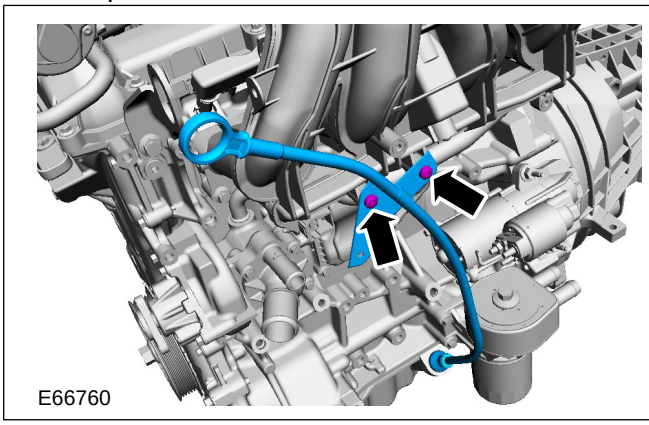
6. Torque: 40 Nm



7. Torque: 25 Nm



8. Torque: 10 Nm



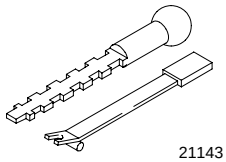
9. Fill the engine with engine oil.

Refer to:Specifications (303-01 Engine - 2.3L Duratec-HE (MI4), Specifications).
Material: Engine Oil - 5W-30

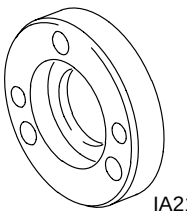
REMOVAL AND INSTALLATION

Crankshaft Front Seal

Special Tool(s)

 21143	Remover, Crankshaft Seal 303-293

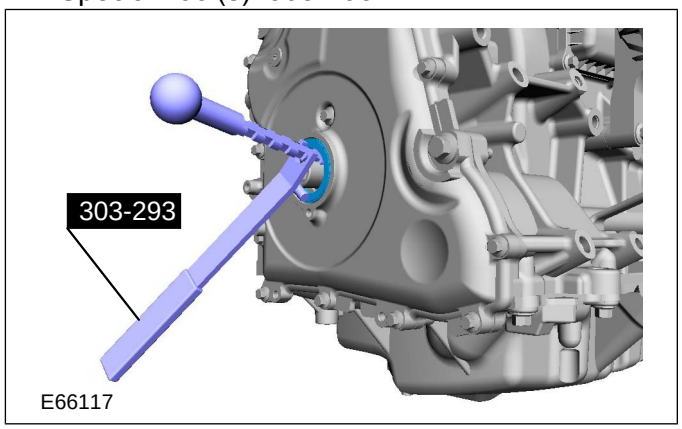
Special Tool(s)

 IA21213	Remover, Vibration Damper Hub 303-509

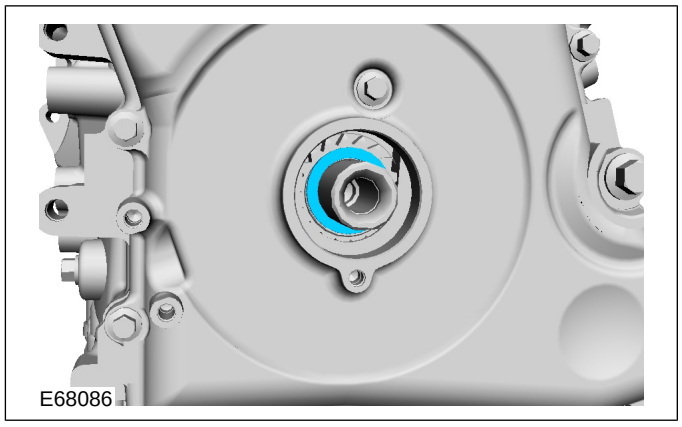
Removal

1. Remove the following items:
1. Refer to:Crankshaft Pulley (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).

2. Special Tool(s): 303-293

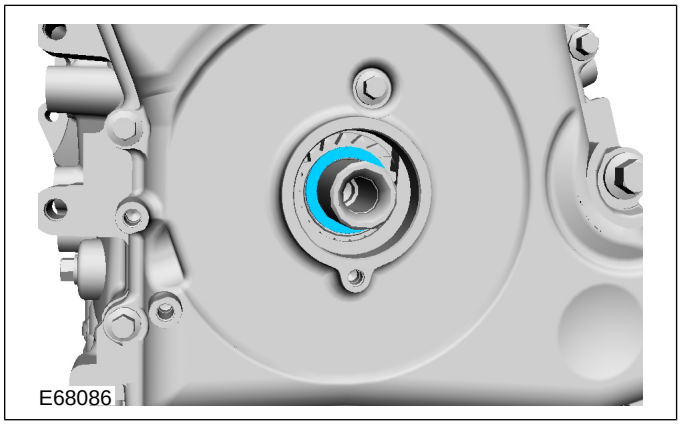


3. • Discard the friction washer.

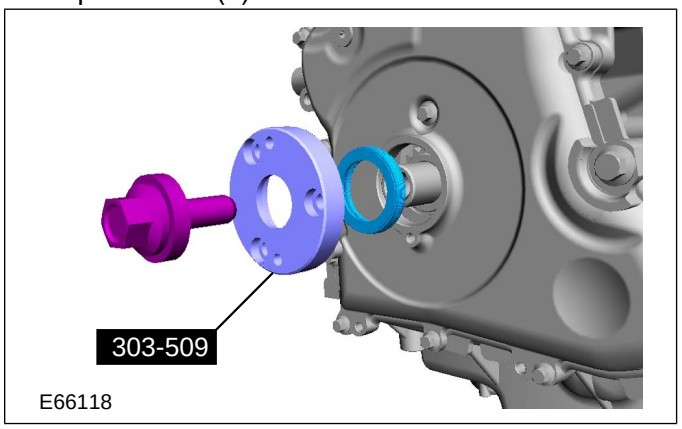


Installation

1. ⚠ **CAUTION:Make sure that a new friction washer is installed.**



2. Special Tool(s): 303-509

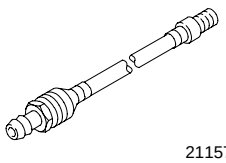
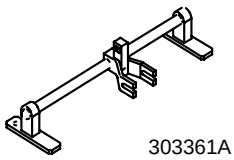
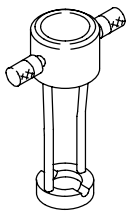


3. Install the following items:
1. Refer to:Crankshaft Pulley (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).

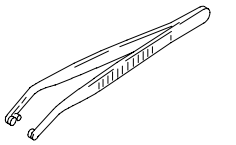
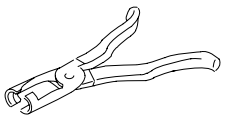
REMOVAL AND INSTALLATION

Valve Stem Seals

Special Tool(s)

 21157	Adapter, Air Supply (Cylinder Head) 303-363
 303361A	Compressor, Valve Spring 303-361A
 2115502A	Adapter for 303-361A 303-361-02

Special Tool(s)

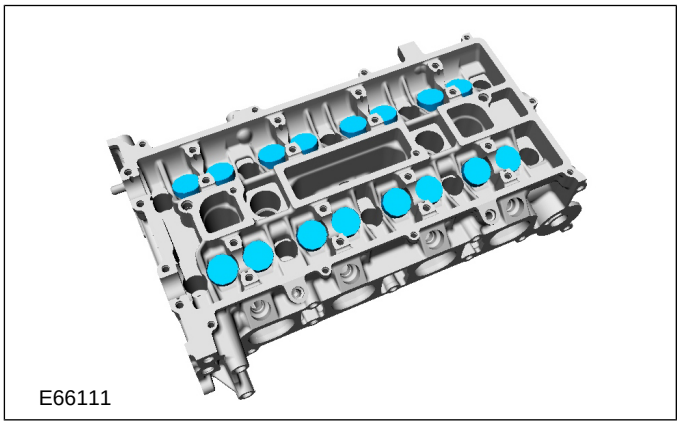
 21156	Installer, Valve Stem Collets 303-362
 21211	Pliers, Valve Stem Seal 303-508

Removal

NOTE: Removal steps in this procedure may contain installation details.

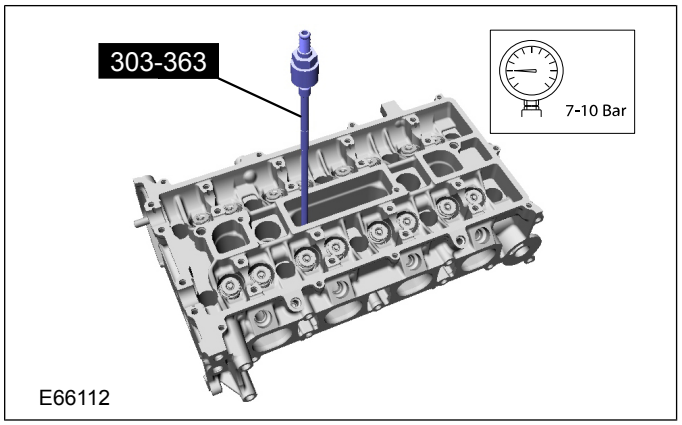
1. Remove the following items:
1. Refer to:Camshafts (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).

2.



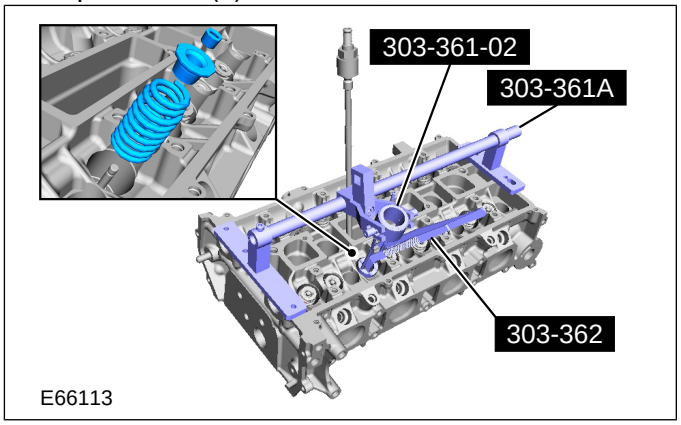
3. • Using the special tool, apply compressed air to the cylinder (7-10 bar).

Special Tool(s): 303-363

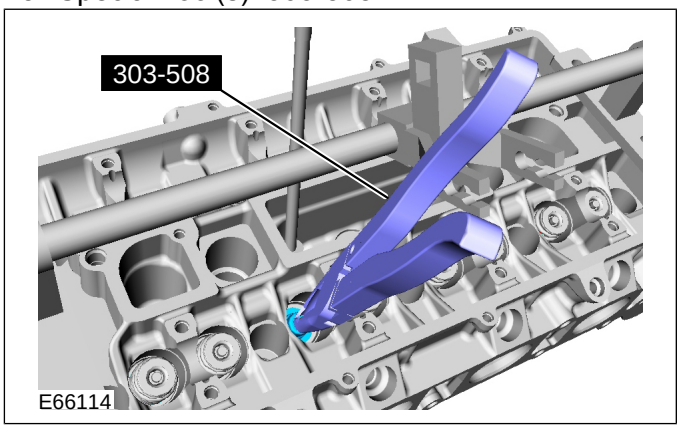


REMOVAL AND INSTALLATION

4. Special Tool(s): 303-361A, 303-361-02, 303-362



5. Special Tool(s): 303-508



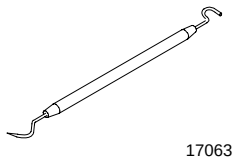
Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Timing Chain

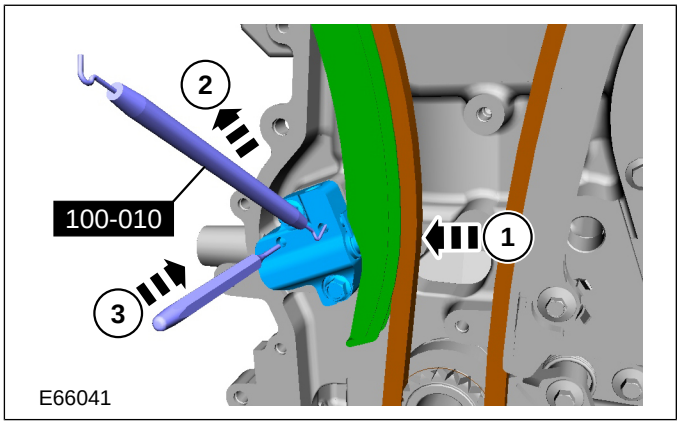
Special Tool(s)

 17063	Remover, O-Ring Seal 100-010

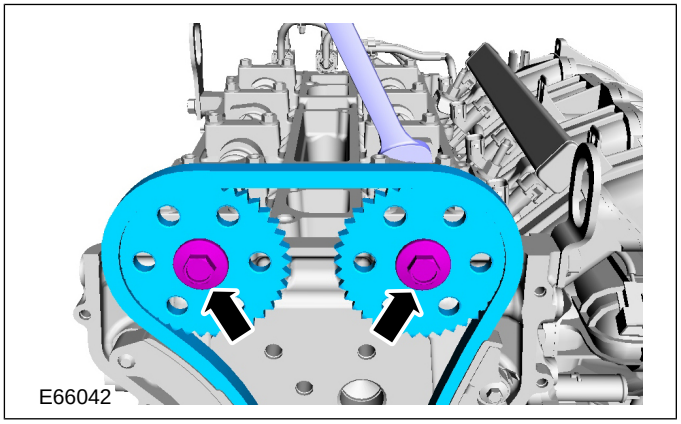
Special Tool(s)

Removal

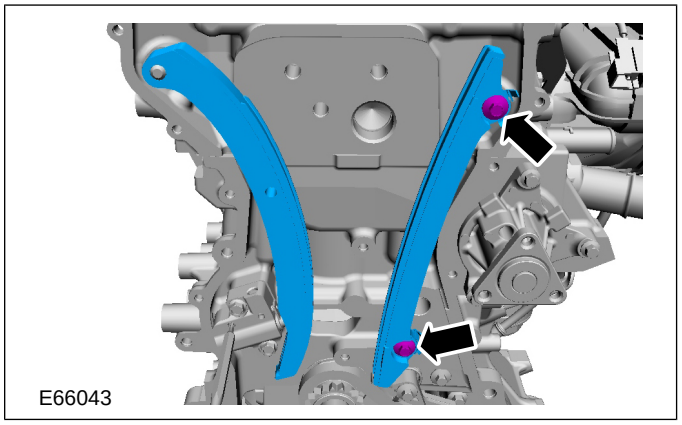
1. Remove the following items:
   1. Refer to:Engine Front Cover (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).
2. 2. Special Tool(s): 100-010
   3. 2 mm punch



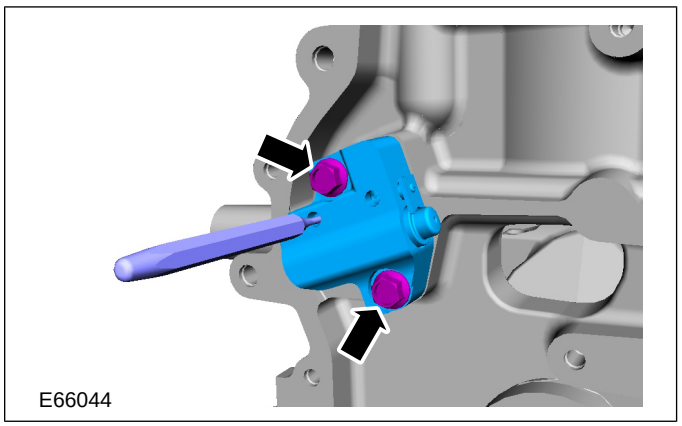
3. **NOTE:**Counterhold the camshafts at the hexagon using an open-ended spanner to prevent the camshafts from turning.



4.



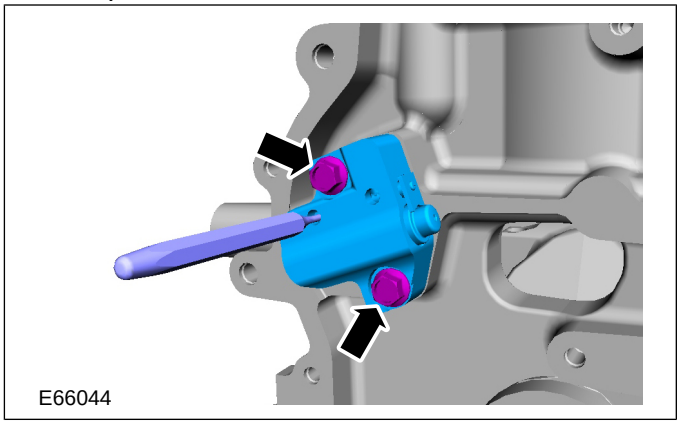
5.



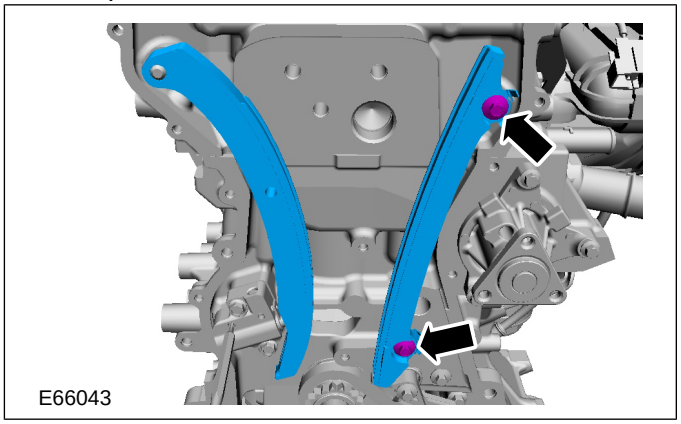
REMOVAL AND INSTALLATION

Installation

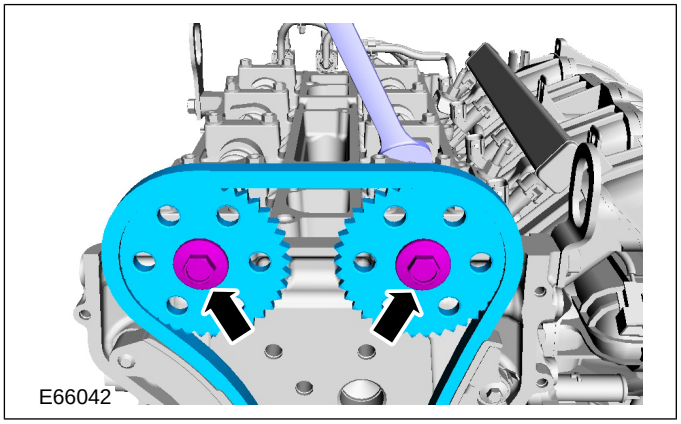
1. Torque: 10 Nm



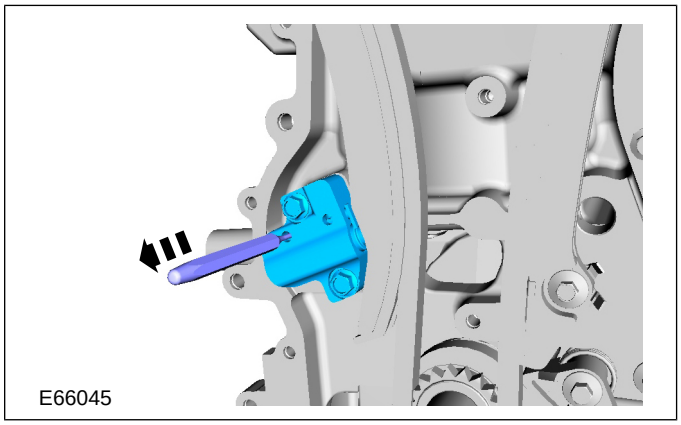
2. Torque: 10 Nm



3. **CAUTION:Only tighten the bolts finger tight at this stage.**

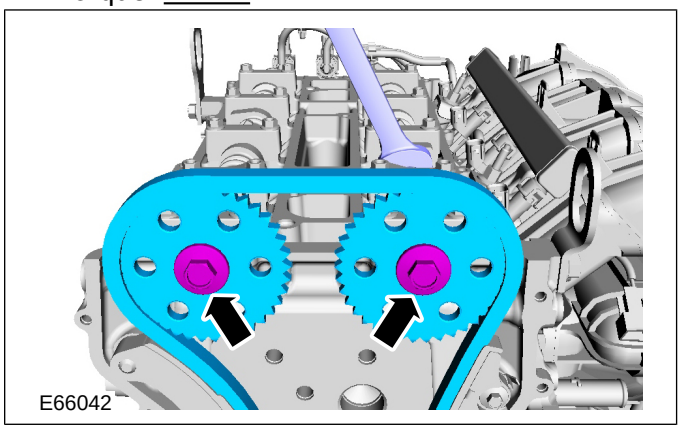


4.



5. **NOTE:**Counterhold the camshafts at the hexagon using an open-ended spanner to prevent the camshafts from turning.

   Torque: 72 Nm

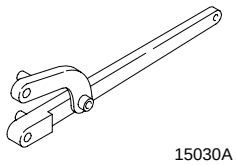


6. Install the following items:
   1. Refer to:Engine Front Cover (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).

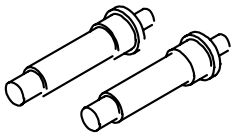
REMOVAL AND INSTALLATION

Oil Pump

Special Tool(s)

 15030A	Universal Flange Holding Wrench 205-072

Special Tool(s)

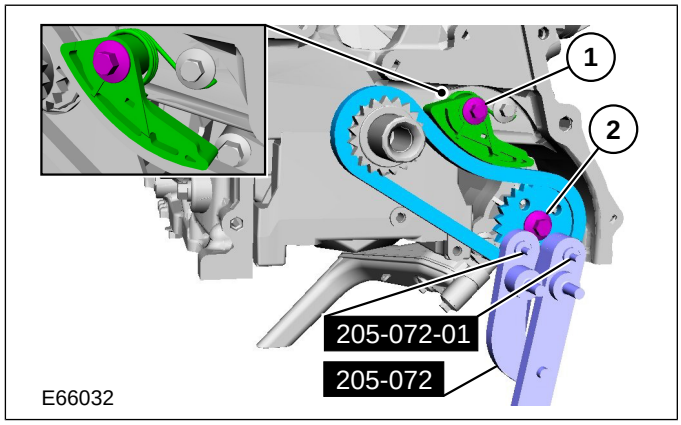
 20507201	Adapter for 205-072 205-072-01

Removal

NOTE: Removal steps in this procedure may contain installation details.

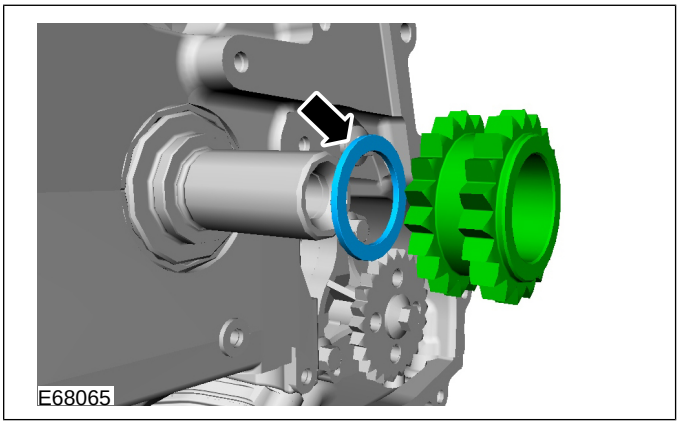
1. Remove the following items:
1. Refer to:Timing Chain (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).
2. Refer to:Oil Pan (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).

2. 1. Torque: 10 Nm
2. Special Tool(s): 205-072, 205-072-01 Torque: 25 Nm

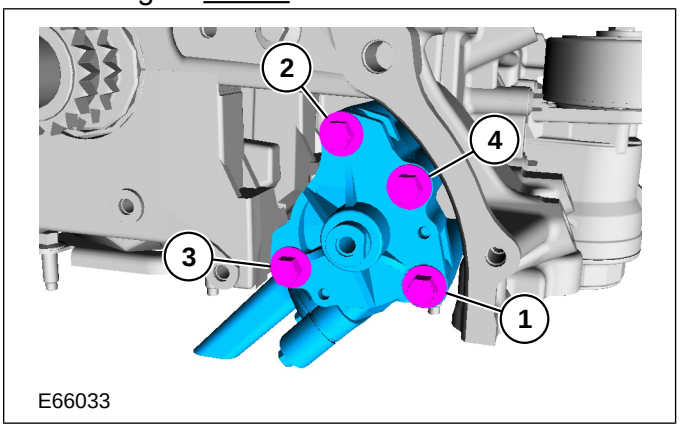


3. ⚠ **CAUTION:Make sure that a new friction washer is installed.**

Install a new friction washer.



4. Torque:
- Stage1: 10 Nm
- Stage2: 23 Nm



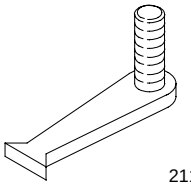
Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Crankshaft Rear Seal

Special Tool(s)

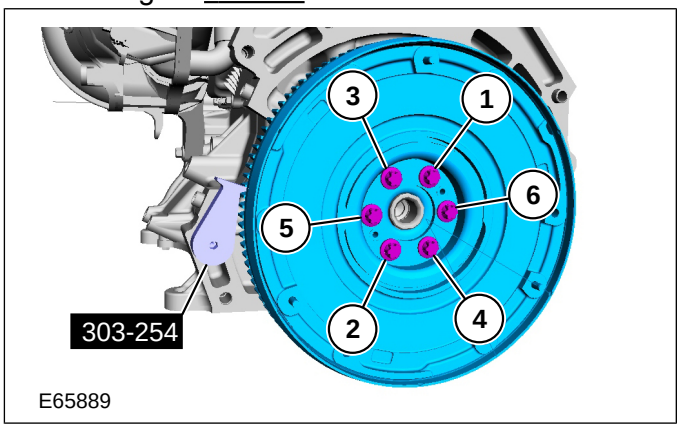
 21135	Locking Tool, Flywheel 303-254

Special Tool(s)

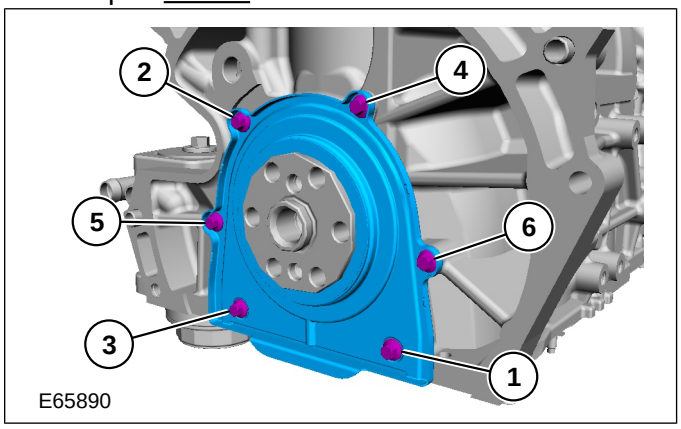
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Remove the following items:
   1. Refer to:
      (308-01A
      Removal and
   2. Refer to:Oil Pan (303-01 Engine - 2.3L Duratec-HE (MI4), Removal and Installation).
2. Discard the flywheel bolts.
   Special Tool(s): 303-254
   Torque:
   - Stage1: 50 Nm
   - Stage2: 80 Nm
   - Stage3: 112 Nm



3. **NOTE:**New crankshaft rear seal carriers are supplied with an alignment sleeve which must be removed after installation.
   Torque: 10 Nm



Installation

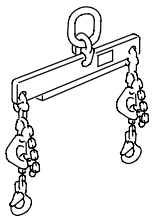
1. To install, reverse the removal procedure.

REMOVAL

Engine

Removal

Special Tool(s)

 23041	Disconnect Tool, Fuel Line (5/16") 310-040
 21068A	Lifting Bracket, Engine 303-122

General Equipment

Coolant hose clamp remover/installer
Vehicle/axle stands
Trolley jack
Hydraulic jib crane

1. Remove the following items:

1. Condenser core

   Refer to:Condenser Core (412-03 Air Conditioning, Removal and Installation).

2. Radiator

   Refer to:Radiator - 2.3L Duratec-HE (MI4) (303-03 Engine Cooling, Removal and Installation).

3. Accessory drive belt

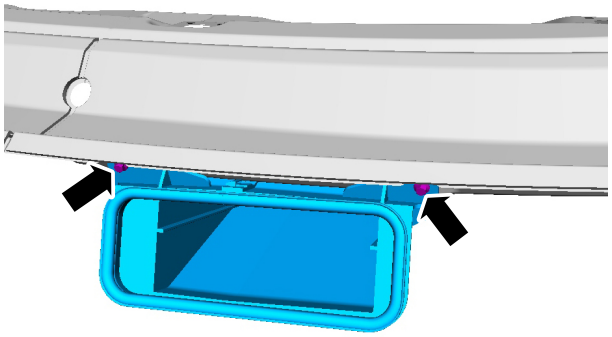
   Refer to:Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

2. Disconnect the following items:

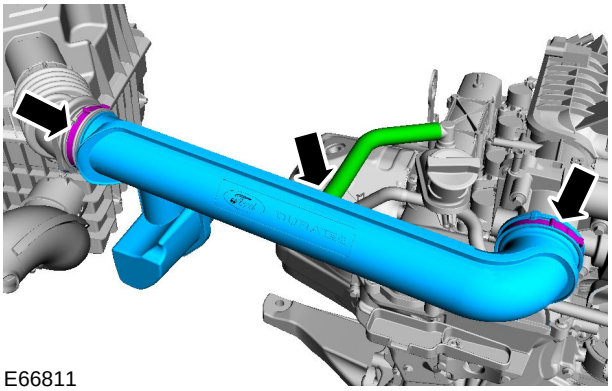
1. Battery

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

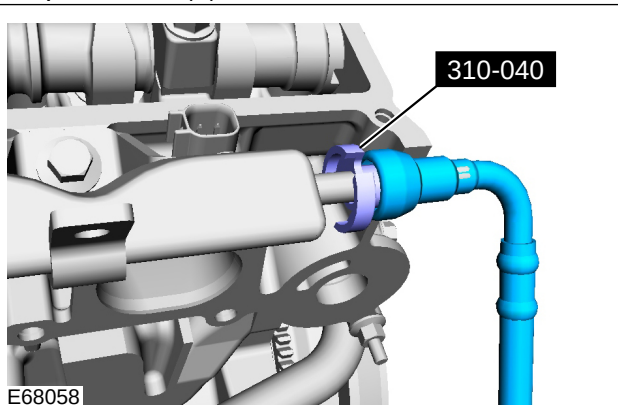
3.



4.

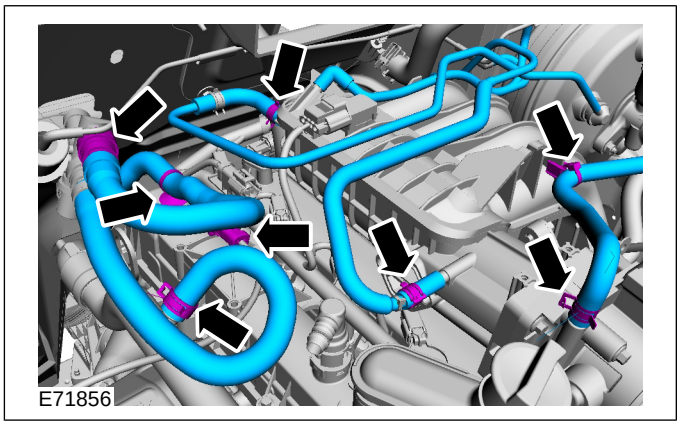


5. Special Tool(s): 310-040

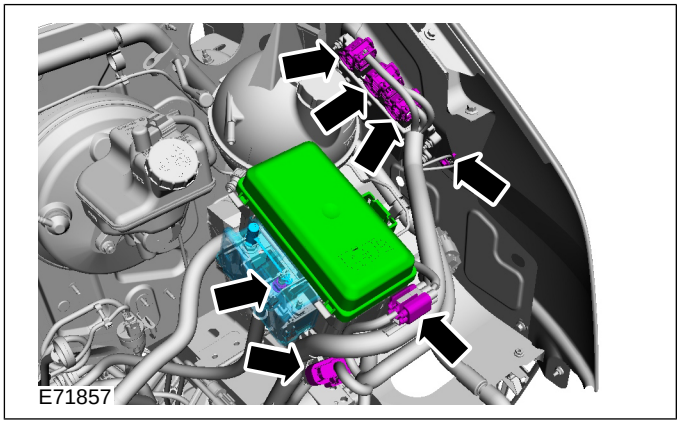


REMOVAL

6. General Equipment: Coolant hose clamp remover/installer



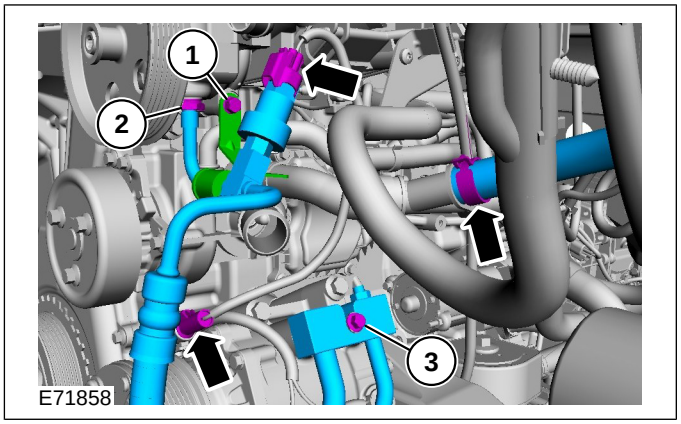
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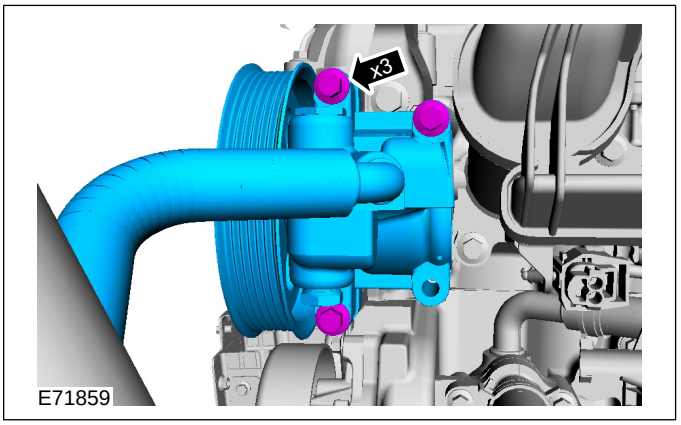
8. **WARNING:Be prepared to collect escaping fluids.**

CAUTION:Make sure that all openings are sealed.

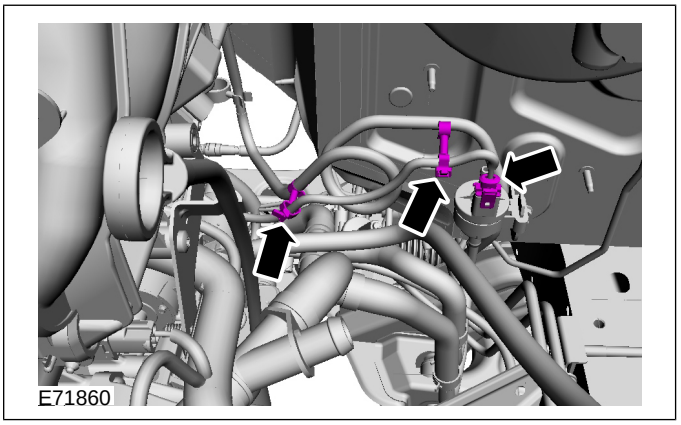
General Equipment: Coolant hose clamp remover/installer



9.



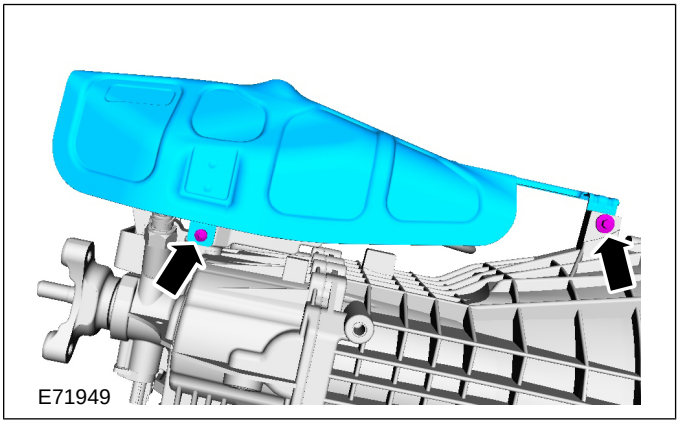
10.



11. Remove the following items:
    1. Catalytic converter

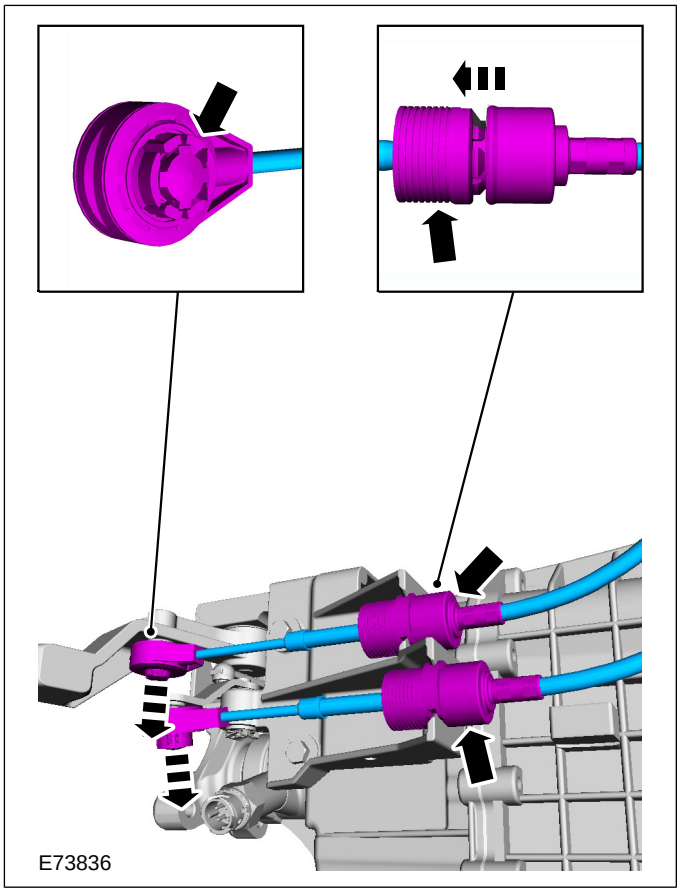
    Refer to:Catalytic Converter - 2.3L Duratec-HE (MI4) (309-00 Exhaust System, Removal and Installation).

12.

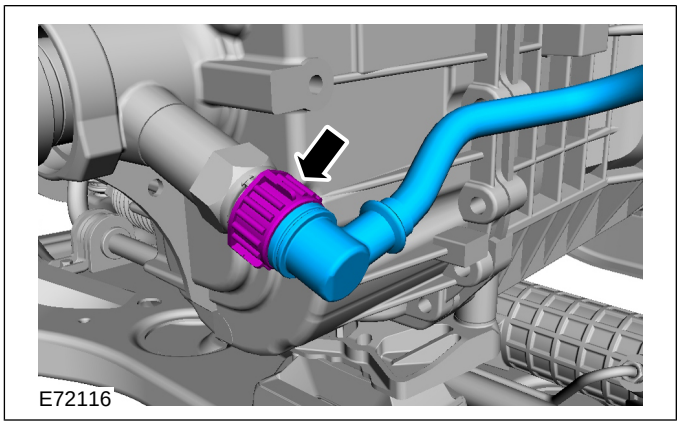


REMOVAL

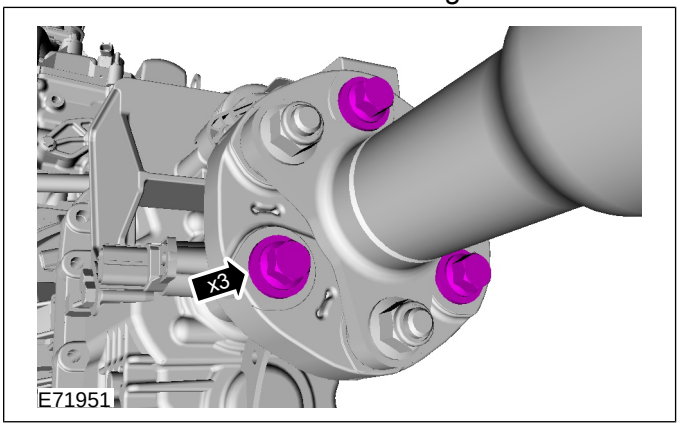
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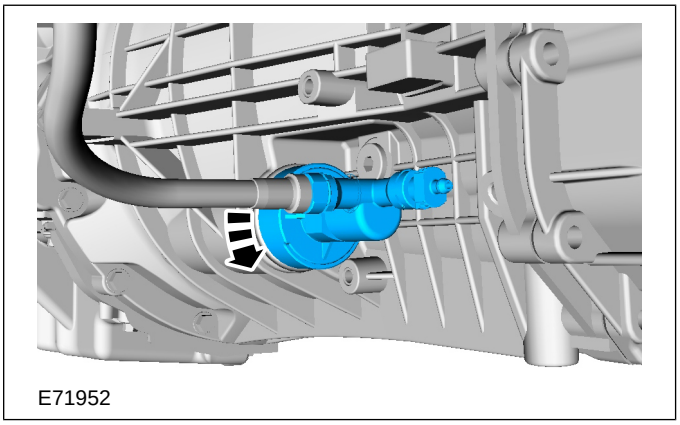
14.



15. Discard the driveshaft retaining bolts.

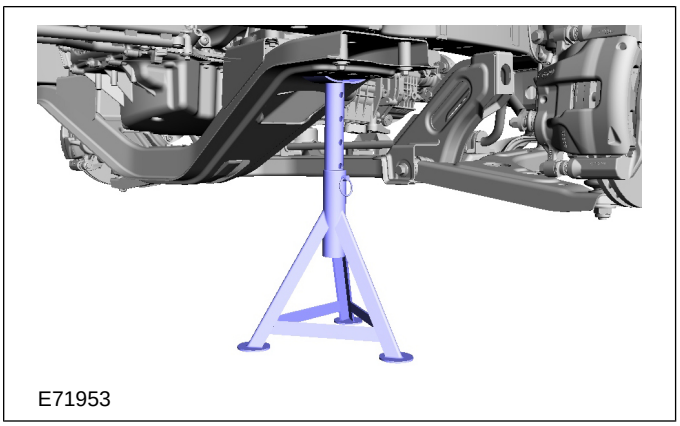


16.



17. • On both sides.

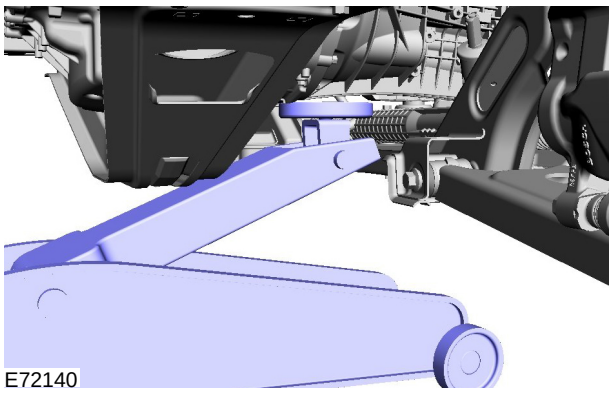
General Equipment: Vehicle/axle stands



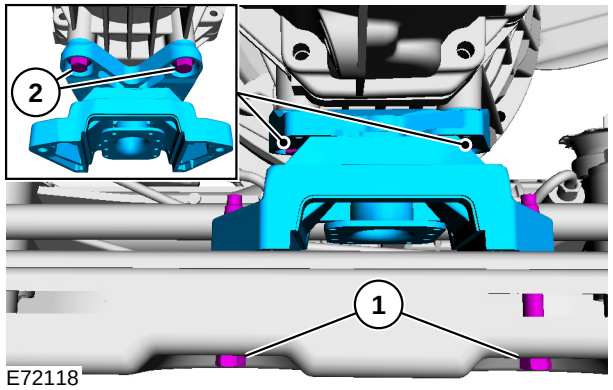
18. Lower the vehicle.

REMOVAL

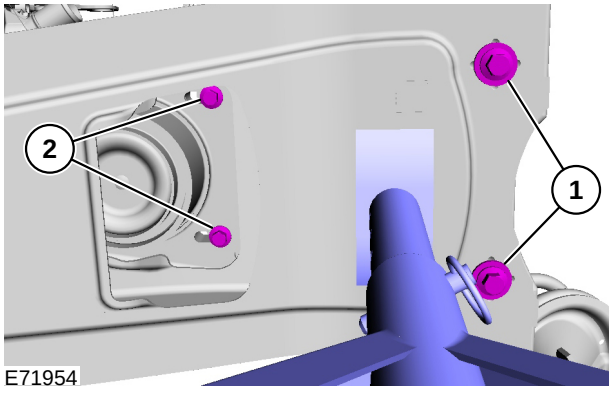
19. General Equipment: Trolley jack



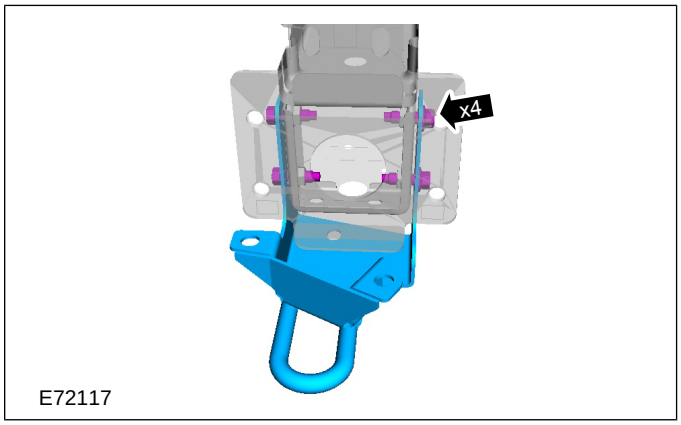
20.



21. On both sides.



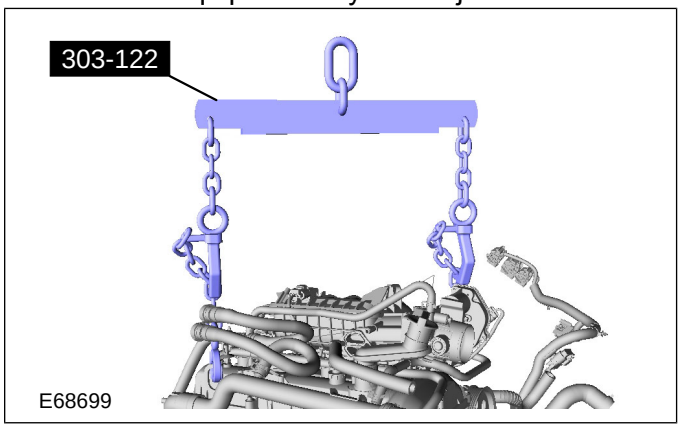
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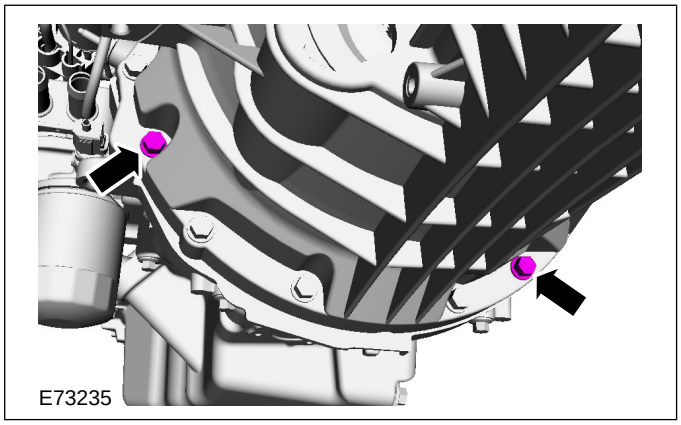
23. Push the vehicle back.

24. Install the special tool.

Special Tool(s): 303-122
General Equipment: Hydraulic jib crane

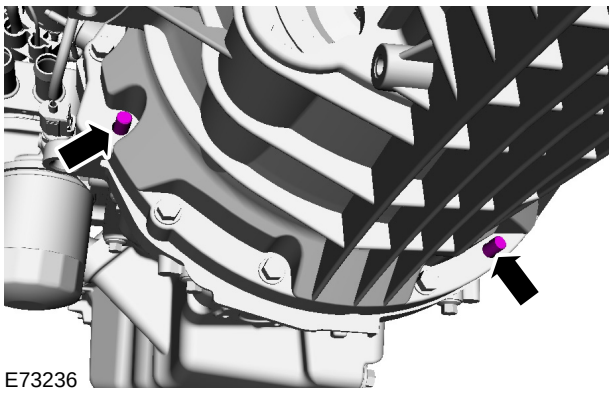


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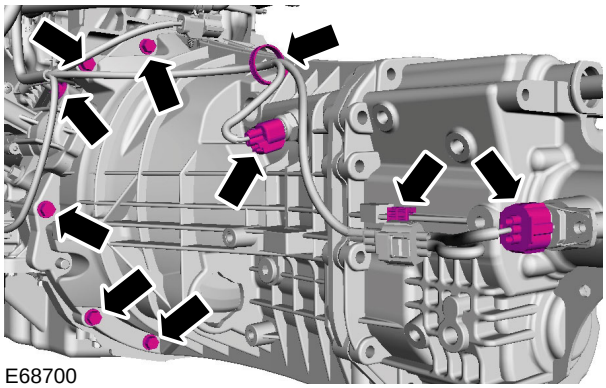


REMOVAL

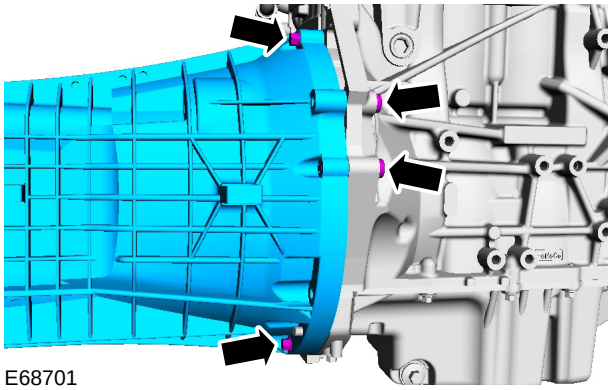
26. Studs M10 x 60



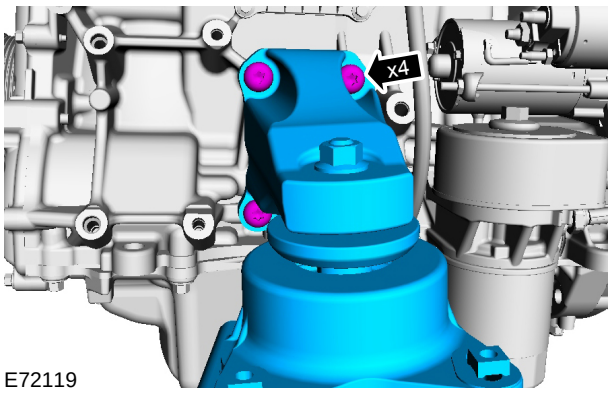
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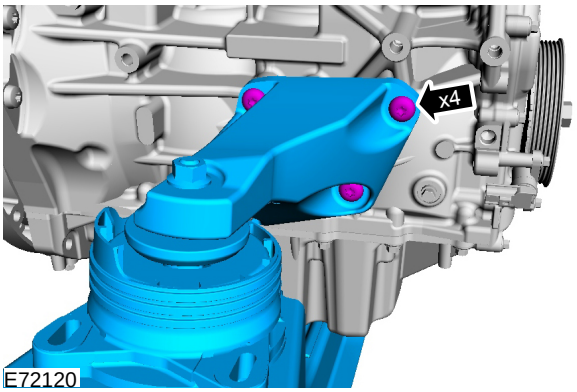
28.



29.



30.

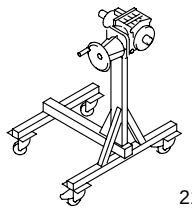
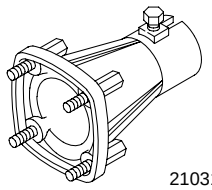
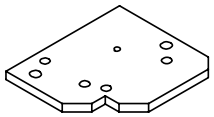
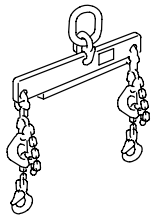
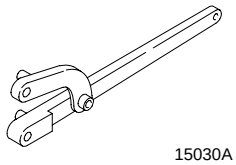
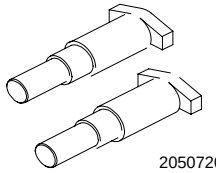


DISASSEMBLY

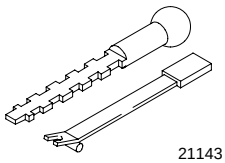
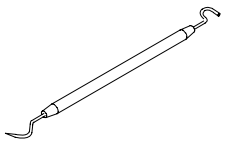
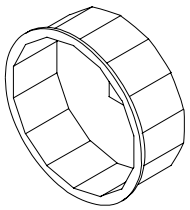
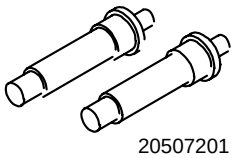
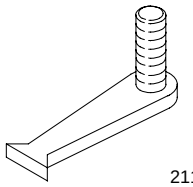
Engine

Disassembly

Special Tool(s)

 21187	Mounting Stand 303-435
 21031B	Mounting Bracket for 303-435 303-435-06
 30343511A	Mounting Plate for 303-435-06 303-435-11A
 21068A	Lifting Bracket, Engine 303-122
 15030A	Universal Flange Holding Wrench 205-072
 20507202	Adapter for 205-072 205-072-02

Special Tool(s)

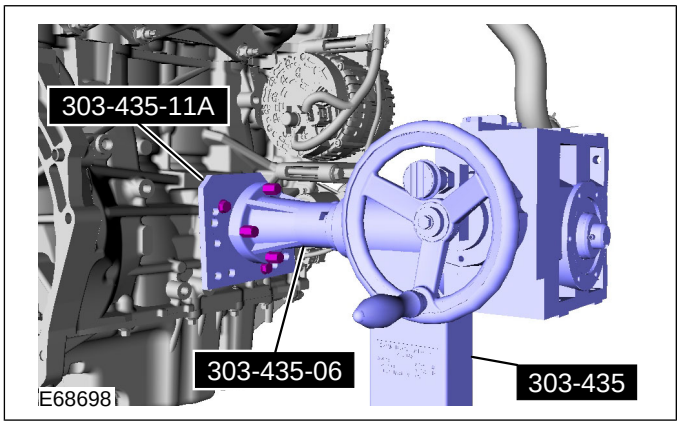
 21143	Remover, Crankshaft Seal 303-293
 17063	Remover, O-Ring Seal 100-010
 303699	Wrench, Oil Filter 303-699
 20507201	Adapter for 205-072 205-072-01
 21135	Locking Tool, Flywheel 303-254

General Equipment

Hydraulic jib crane
Coolant hose clamp remover/installer

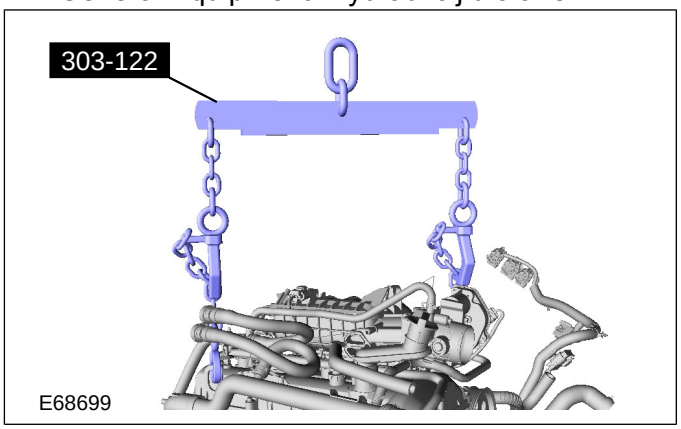
DISASSEMBLY

1. Special Tool(s): 303-435, 303-435-06, 303-435-11A

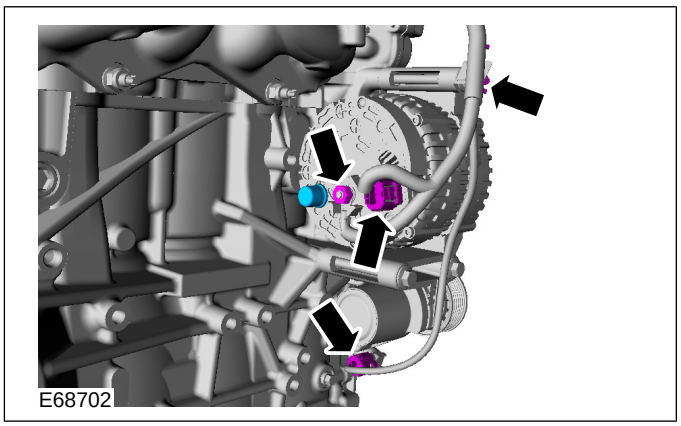


2. Remove the special tool.

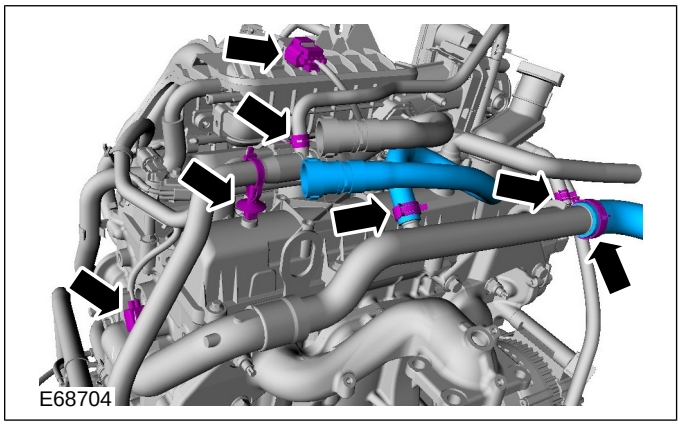
   Special Tool(s): 303-122
   General Equipment: Hydraulic jib crane



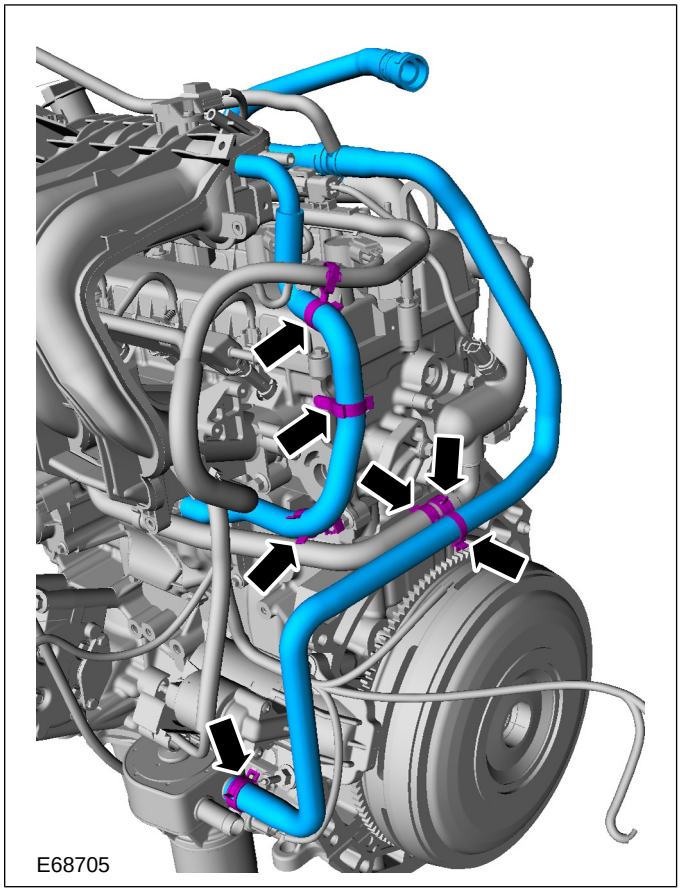
3. Discard the electrical connector nut cover.



4. General Equipment: Coolant hose clamp remover/installer

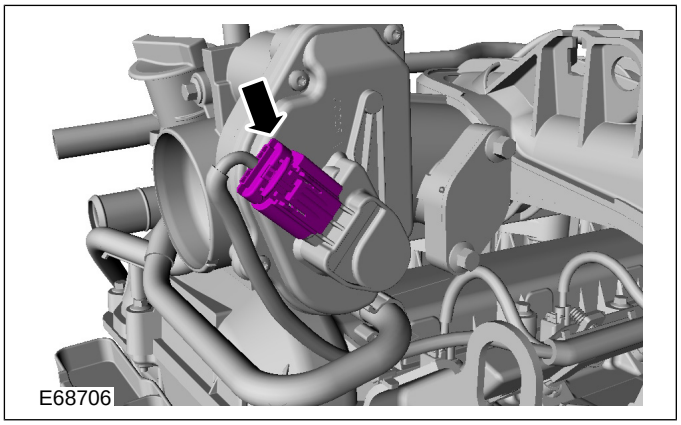


5. General Equipment: Coolant hose clamp remover/installer

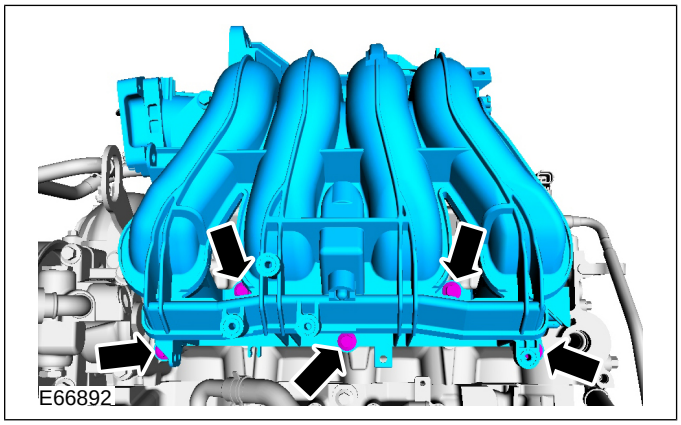


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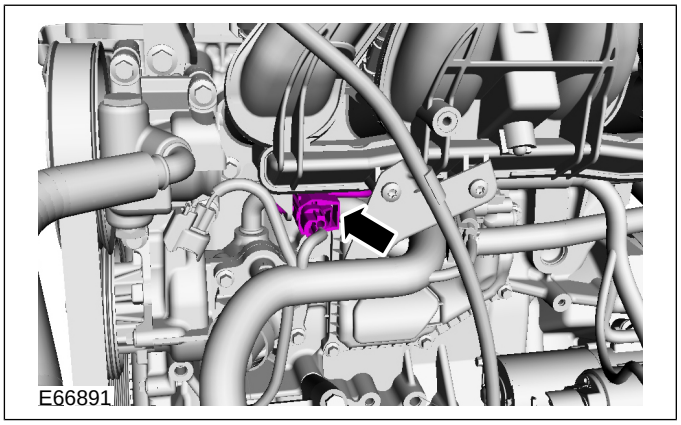
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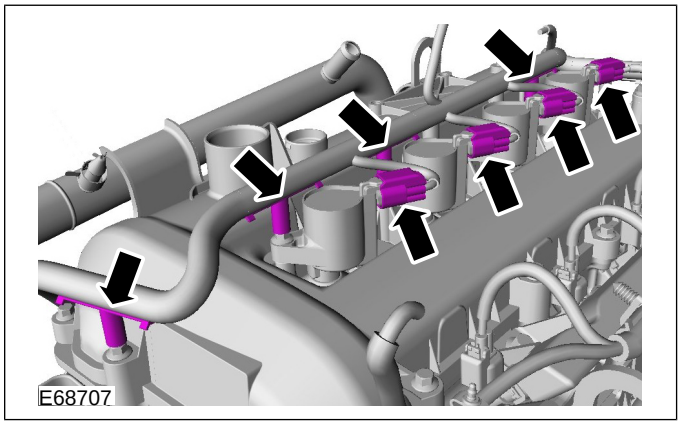
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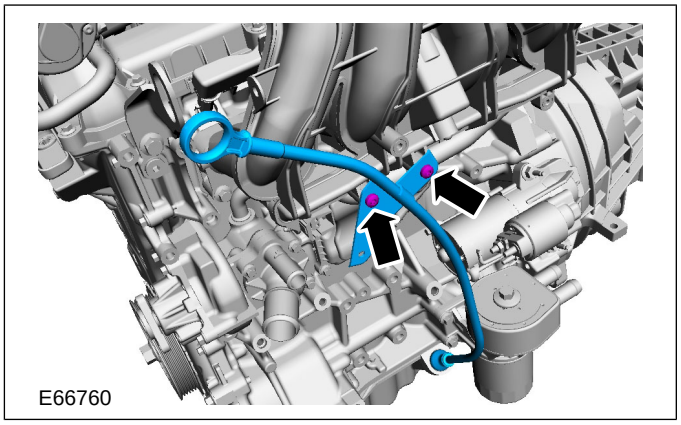
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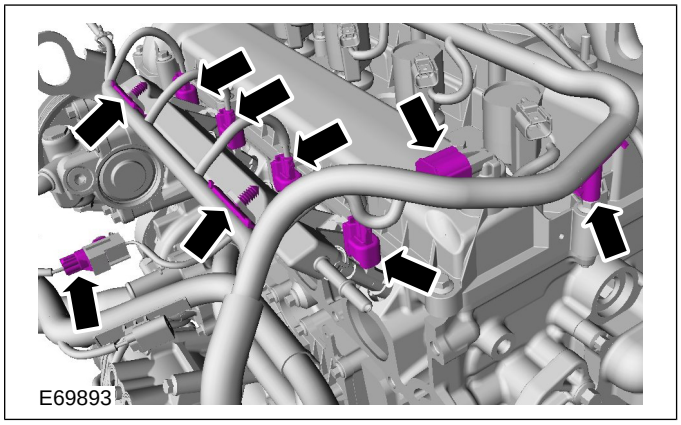
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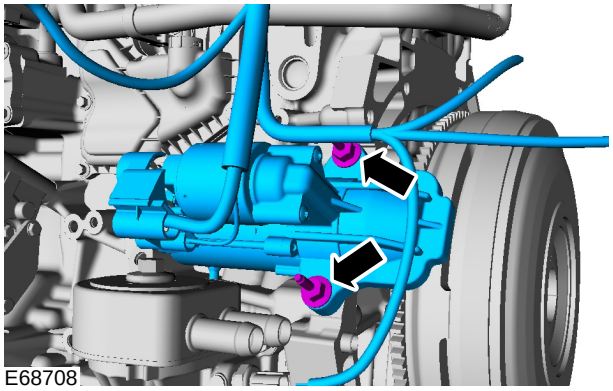


11.

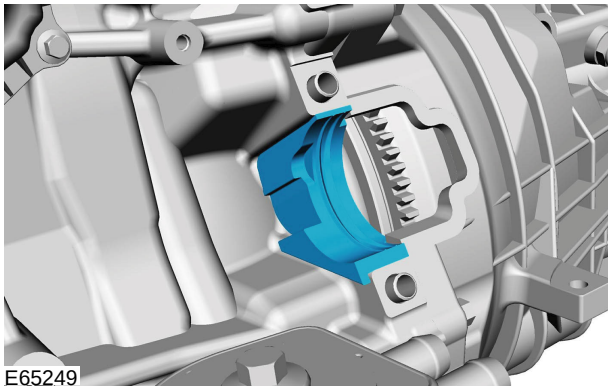


DISASSEMBLY

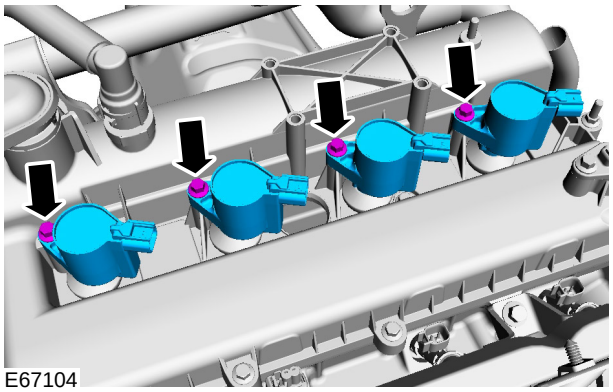
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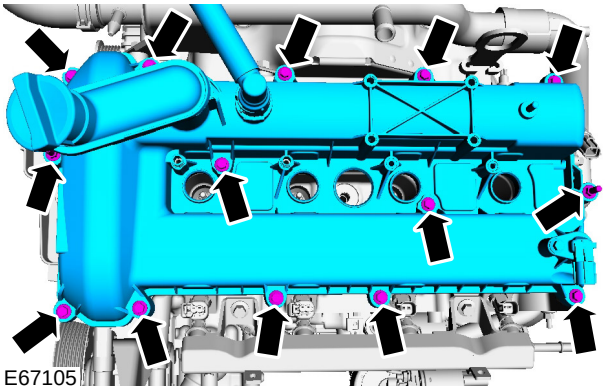
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14.

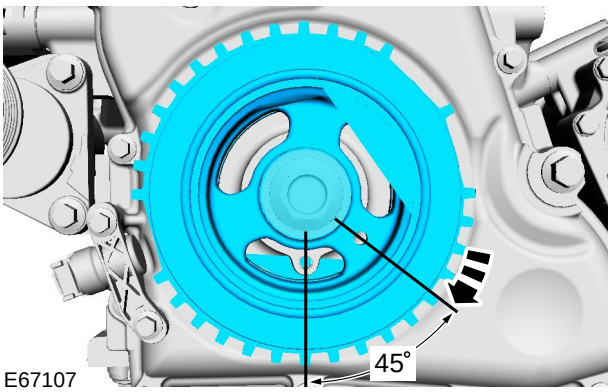


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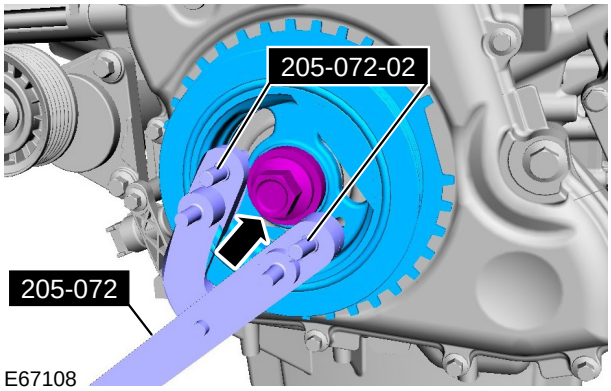


16. **CAUTION:Only rotate the crankshaft clockwise.**

Rotate the crankshaft until piston No. 1 is approximately 45 degrees before top dead center (TDC).

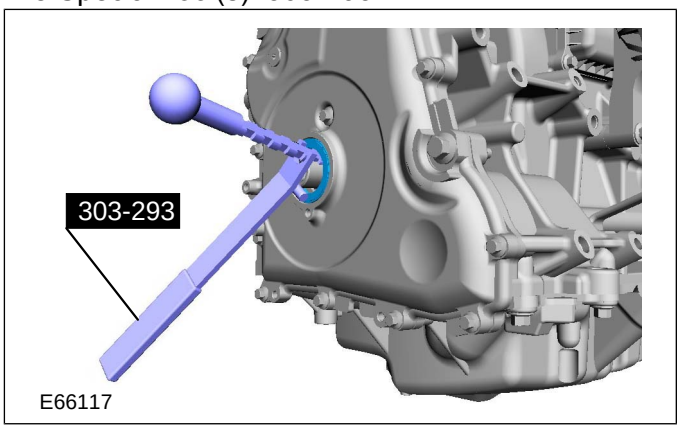


17. Special Tool(s): 205-072, 205-072-02

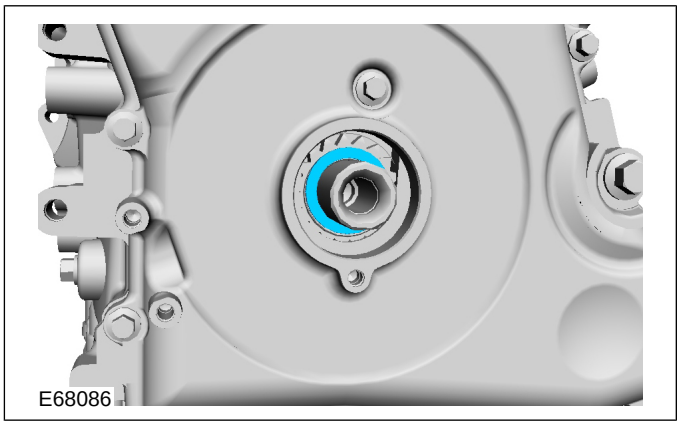


DISASSEMBLY

18. Special Tool(s): 303-293



19. • Discard the friction washer.

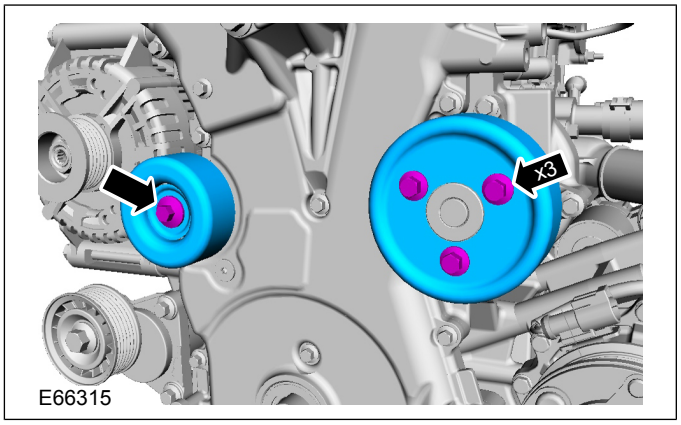


20. Remove the following items:

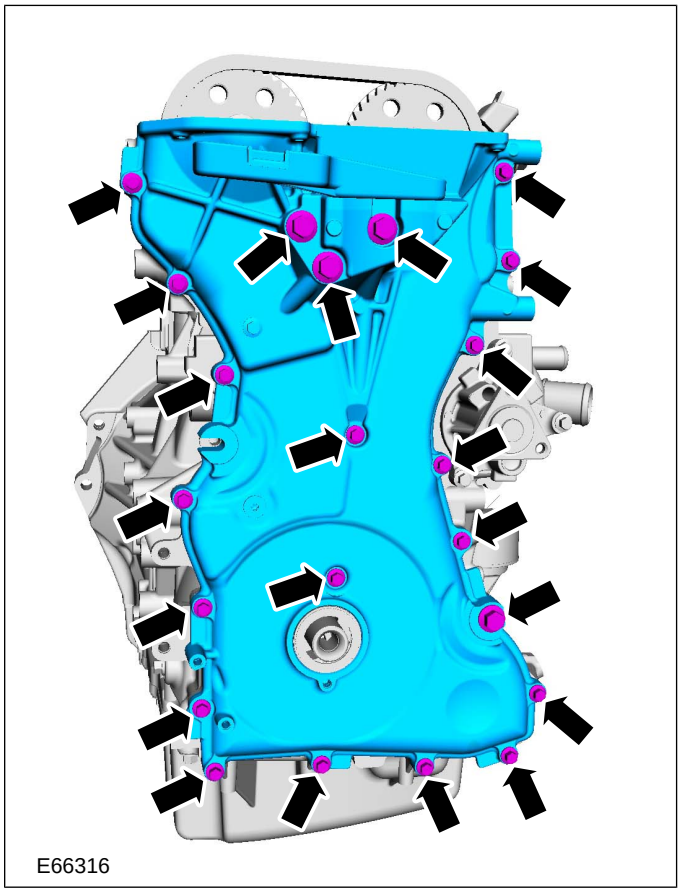
1. Crankshaft position (CKP) sensor

   Refer to:Crankshaft Position (CKP) Sensor - 2.3L Duratec-HE (MI4) (303-14 Electronic Engine Controls, Removal and Installation).

21.

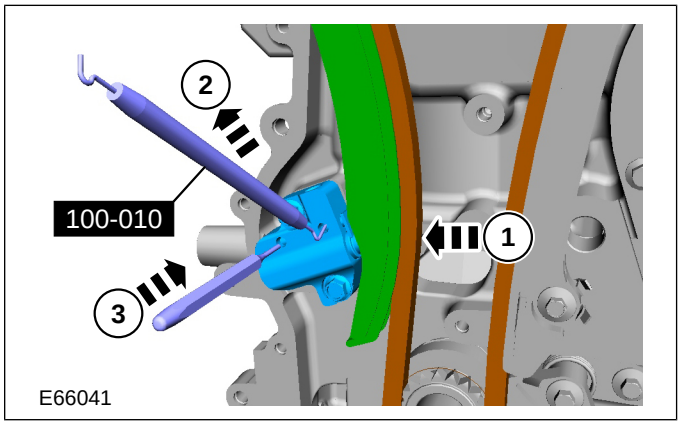


22.



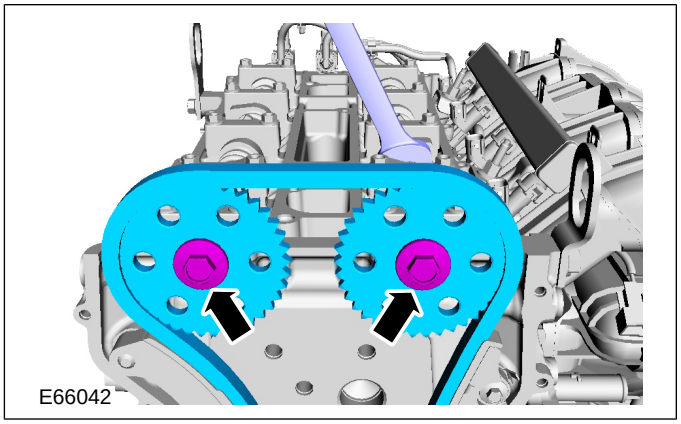
23. 2. Special Tool(s): 100-010

3. Punch, 2 mm

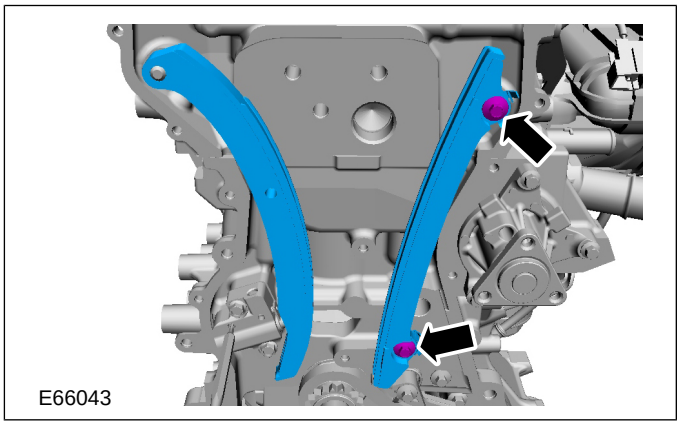


DISASSEMBLY

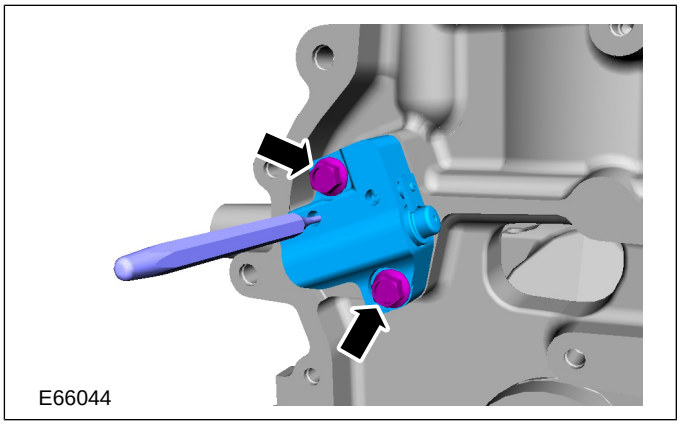
24. ⚠ **CAUTION:Use an open-ended wrench to hold the camshafts by the hexagon to prevent the camshafts from turning.**



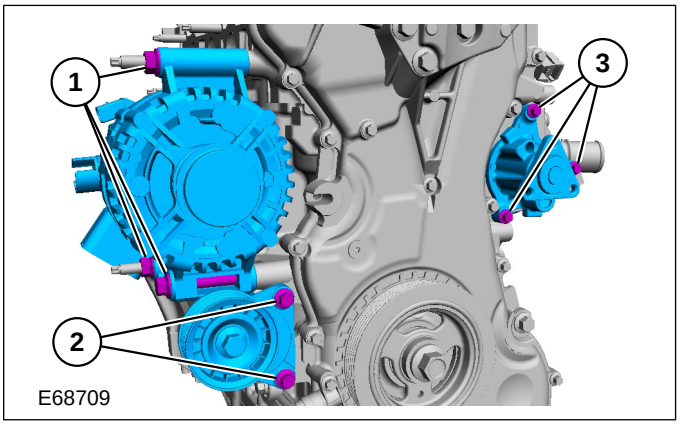
25.



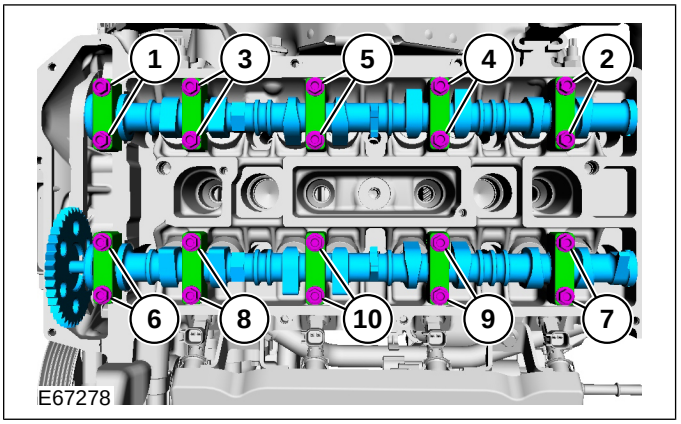
26.



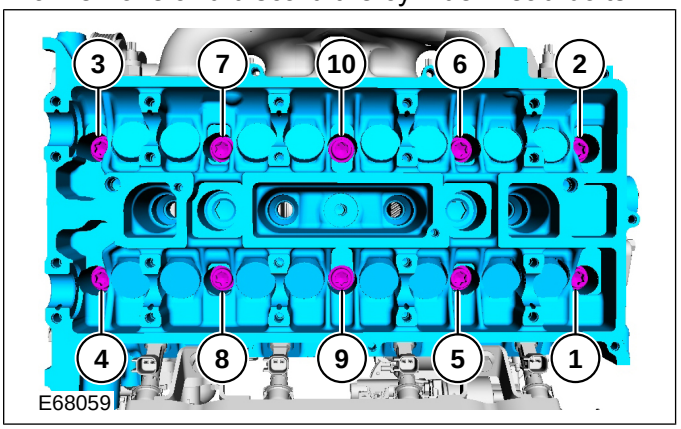
27.



28. **NOTE:**Note the position of the bearings.

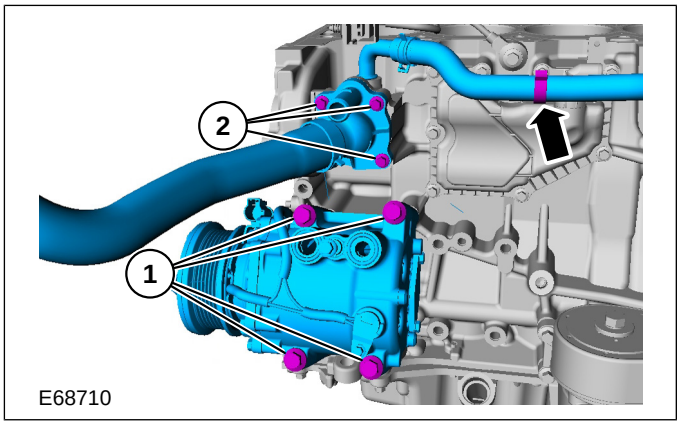


29. Remove and discard the cylinder head bolts.

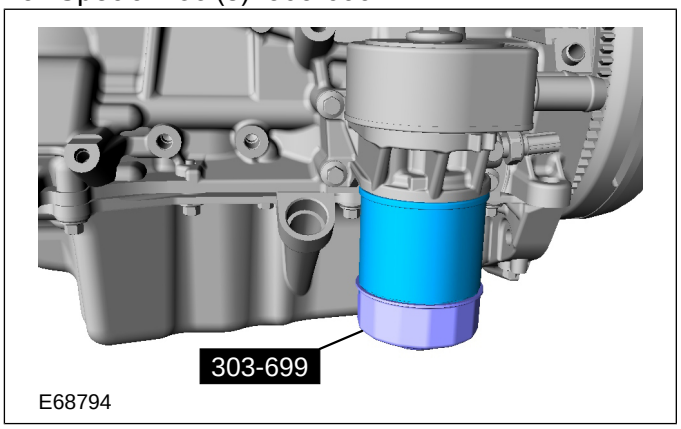


DISASSEMBLY

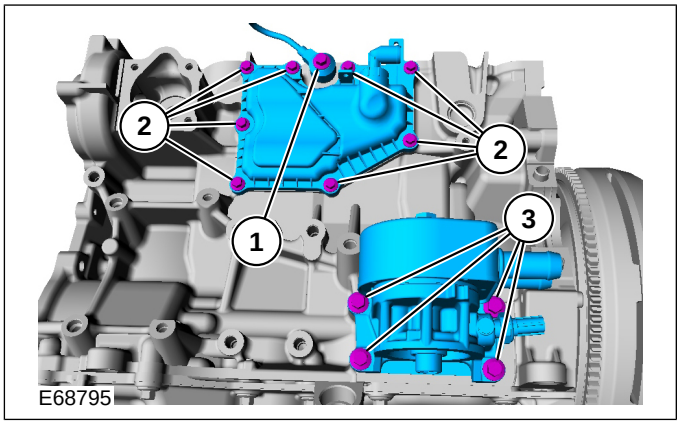
30.



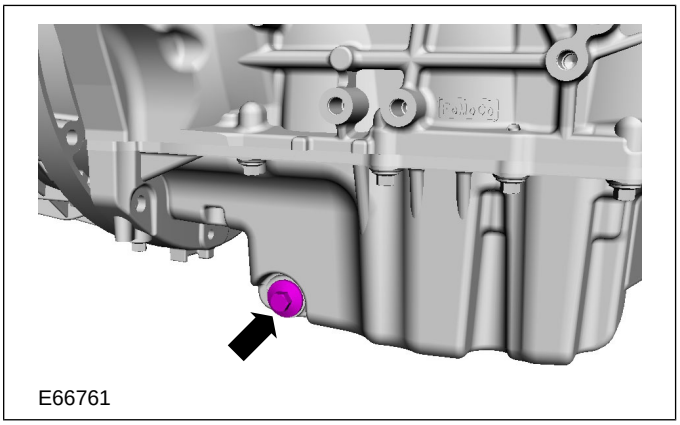
31. Special Tool(s): 303-699



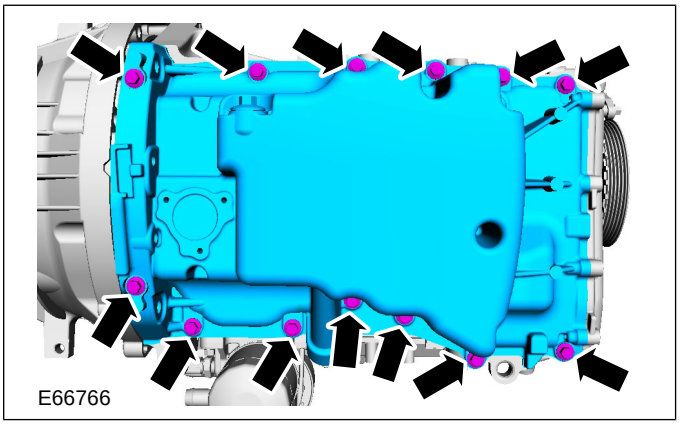
32.



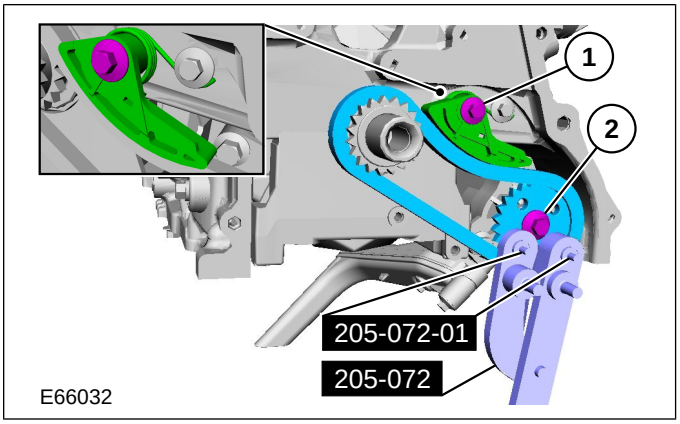
33. NOTE: The seal is to be reused unless damaged.



34.

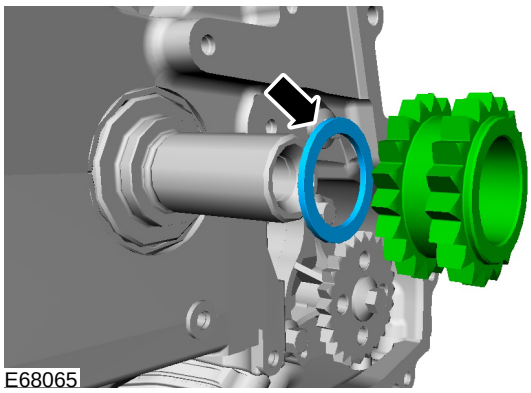


35. 2. Special Tool(s): 205-072, 205-072-01

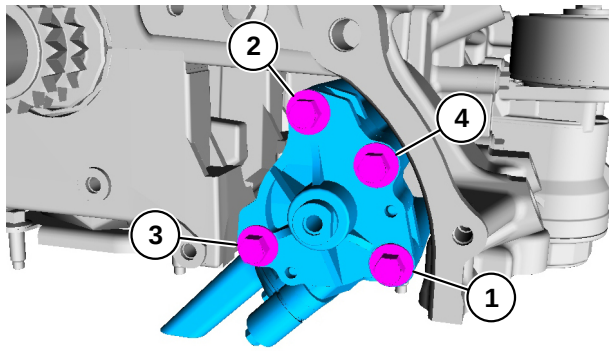


DISASSEMBLY

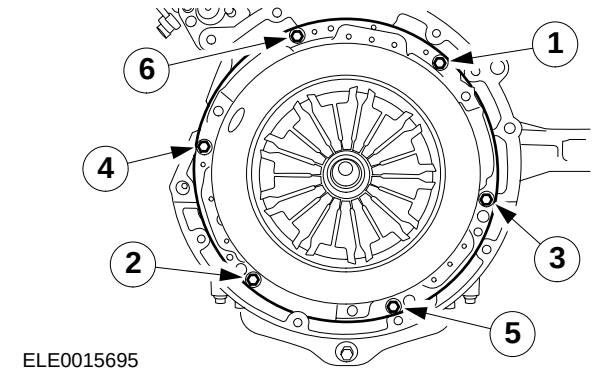
36. Discard the friction washer.



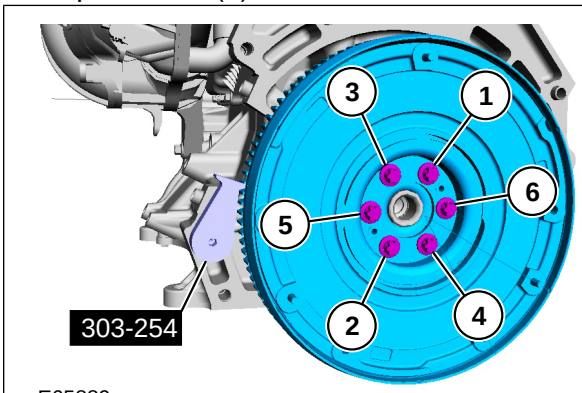
37.



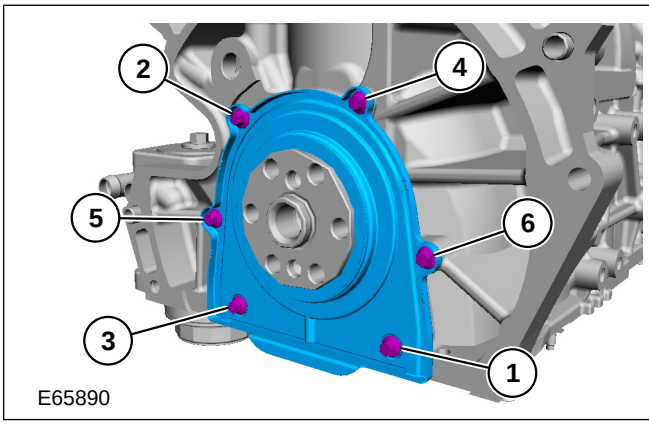
38.



39. Special Tool(s): 303-254



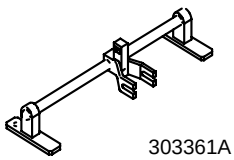
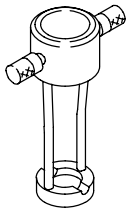
40.



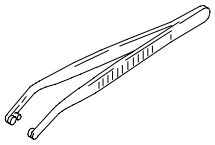
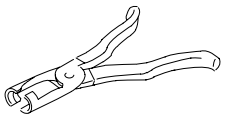
DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

Cylinder Head

Special Tool(s)

 303361A	Compressor, Valve Spring 303-361A
 2115502A	Adapter for 303-361A 303-361-02

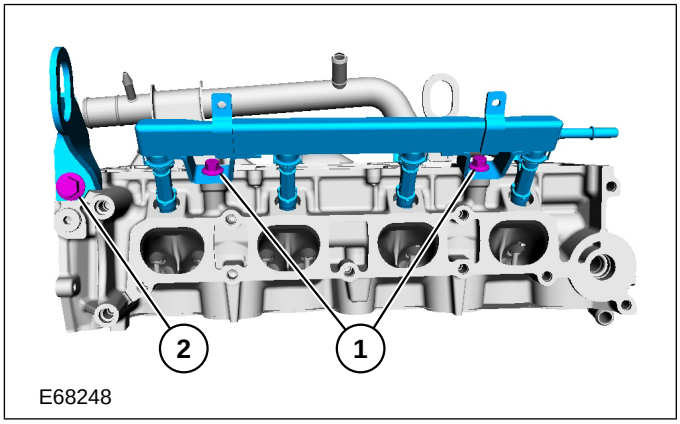
Special Tool(s)

 21156	Installer, Valve Stem Collets 303-362
 21211	Pliers, Valve Stem Seal 303-508

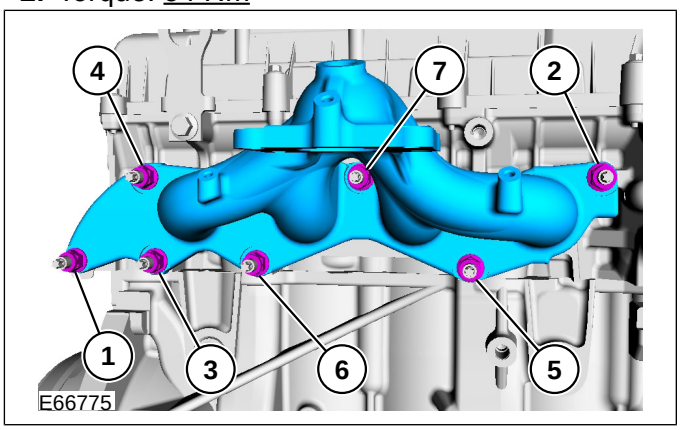
Disassembly

NOTE: Removal steps in this procedure may contain installation details.

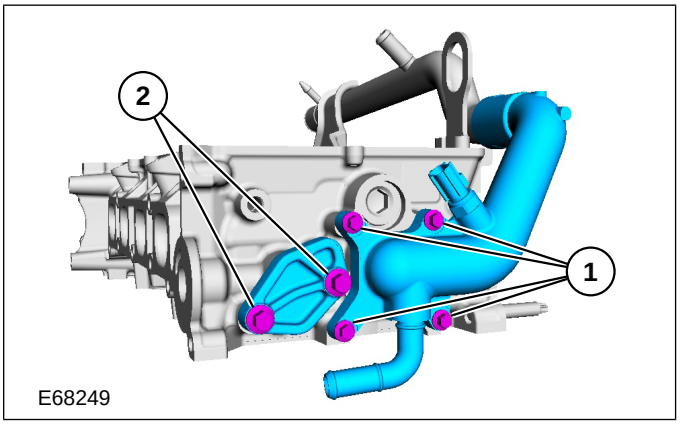
1. 1. Torque: 25 Nm
2. Torque: 45 Nm



2. Torque: 54 Nm

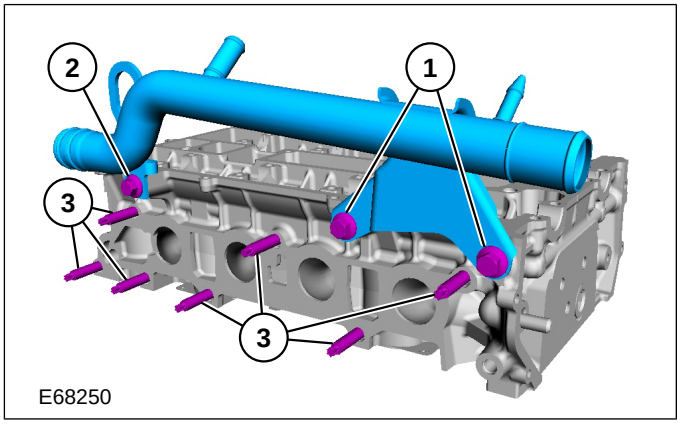


3. 1. Torque: 10 Nm
2. Torque: 25 Nm



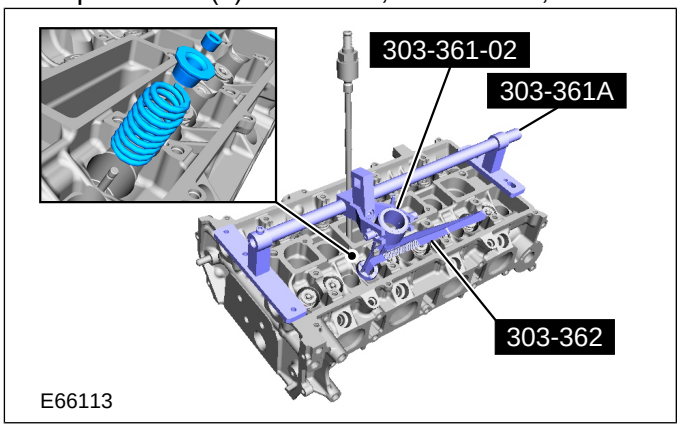
DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

4. **NOTE:**The O-ring seals are to be reused unless damaged.
   1. Torque: 45 Nm
   2. Torque: 45 Nm
   3. Torque: 17 Nm



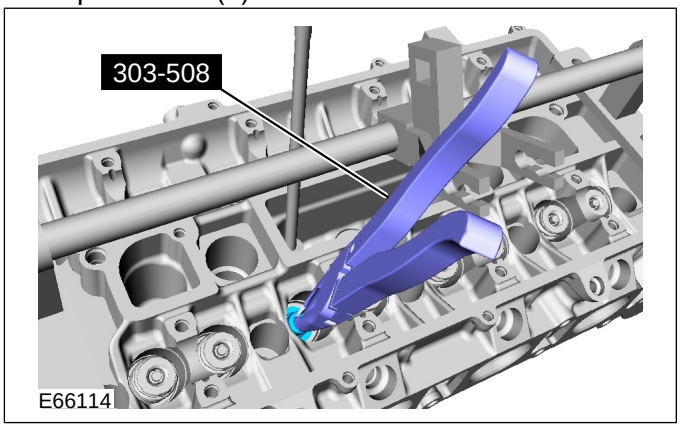
E68250

5. Special Tool(s): 303-361A, 303-361-02, 303-362



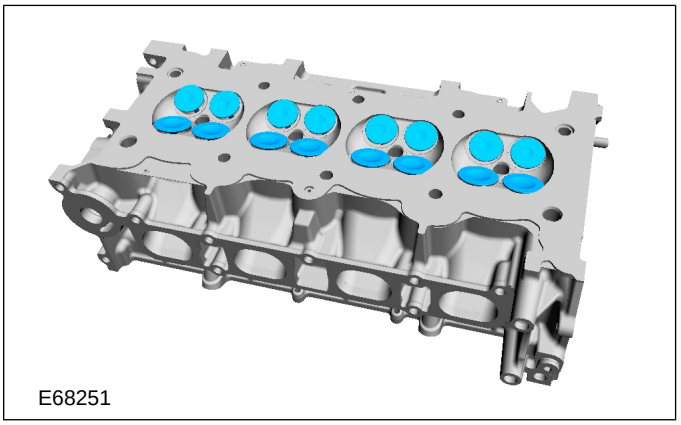
E66113

6. Special Tool(s): 303-508



E66114

7.


E68251

Assembly

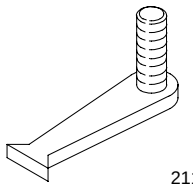
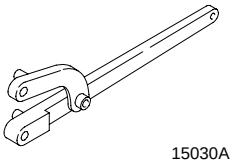
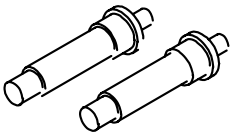
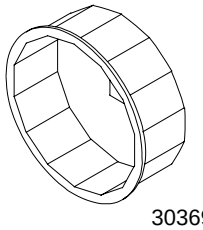
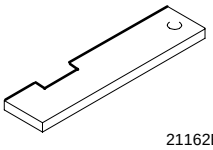
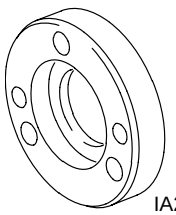
8. To install, reverse the removal procedure.

ASSEMBLY

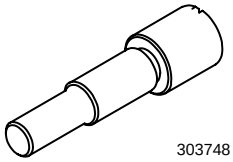
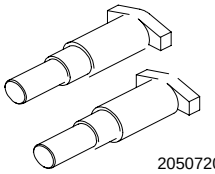
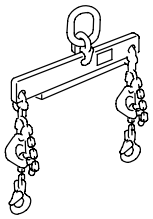
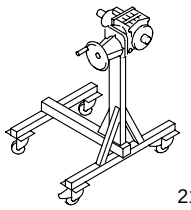
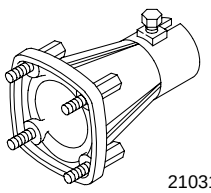
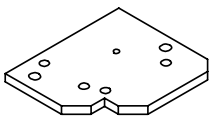
Engine

Assembly

Special Tool(s)

 21135	Locking Tool, Flywheel 303-254
 15030A	Universal Flange Holding Wrench 205-072
 20507201	Adapter for 205-072 205-072-01
 303699	Wrench, Oil Filter 303-699
 21162B	Alignment Plate, Camshaft 303-376B
 IA21213	Remover, Vibration Damper Hub 303-509

Special Tool(s)

 303748	Locking Tool, Crankshaft 303-748
 20507202	Adapter for 205-072 205-072-02
 21068A	Lifting Bracket, Engine 303-122
 21187	Mounting Stand 303-435
 21031B	Mounting Bracket for 303-435 303-435-06
 30343511A	Mounting Plate for 303-435-06 303-435-11A

ASSEMBLY

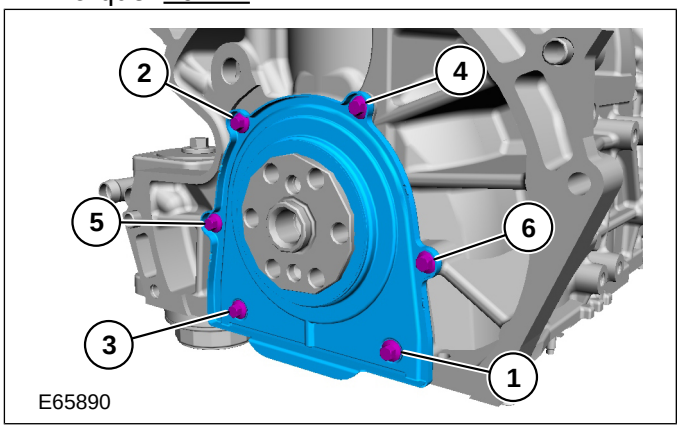
Materials	
Name	**Specification**
Silicone Sealant	WSE-M4G323-A4
Hypoid Gear Oil	SQM-2C9002-AA

General Equipment

Coolant hose clamp remover/installer
Hydraulic jib crane

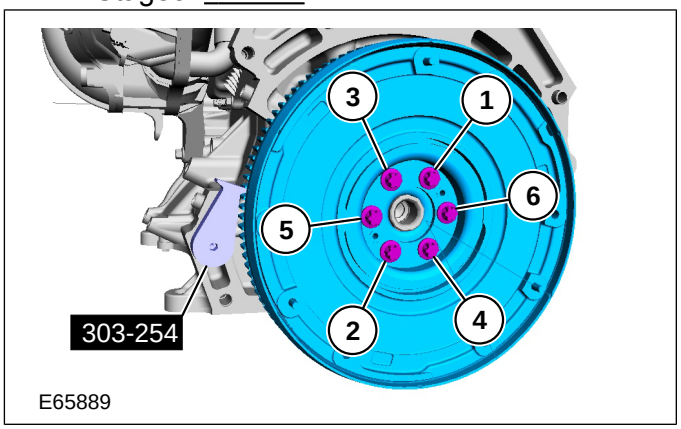
1. **NOTE:**New crankshaft rear seal carriers are supplied with an alignment sleeve which must be removed after installation.

   Torque: 10 Nm

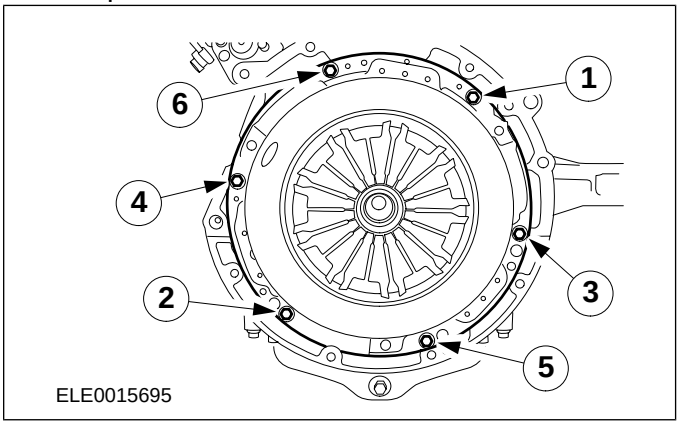


2. ⚠ **CAUTION:Make sure that new flywheel bolts are installed.**

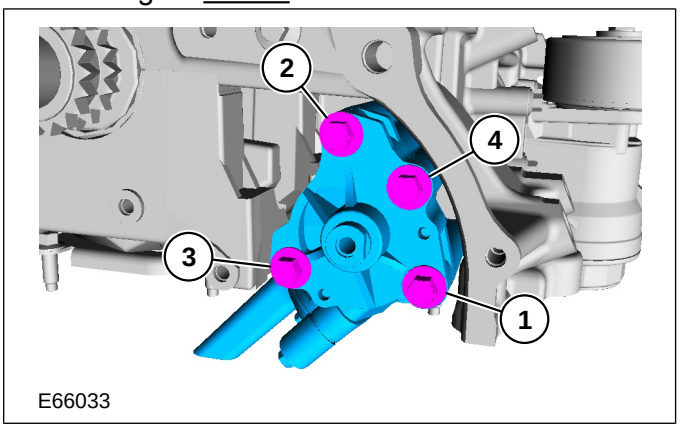
   Special Tool(s): 303-254
   Torque:
   - Stage1: 50 Nm
   - Stage2: 80 Nm
   - Stage3: 112 Nm



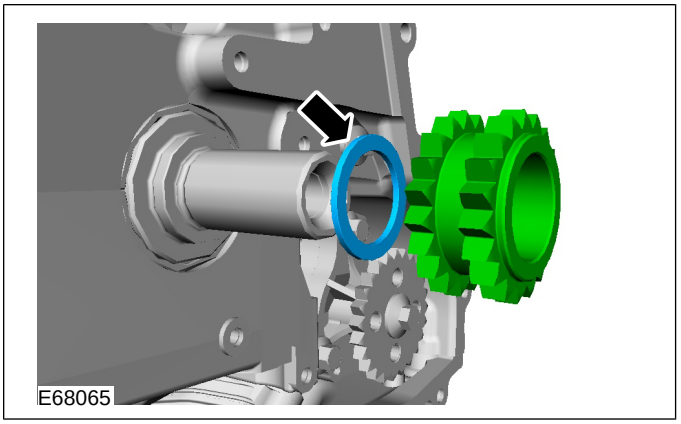
3. Torque: 29 Nm



4. Torque:
   - Stage1: 10 Nm
   - Stage2: 23 Nm

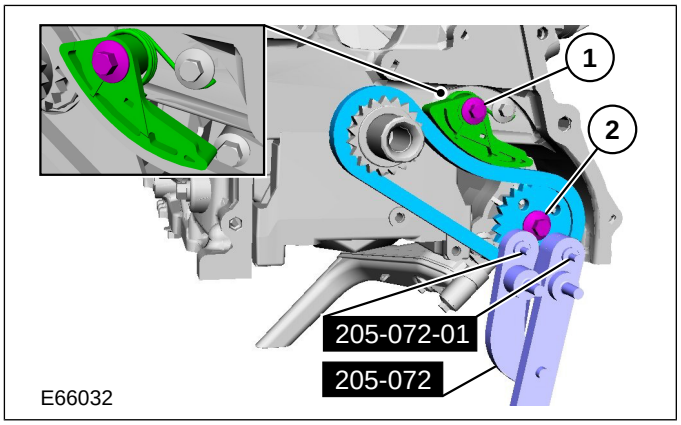


5. ⚠ **CAUTION:Make sure that a new friction washer is installed.**



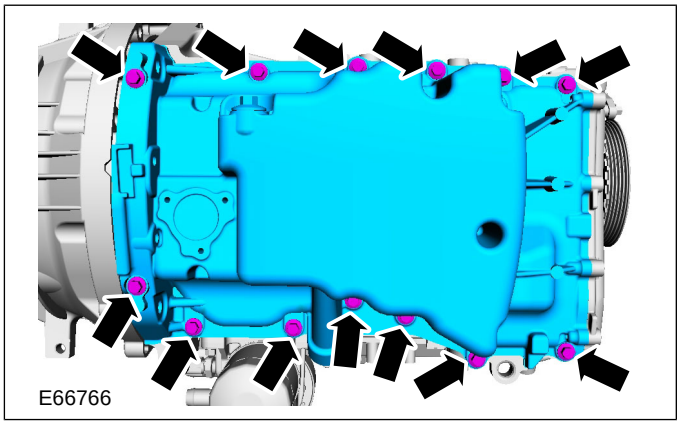
ASSEMBLY

6. 1. Torque: 10 Nm
2. Special Tool(s): 205-072, 205-072-01
Torque: 25 Nm

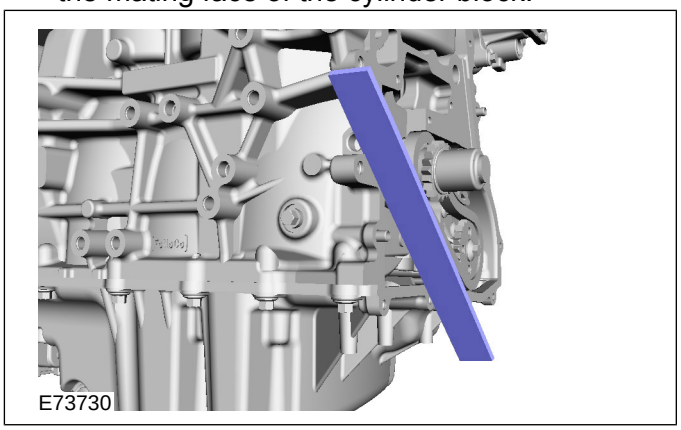


7. **NOTE:** Only tighten the bolts finger tight at this stage.

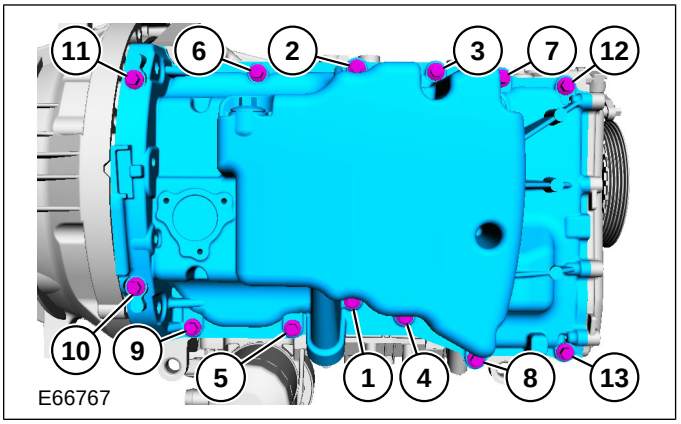
- Apply a 3 mm bead of sealant to the oil pan.
  Material: Silicone Sealant



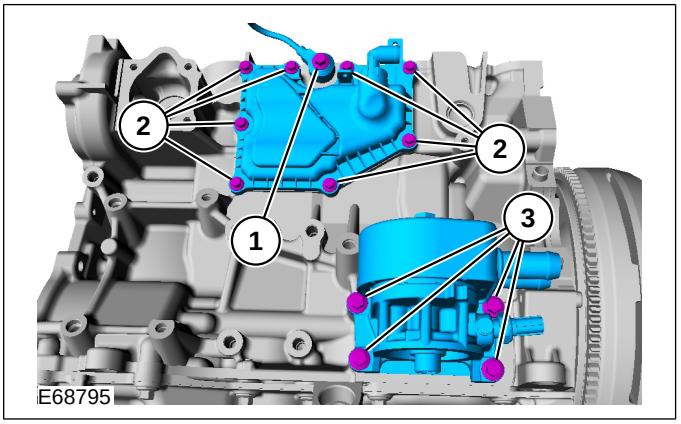
8. Use a steel straight edge, align the oil pan to the mating face of the cylinder block.



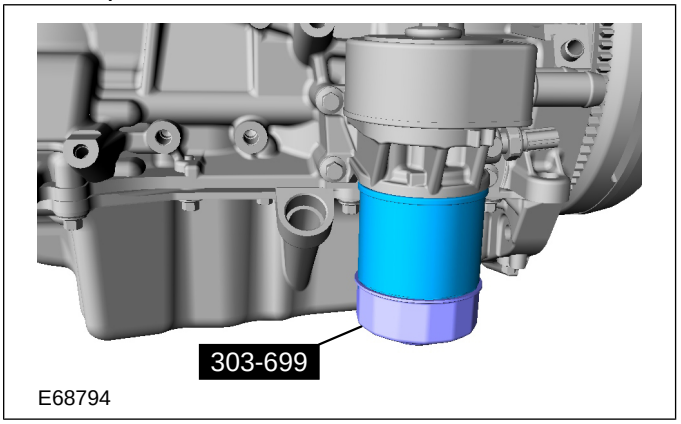
9. • Torque: 25 Nm



10. 1. Torque: 20 Nm
2. Torque: 10 Nm
3. Torque: 25 Nm

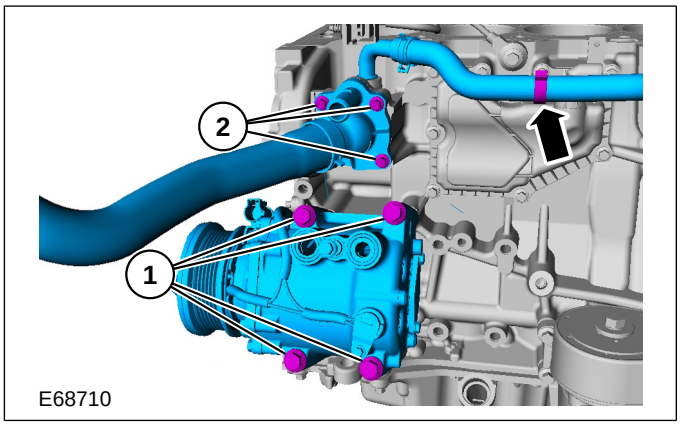


11. Special Tool(s): 303-699
Torque: 17 Nm

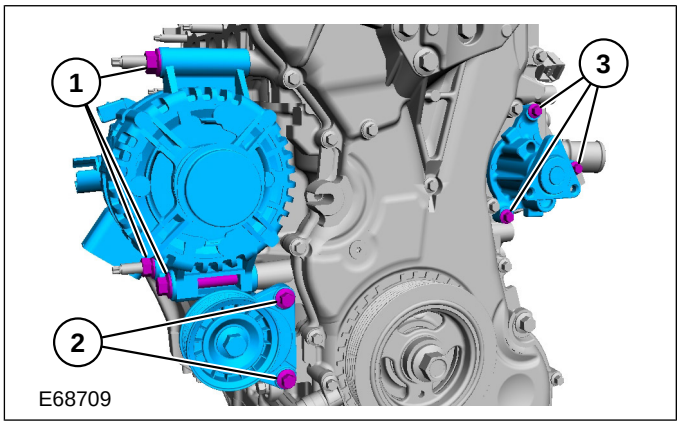


ASSEMBLY

12. 1. Torque: 25 Nm
2. Torque: 10 Nm

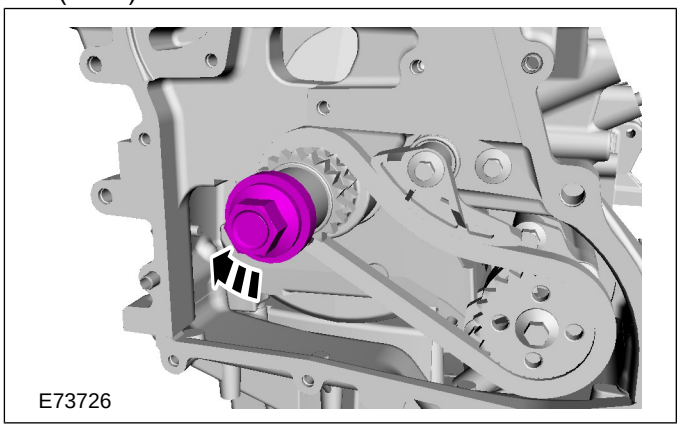


13. 1. Torque: 47 Nm
2. Torque: 25 Nm
3. Torque: 10 Nm

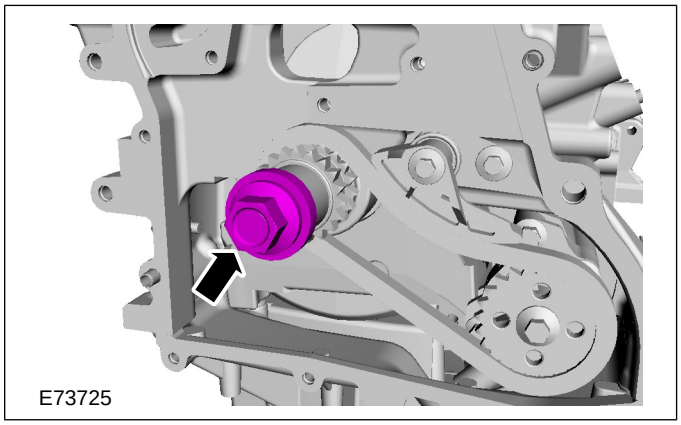


14. ⚠ **CAUTION:Only rotate the crankshaft clockwise.**

Rotate the crankshaft until piston No. 1 is approximately 20 mm before top dead center (TDC).

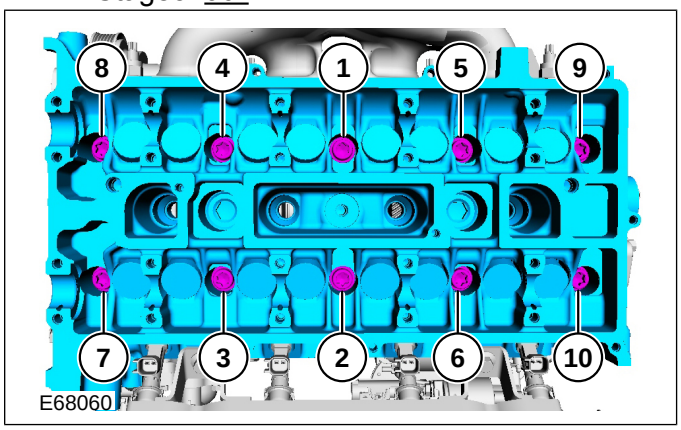


15.



16. ⚠ **CAUTION:Make sure that new cylinder head bolts are installed.**

Torque:
- Stage1: 5 Nm
- Stage2: 15 Nm
- Stage3: 45 Nm
- Stage4: 90°
- Stage5: 90°

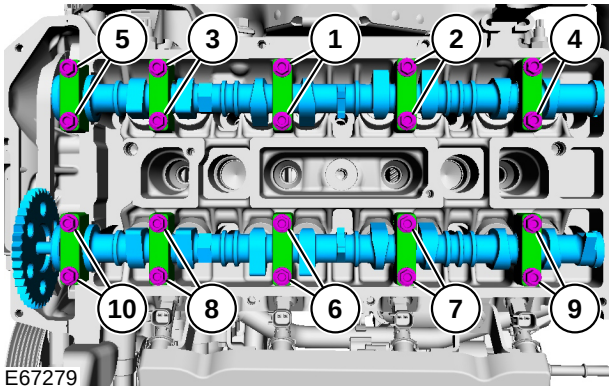


17. ⚠ **CAUTION:Make sure that the camshafts and camshaft bearing caps are installed in their original locations.**

ASSEMBLY

Coat the camshaft bearing caps with oil.

Material: Hypoid Gear Oil
Torque:
- Stage1: 7 Nm
- Stage2: 16 Nm



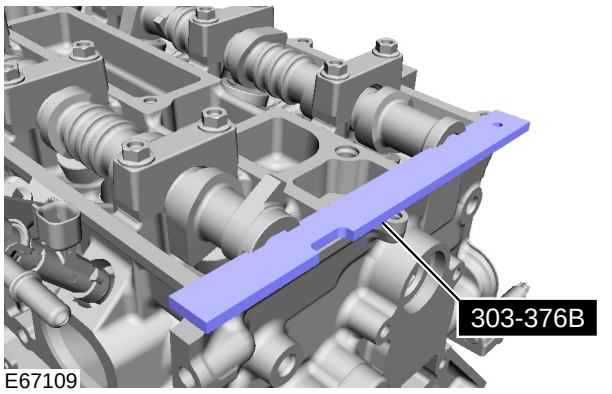
18. **NOTE:** This step is only necessary when installing a new component.

Check the valve clearance.

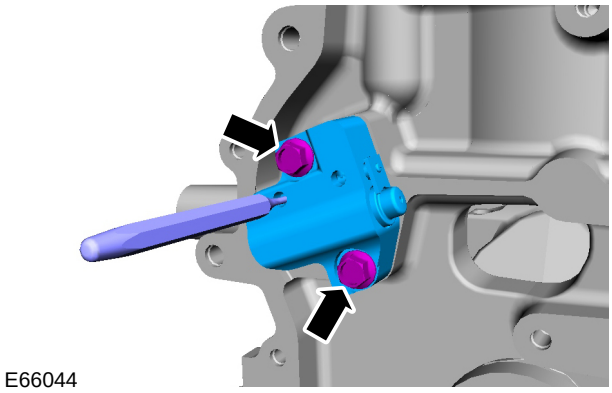
Refer to: Specifications (303-01 Engine - 2.3L Duratec-HE (MI4), Specifications).

19. Install the special tool.

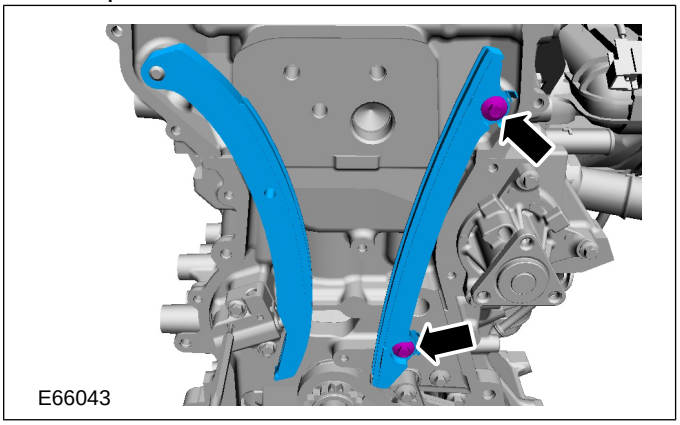
Special Tool(s): 303-376B



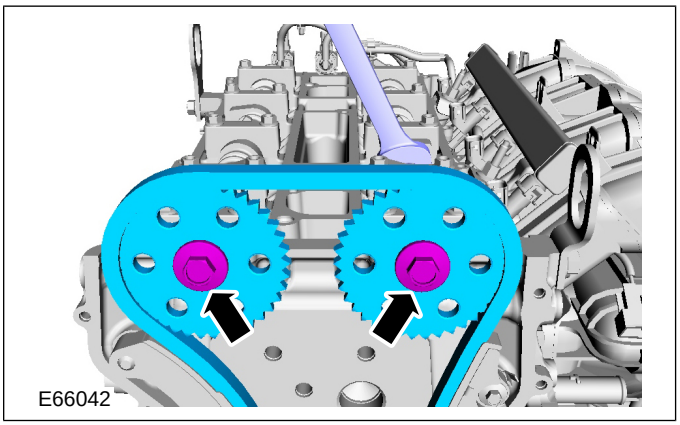
20. Torque: 10 Nm



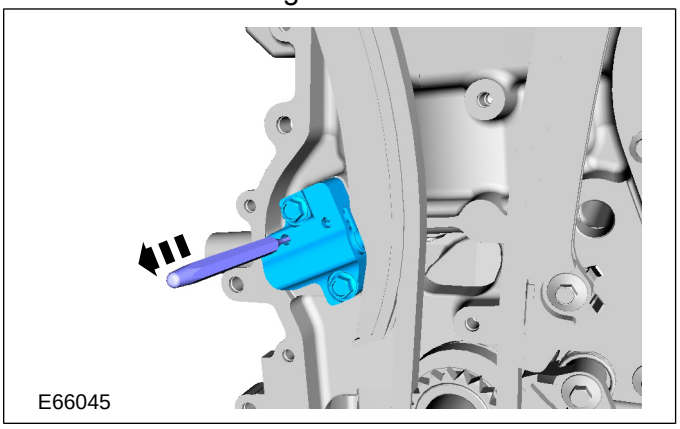
21. Torque: 10 Nm



22. ⚠ **CAUTION: Only tighten the bolt finger tight at this stage.**



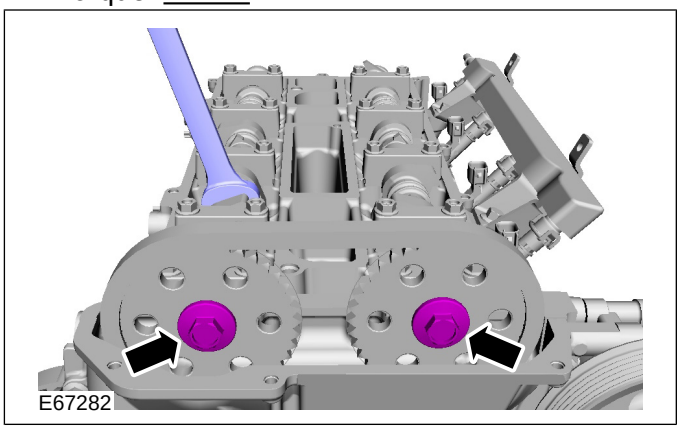
23. Release the timing chain tensioner.



ASSEMBLY

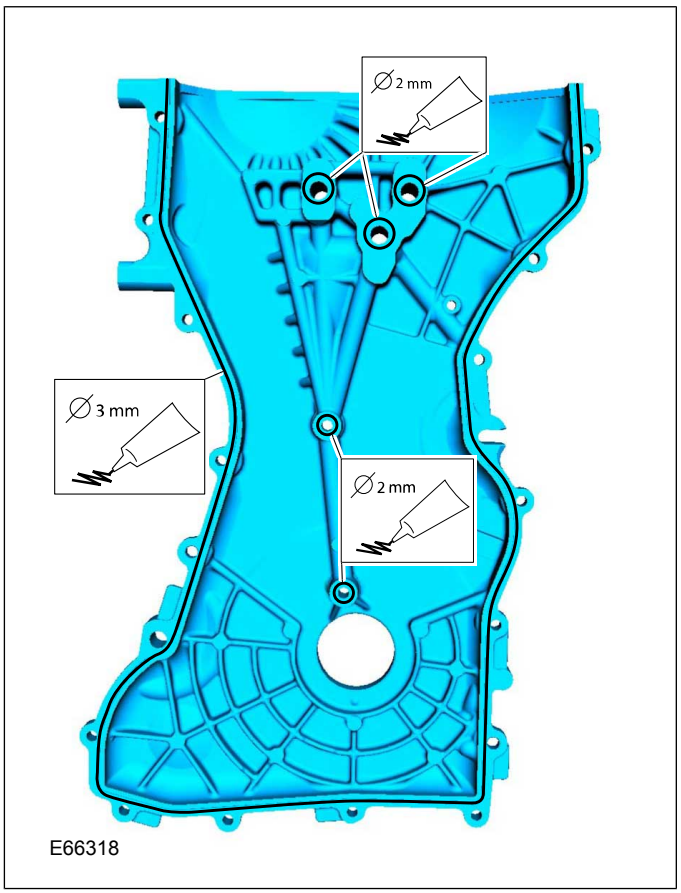
24. ⚠ **CAUTION:Use an open-ended wrench to hold the camshafts by the hexagon to prevent the camshafts from turning.**

Torque: 72 Nm

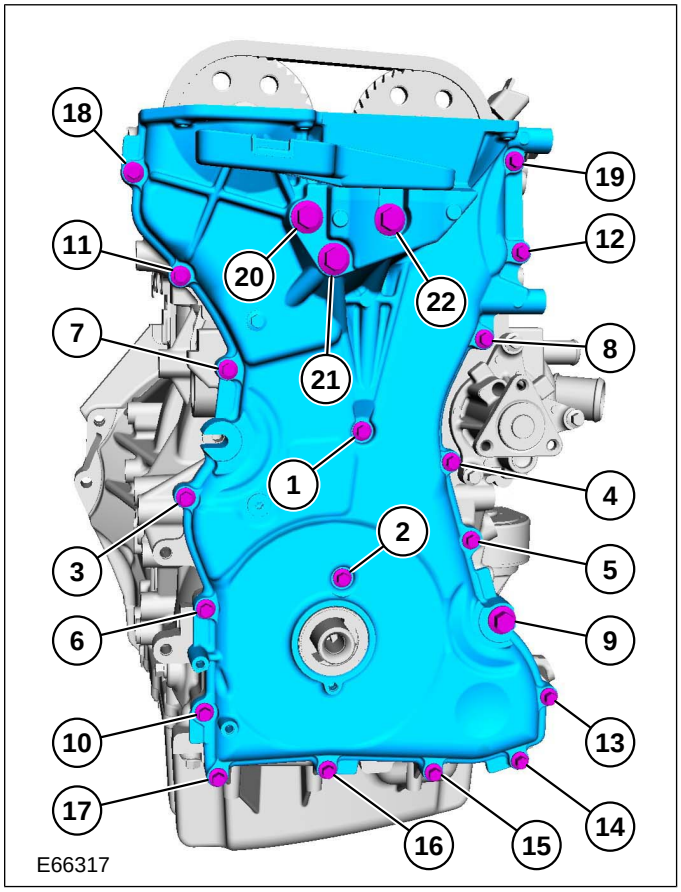


25. • Apply a 3 mm bead of sealant to the engine front cover.

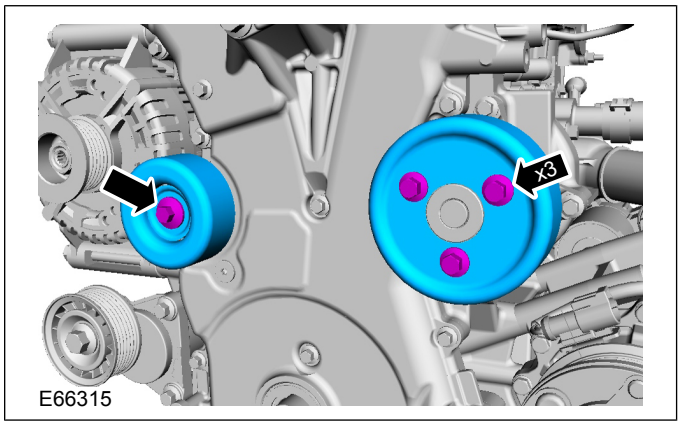
Material: Silicone Sealant



26. Torque:
- 1-8 10 Nm
- 9 48 Nm
- 10-19 10 Nm
- 20-22 48 Nm

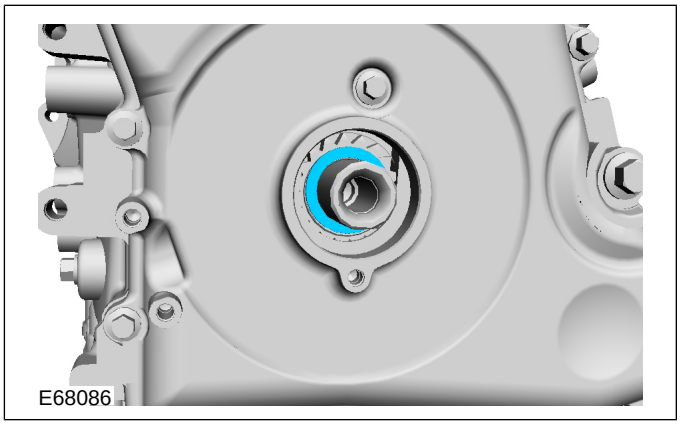


27. 1. Torque: 25 Nm
2. Torque: 20 Nm

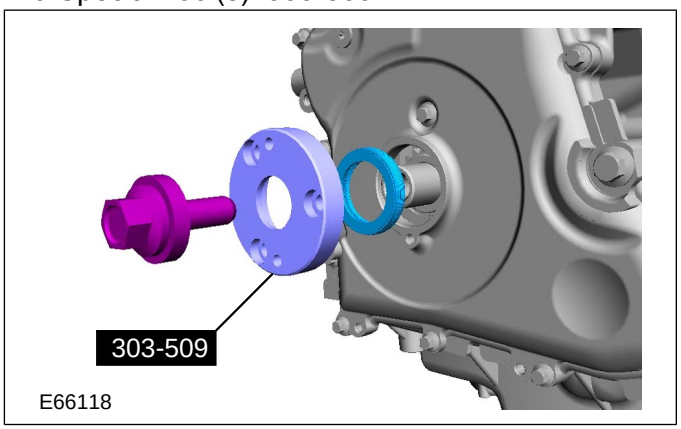


ASSEMBLY

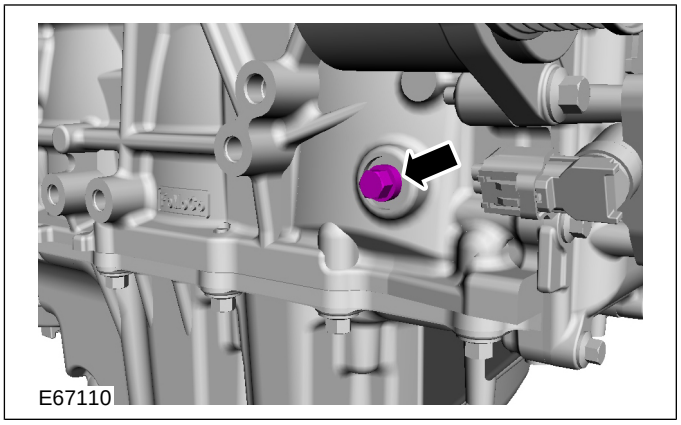
28. ⚠ **CAUTION:Make sure that a new friction washer is installed.**



29. Special Tool(s): 303-509

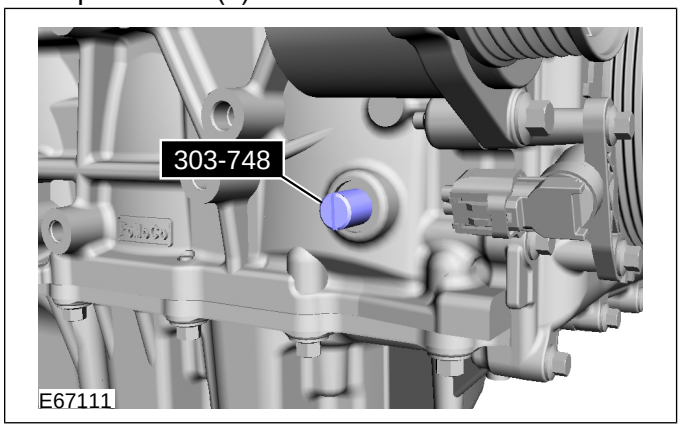


30.



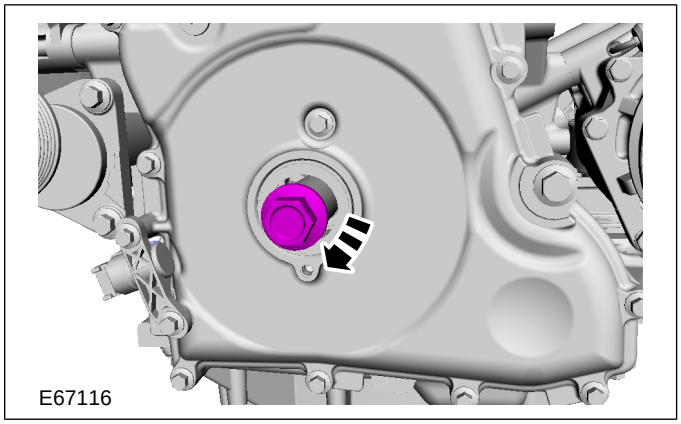
31. Install the special tool.

Special Tool(s): 303-748

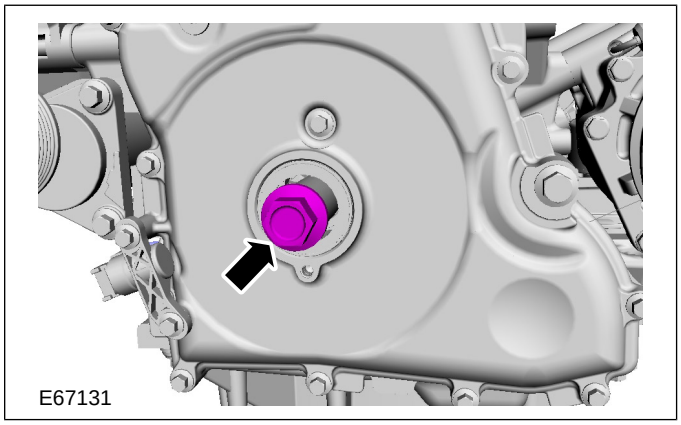


32. ⚠ **CAUTION:Only rotate the crankshaft clockwise.**

Rotate the crankshaft until it contacts the special tool.

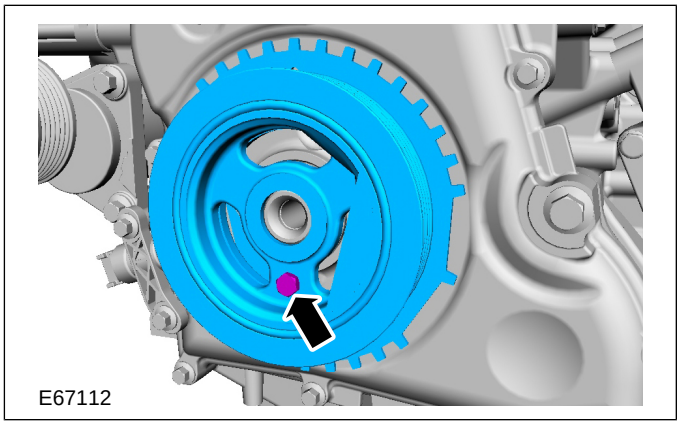


33. • Discard the crankshaft pulley retaining bolt.



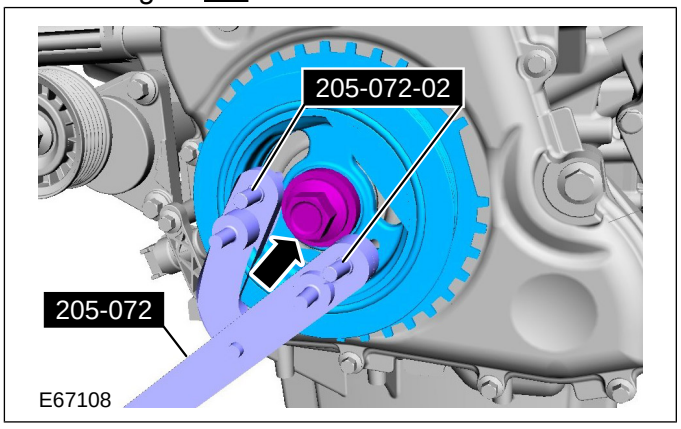
ASSEMBLY

34. **NOTE:** Only tighten the bolt finger tight at this stage.
    - Bolt M6 x 18 mm

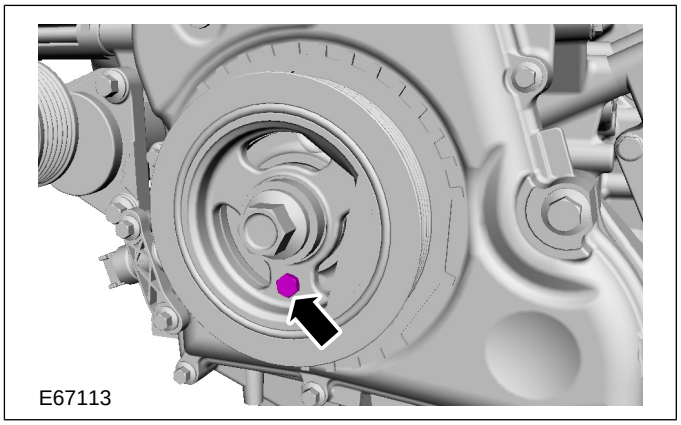


35. ⚠ **CAUTION: Make sure that a new crankshaft pulley bolt is installed.**

    Special Tool(s): 205-072, 205-072-02
    Torque:
    - Stage1: 100 Nm
    - Stage2: 90°

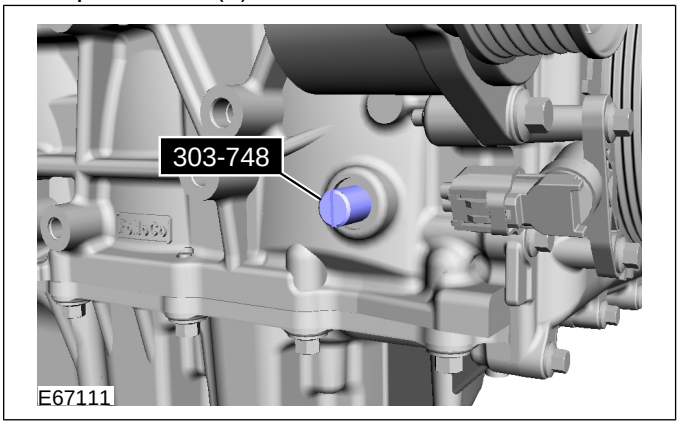


36.



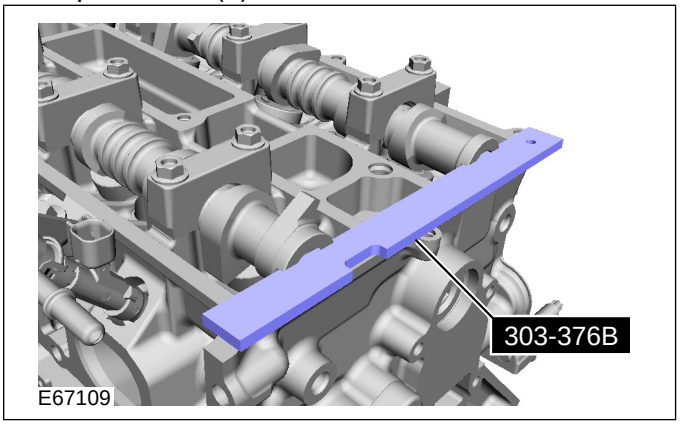
37. Remove the special tool.

    Special Tool(s): 303-748



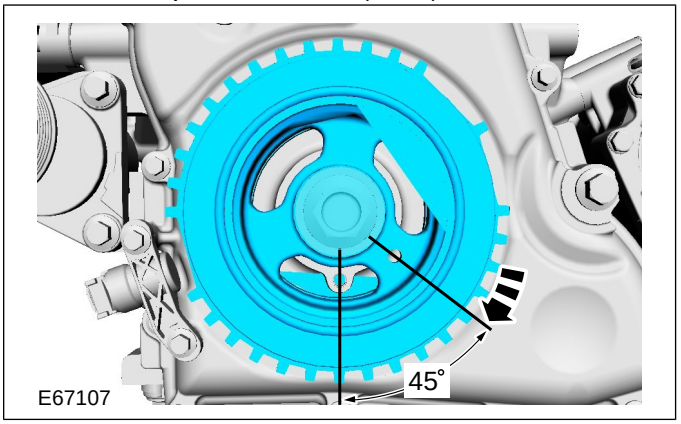
38. Remove the special tool.

    Special Tool(s): 303-376B



39. ⚠ **CAUTION: Only rotate the crankshaft clockwise.**

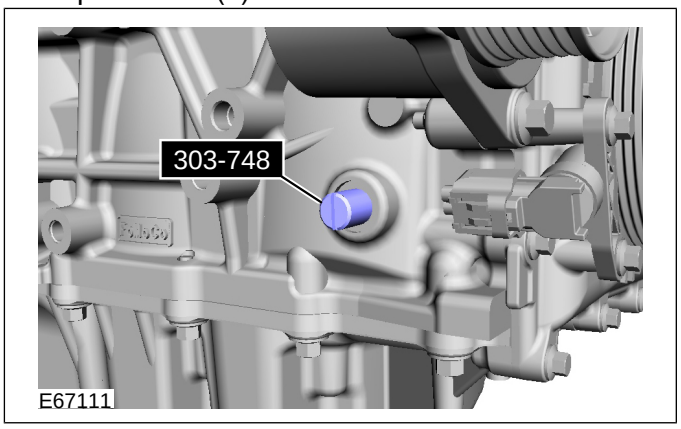
    Rotate the crankshaft one and three quarters until piston No. 1 is approximately 45 degrees before top dead center (TDC).



ASSEMBLY

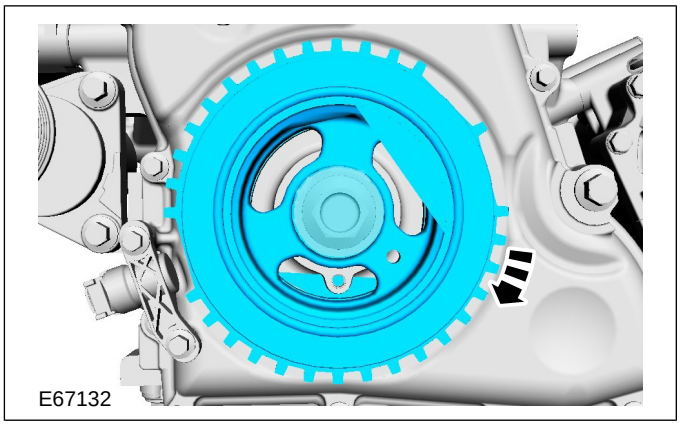
40. Install the special tool.

Special Tool(s): 303-748



41. ⚠ **CAUTION:Only rotate the crankshaft clockwise.**

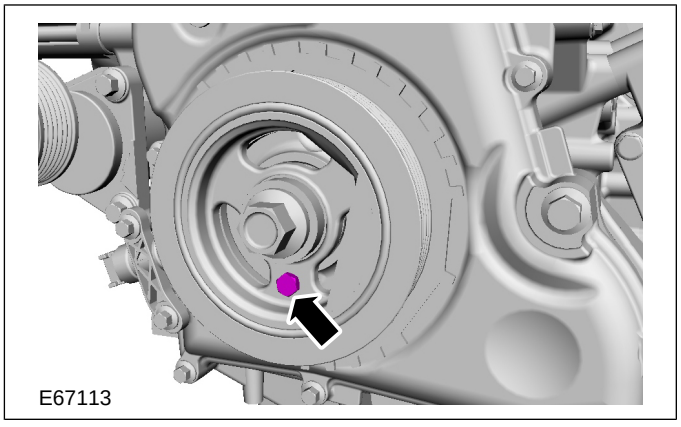
Rotate the crankshaft until it contacts the special tool.



42. **NOTE:**Only tighten the bolt finger tight at this stage.

NOTE: The bolt can only be installed if the valve timing is correct.

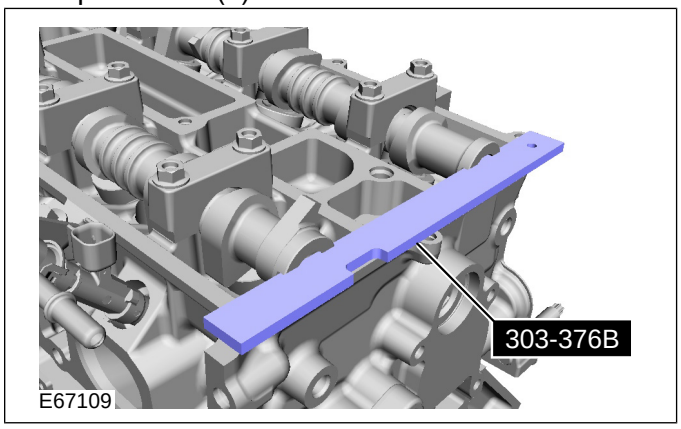
- Bolt M6 x 18 mm



43. **NOTE:**The special tool can only be installed if the valve timing is correct.

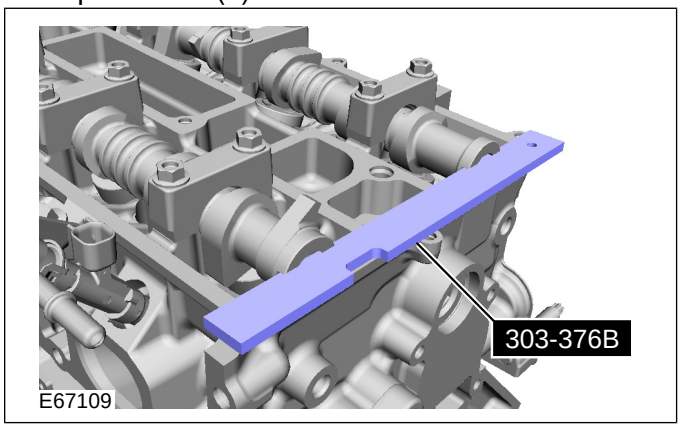
Install the special tool.

Special Tool(s): 303-376B



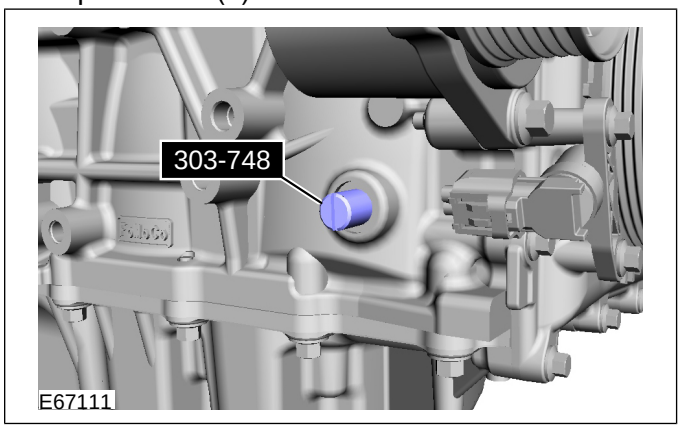
44. Remove the special tool.

Special Tool(s): 303-376B



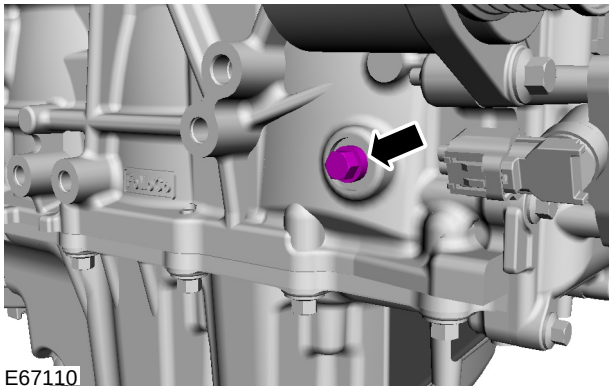
45. Remove the special tool.

Special Tool(s): 303-748

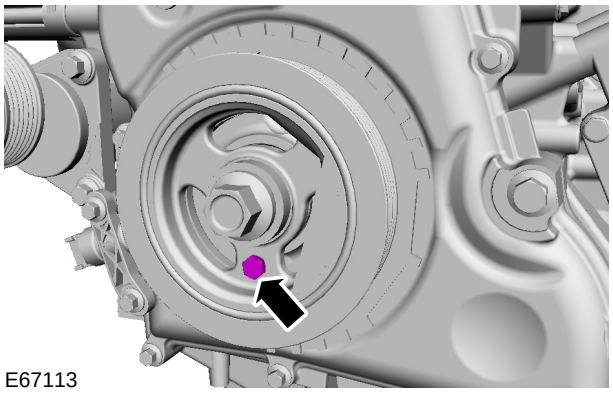


ASSEMBLY

46. Torque: 20 Nm



47.

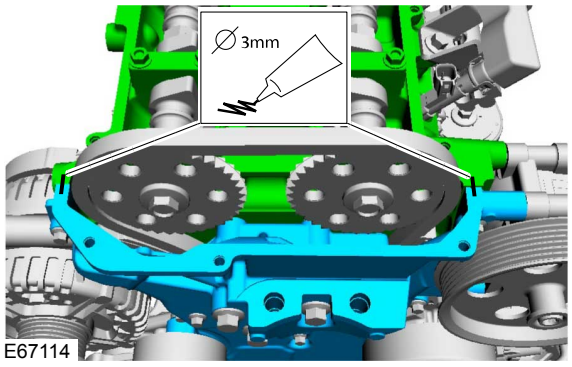


48. Install the crankshaft position (CKP) sensor.

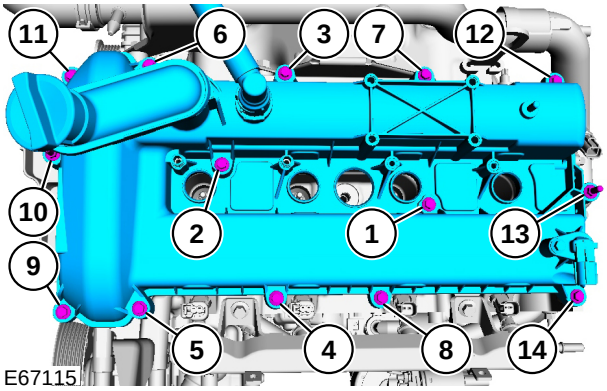
Refer to:Crankshaft Position (CKP) Sensor - 2.3L Duratec-HE (MI4) (303-14 Electronic Engine Controls, Removal and Installation).

49. Apply a dot of sealant to the areas indicated.

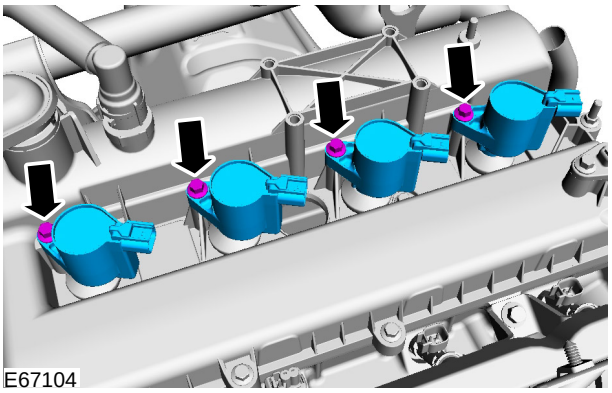
Material: Silicone Sealant



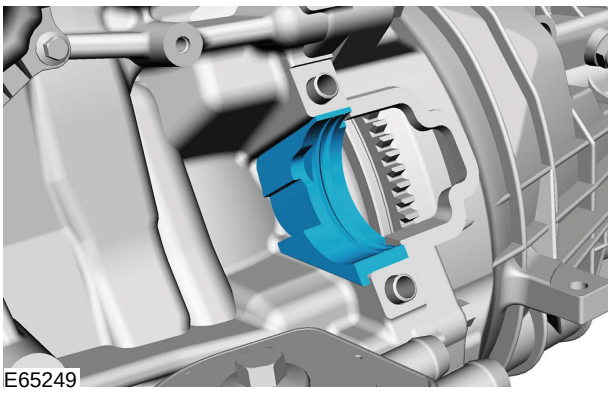
50. Torque: 10 Nm



51. Torque: 10 Nm

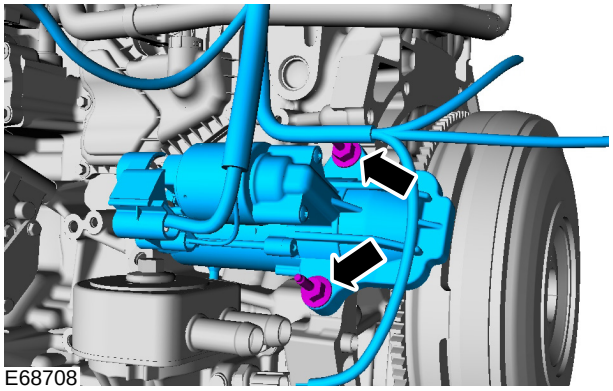


52.

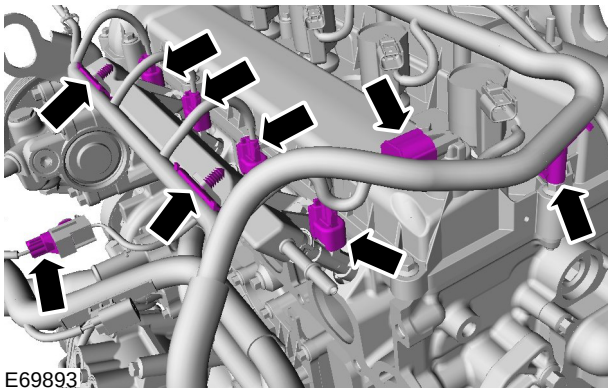


ASSEMBLY

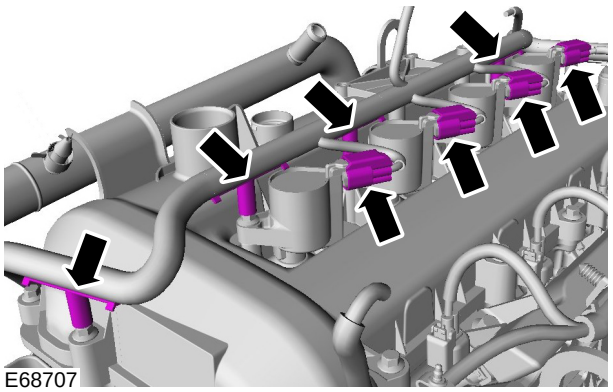
53. Torque: 25 Nm



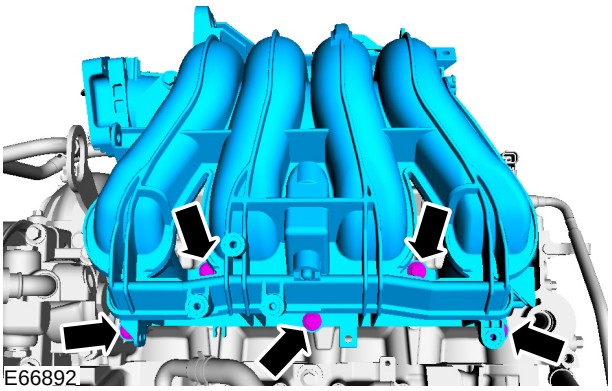
54.



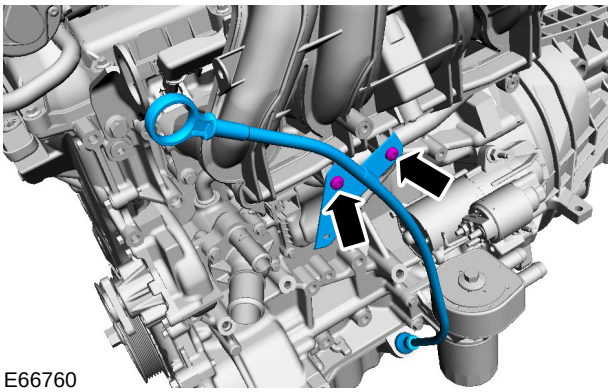
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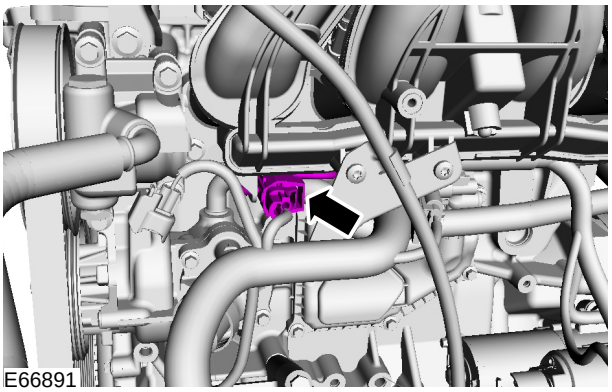
56. Torque: 18 Nm



57. Torque: 10 Nm

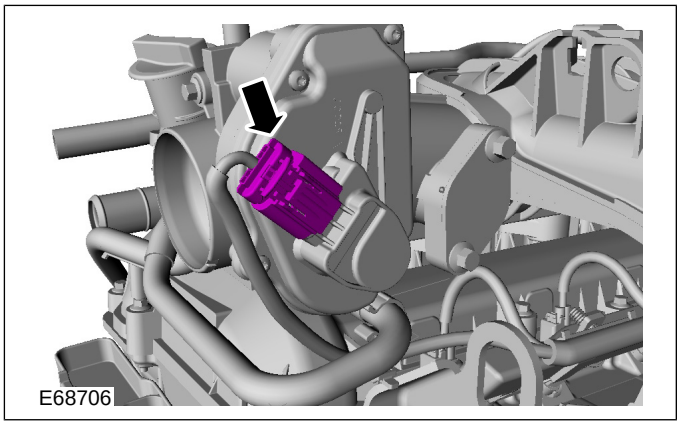


58.

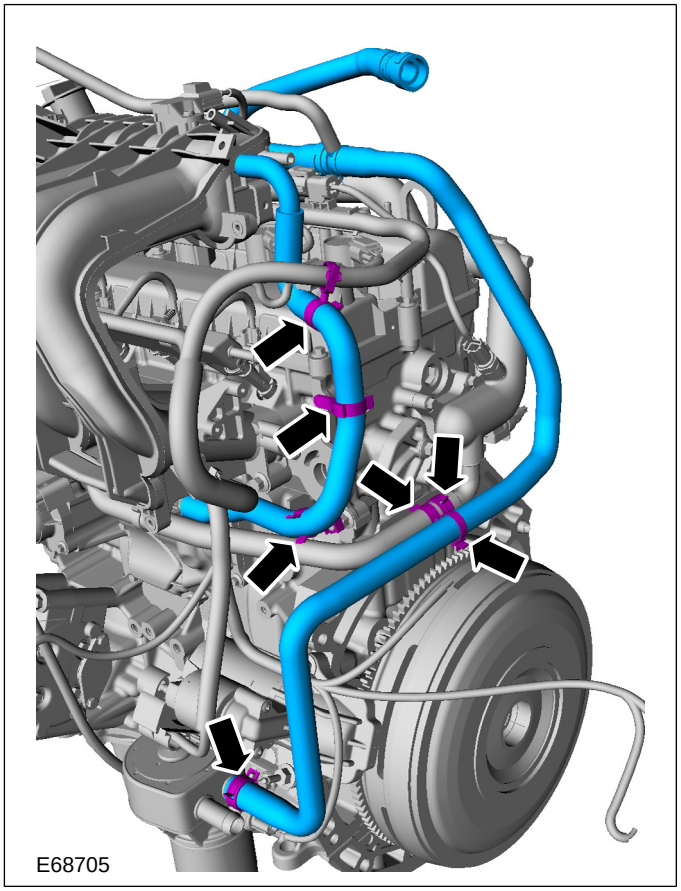


ASSEMBLY

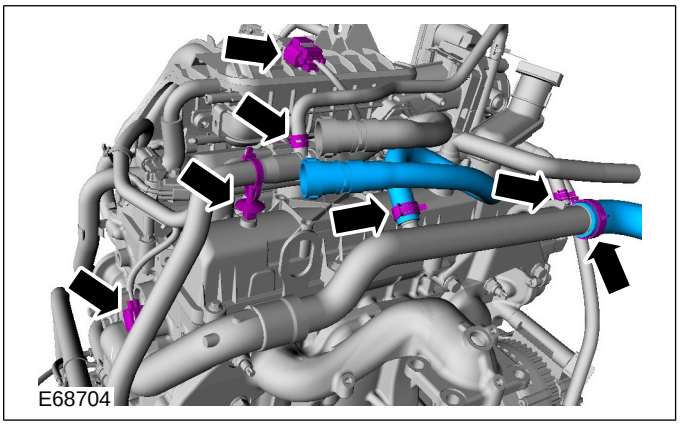
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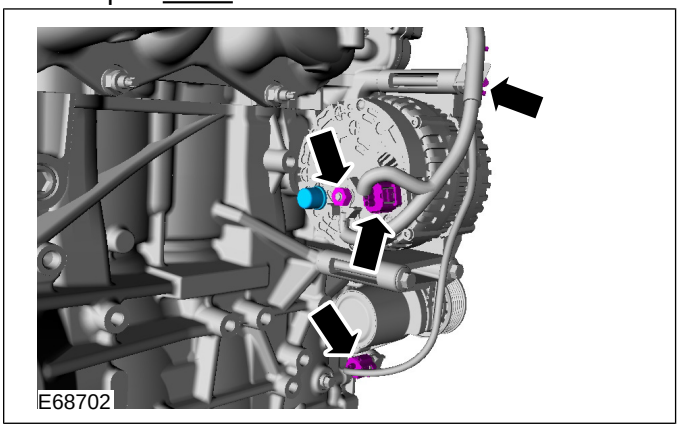
60. General Equipment: Coolant hose clamp remover/installer



61. General Equipment: Coolant hose clamp remover/installer

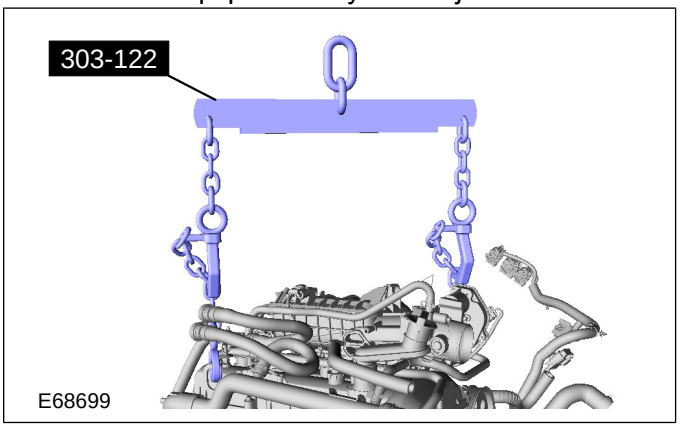


62. Install a new electrical connector nut cover.
Torque: 8 Nm



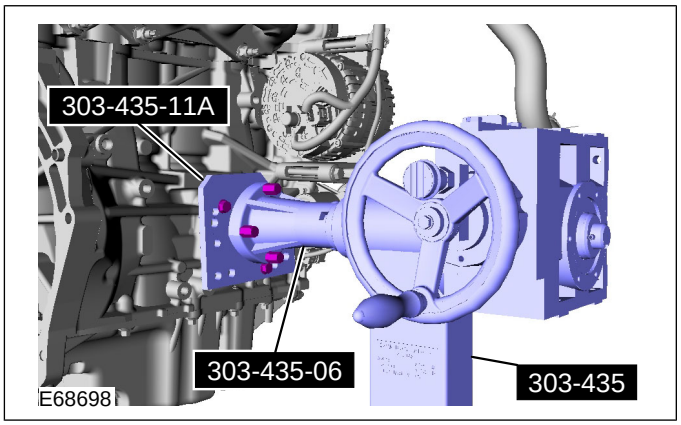
63. Install the special tool.

Special Tool(s): 303-122
General Equipment: Hydraulic jib crane



ASSEMBLY

64. Special Tool(s): 303-435, 303-435-06, 303-435-11A

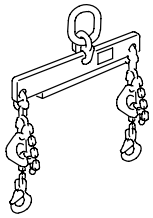


INSTALLATION

Engine

Installation

Special Tool(s)

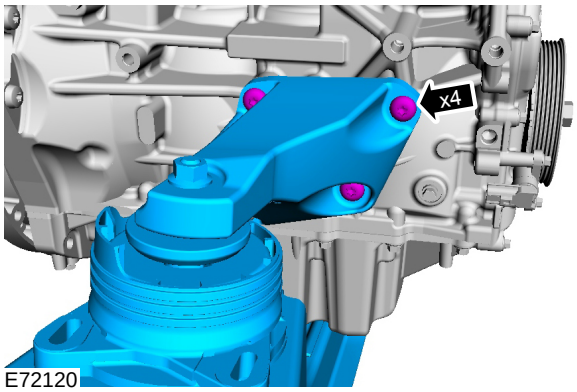
 21068A	Lifting Bracket, Engine 303-122

Materials	
Name	**Specification**
High-Temperature Grease	ESD-M1C220-A

General Equipment

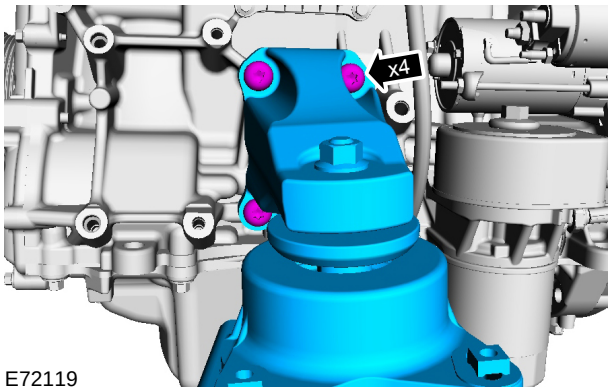
Vehicle/axle stands
Hydraulic jib crane
Trolley jack
Coolant hose clamp remover/installer

1. Torque: 62 Nm



E72120

2. Torque: 62 Nm

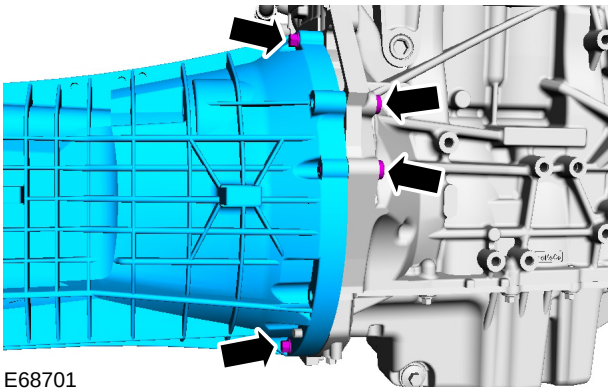


E72119

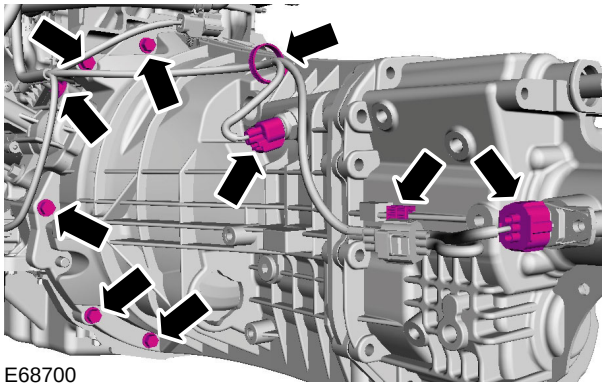
3. ⚠ **CAUTION:Make sure that the transmission is installed straight in relation to the engine to prevent damage to the pilot bearing.**

Apply a thin film of grease to the input shaft guide sleeve.

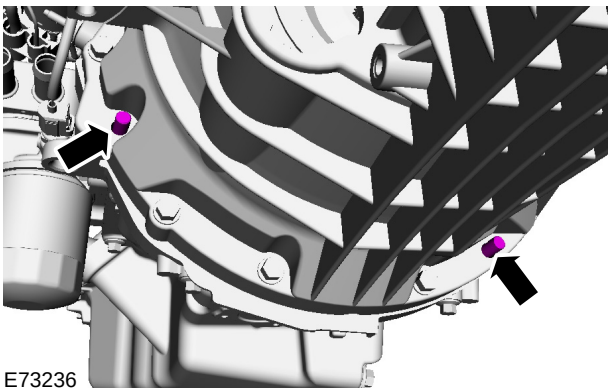
Material: High-Temperature Grease
Torque: 40 Nm


E68701

4. Torque: 40 Nm

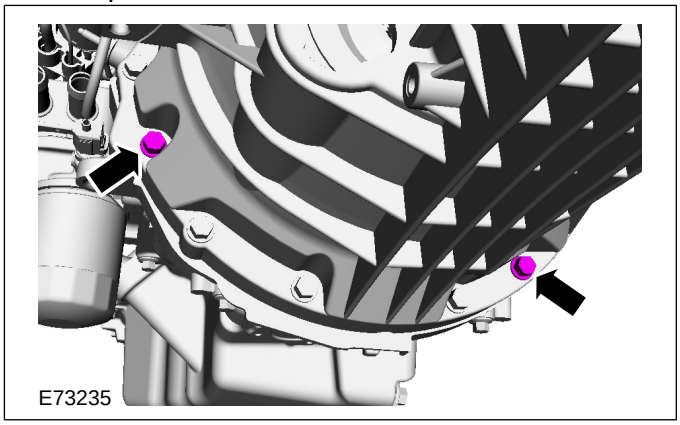

E68700

5.


E73236

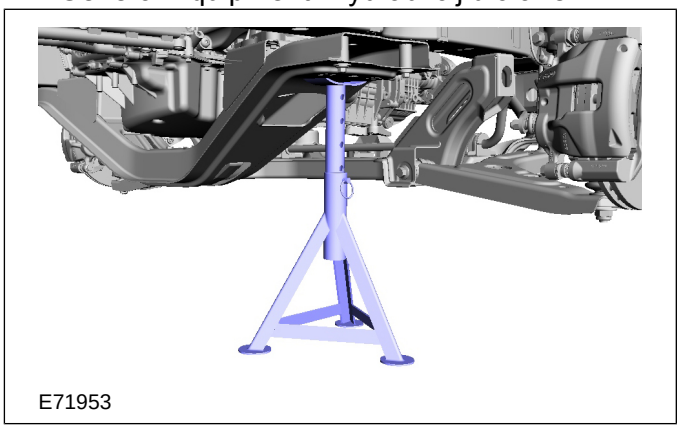
INSTALLATION

6. Torque: 40 Nm

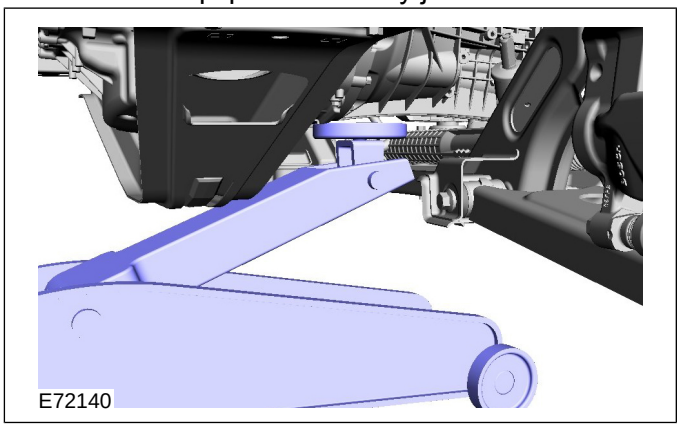


7. Lower the hydraulic jib crane and support the engine crossmember on suitable axle stands on both sides.

   General Equipment: Vehicle/axle stands
   General Equipment: Hydraulic jib crane

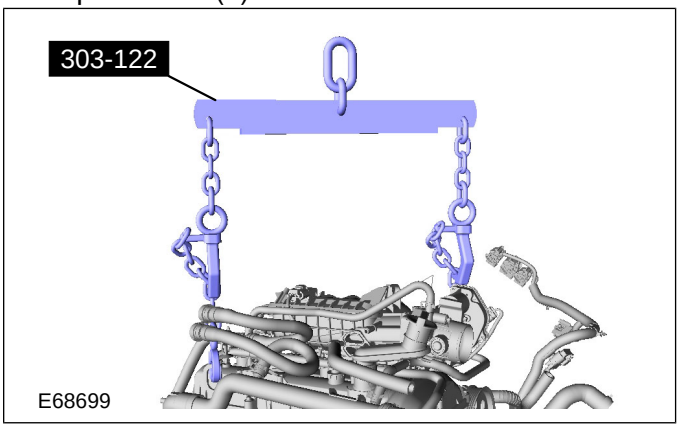


8. General Equipment: Trolley jack

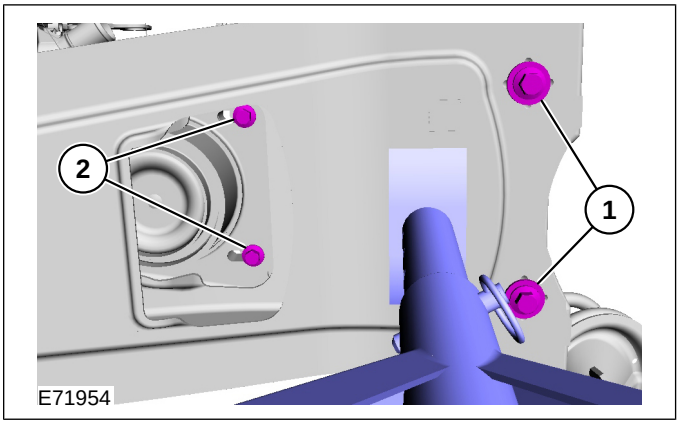


9. Remove the special tool.

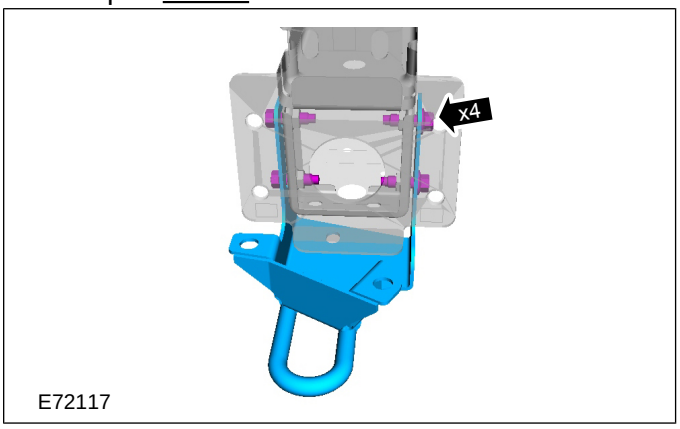
   Special Tool(s): 303-122



10. Push the vehicle forward until the engine and transmission assembly is in place of the engine compartment.
11. • On both sides.
    1. Torque: 70 Nm
    2. Torque: 40 Nm



12. Torque: 48 Nm

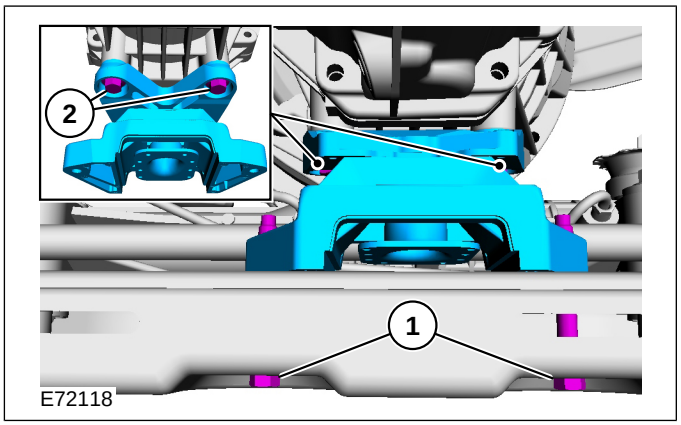


13. Raise and support the vehicle.

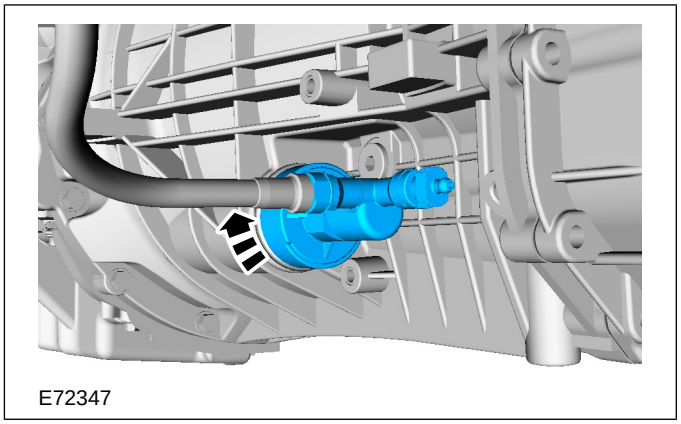
    Refer to:Jacking (100-02 Jacking and Lifting, Description and Operation).
    Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

INSTALLATION

14. 1. Torque: 40 Nm
2. Torque: 55 Nm

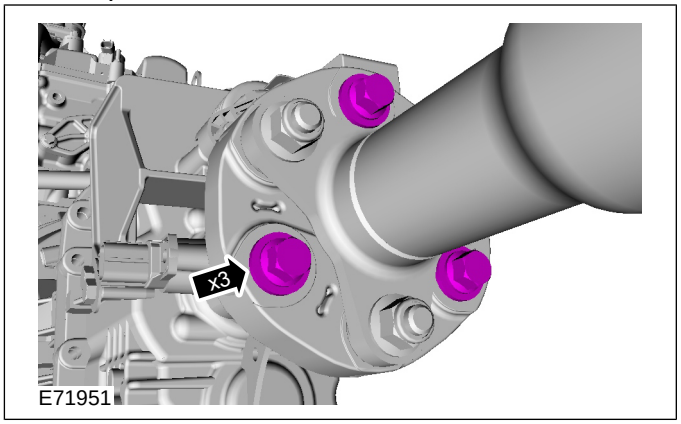


15.

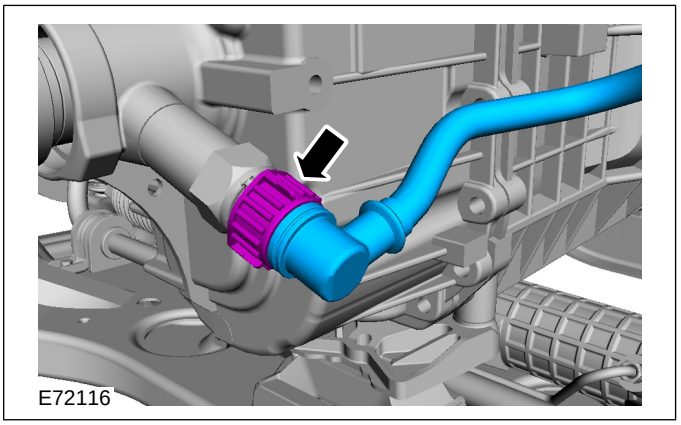


16. ⚠ **CAUTION:Make sure that new driveshaft retaining bolts are installed.**

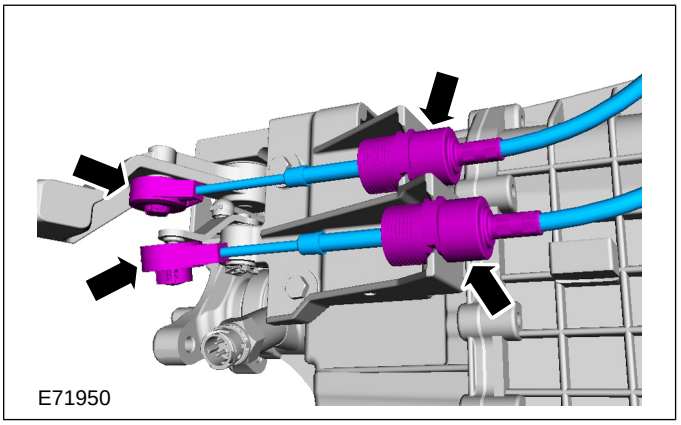
Torque: 115 Nm



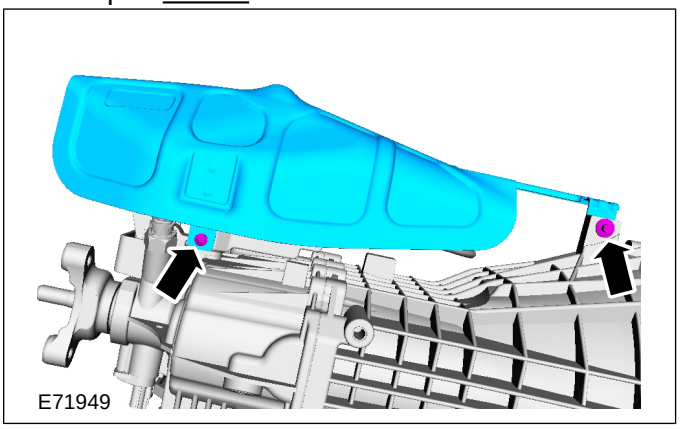
17.



18.



19. Torque: 10 Nm

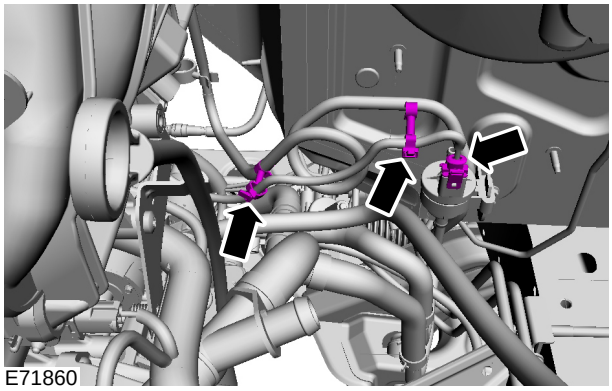


20. Install the following items:
1. Catalytic converter

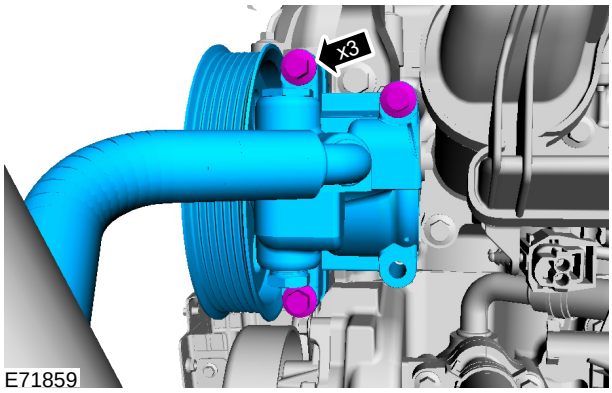
Refer to:Catalytic Converter - 2.3L Duratec-HE (MI4) (309-00 Exhaust System, Removal and Installation).

INSTALLATION

21.

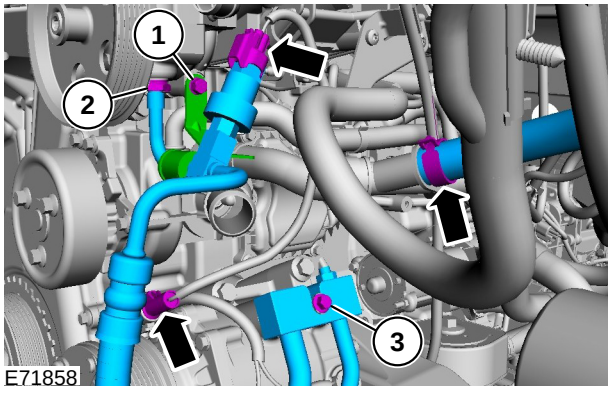


22. Torque: 25 Nm

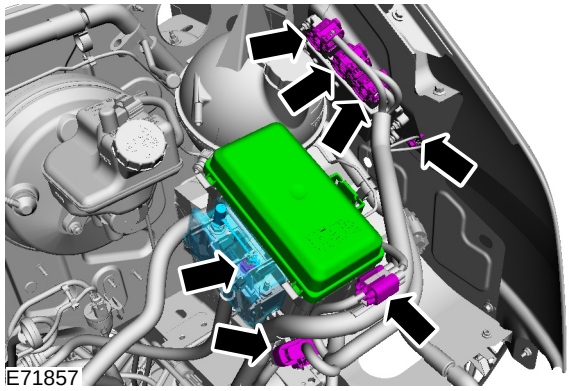


23.
1. Torque: 25 Nm
2. Torque: 63 Nm
3. Torque: 20 Nm

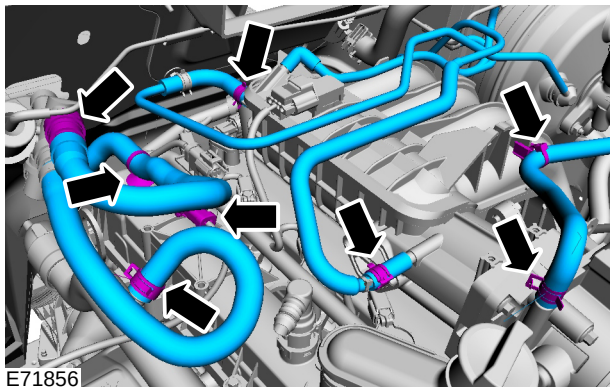
24. General Equipment: Coolant hose clamp remover/installer



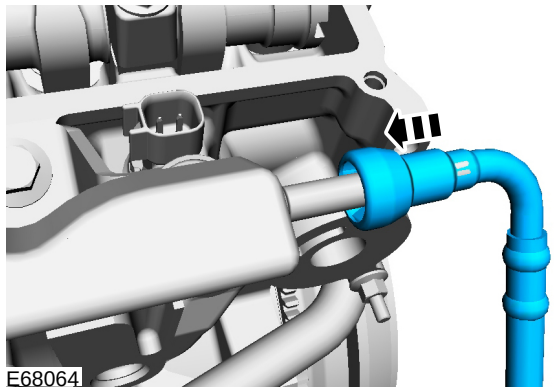
25. Torque: 10 Nm



26. General Equipment: Coolant hose clamp remover/installer

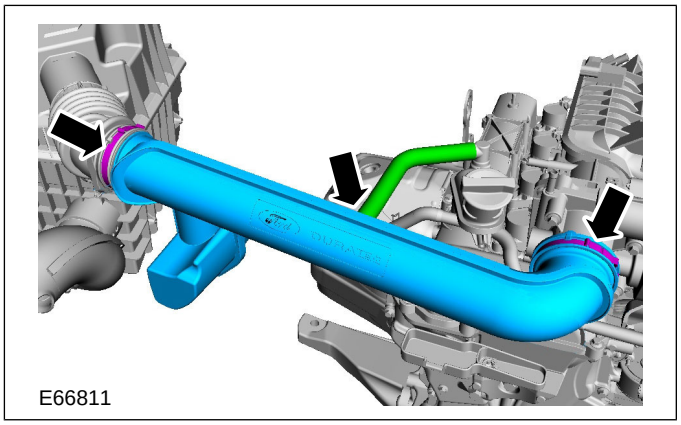


27.

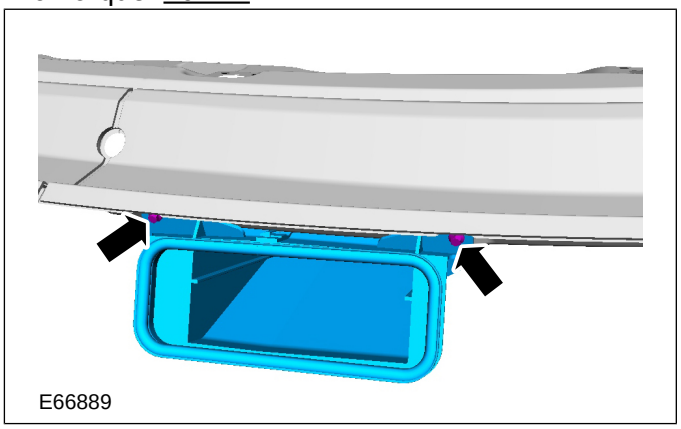


INSTALLATION

28.



29. Torque: 10 Nm



30. Adjust the gearshift cables.

Refer to:Gearshift Cable Adjustment - Vehicles With: MT-75/MT82 (308-00 Manual Transmission/Transaxle and Clutch - General Information, General Procedures).

31. Connect the following items:

1. Battery

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

32. Install the following items:

1. Radiator

   Refer to:Radiator - 2.3L Duratec-HE (MI4) (303-03 Engine Cooling, Removal and Installation).

2. Condenser core

   Refer to:Condenser Core (412-03 Air Conditioning, Removal and Installation).

3. Accessory drive belt

   Refer to:Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

33. Fill and bleed the cooling system.

Refer to:Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

Refer to:Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

SECTION 303-03 Engine Cooling

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 303-03-2

DESCRIPTION AND OPERATION

Engine Cooling 303-03-3
Vehicles with 2.3L Duratec-HE (MI4) engine 303-03-3
Vehicles with 2.2L Duratorq-TDCi (Puma) diesel engine 303-03-4
Vehicles with 2.4L Duratorq-TDCi (Puma) diesel engine 303-03-5

DIAGNOSIS AND TESTING

Engine Cooling — 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel. 303-03-7
Inspection and Verification 303-03-7
Symptom Chart 303-03-7
Component Tests 303-03-12
Engine Cooling — 2.3L Duratec-HE (MI4) 303-03-16
Inspection and Verification 303-03-16
Symptom Chart 303-03-16
Component Tests 303-03-21

GENERAL PROCEDURES

Cooling System Draining, Filling and Bleeding — 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater 303-03-25
Draining 303-03-25
Filling and Bleeding 303-03-25
Cooling System Draining, Filling and Bleeding — 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater 303-03-26
Draining 303-03-26
Filling and Bleeding 303-03-26

REMOVAL AND INSTALLATION

Thermostat — 2.4L Duratorq-TDCi (Puma) Diesel 303-03-27
Thermostat Housing — 2.4L Duratorq-TDCi (Puma) Diesel 303-03-28
Coolant Pump — 2.4L Duratorq-TDCi (Puma) Diesel ..... (24 404 0) 303-03-30
Cooling Fan — 2.4L Duratorq-TDCi (Puma) Diesel 303-03-32
Coolant Pump — 2.3L Duratec-HE (MI4) 303-03-33
Thermostat — 2.3L Duratec-HE (MI4) 303-03-34
Coolant Outlet Connector — 2.3L Duratec-HE (MI4) 303-03-35
Radiator 303-03-37
Cooling Fan Motor and Shroud 303-03-40

SPECIFICATIONS

Antifreeze Specifications

Description	Specification
Motorcraft Super Plus 2000	WSS-M97B44-D
Specific gravity (providing no other additive is in the coolant)	1.061 at +15°C
Approximate percentage of antifreeze (by volume)	40%
Coolant remains fluid to	-25°C (-13°F)
Coolant solidifies at	-30°C (-22°F)

Cooling System Capacities — Vehicles with Diesel Engine

Description	Liters
Vehicles with fuel fired heater and auxiliary heater	13
Vehicles with auxiliary heater	12.8
Vehicles with fuel fired heater	11.5
Vehicles with front heater only	10

Cooling System Capacities — Vehicles with 2.3L Engine

Description	Liters
Vehicles with auxiliary heater	10.1
Vehicles with front heater only	7.8

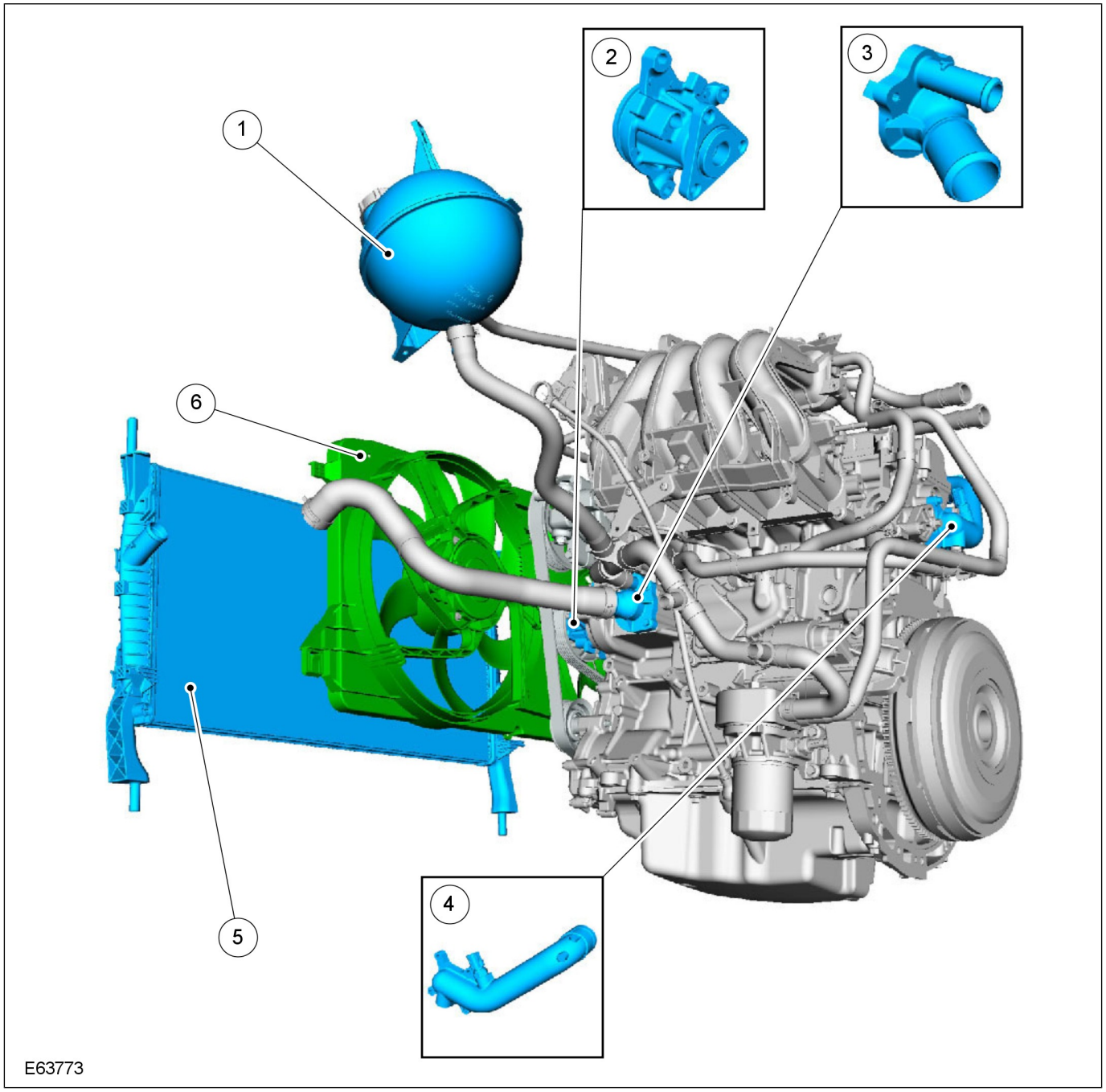
Cooling System Pressure Specification

Description	Pressure kPa (psi)
Radiator pressure test	138 (20)
Coolant expansion tank cap release pressure	135-155 (19-22)

DESCRIPTION AND OPERATION

Engine Cooling

Vehicles with 2.3L Duratec-HE (MI4) engine

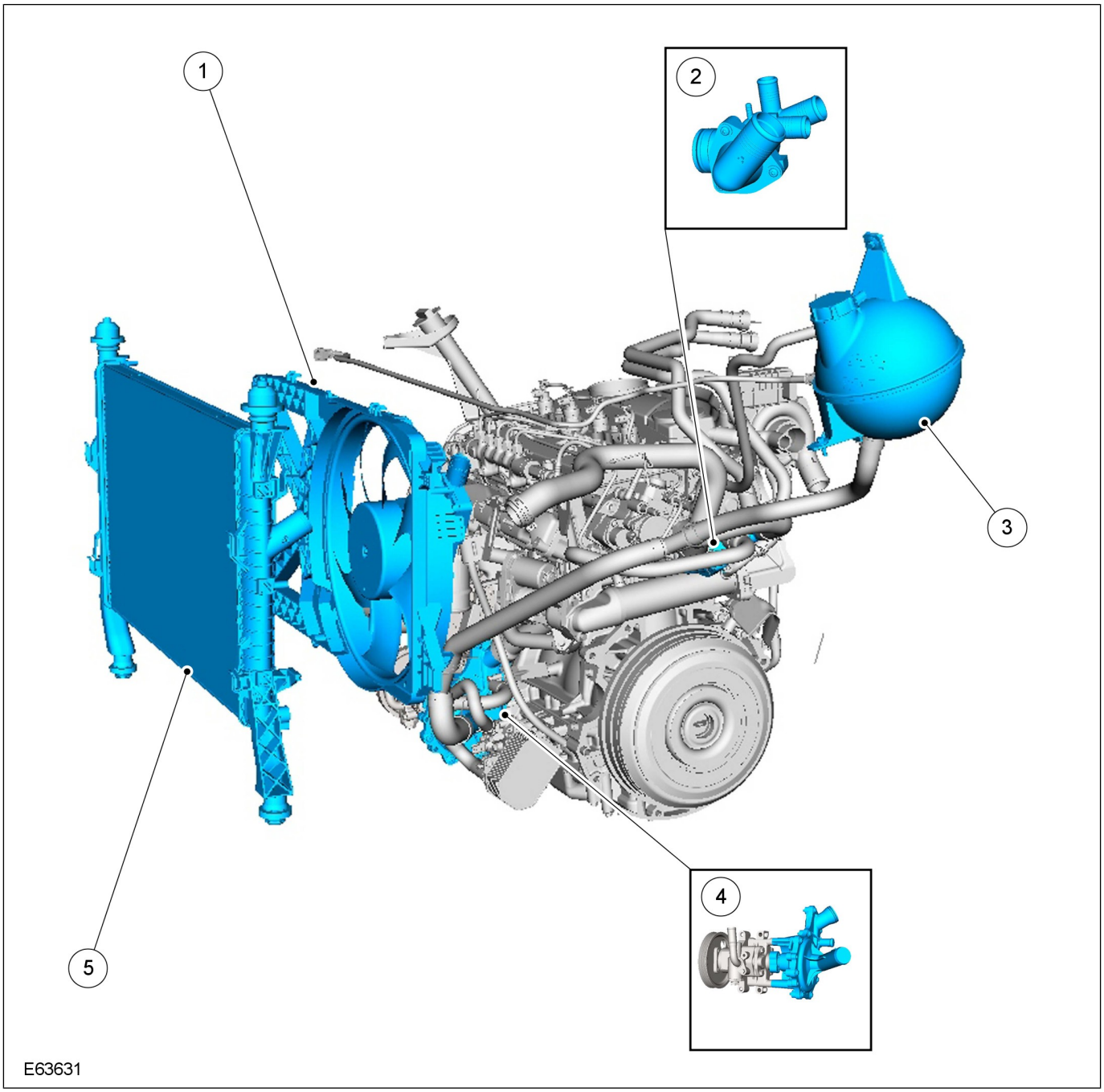


Item	Description
1	Coolant expansion tank
2	Coolant pump
3	Thermostat housing

Item	Description
4	Coolant outlet connector
5	Radiator
6	Cooling fan motor and shroud

DESCRIPTION AND OPERATION

Vehicles with 2.2L Duratorq-TDCi (Puma) diesel engine

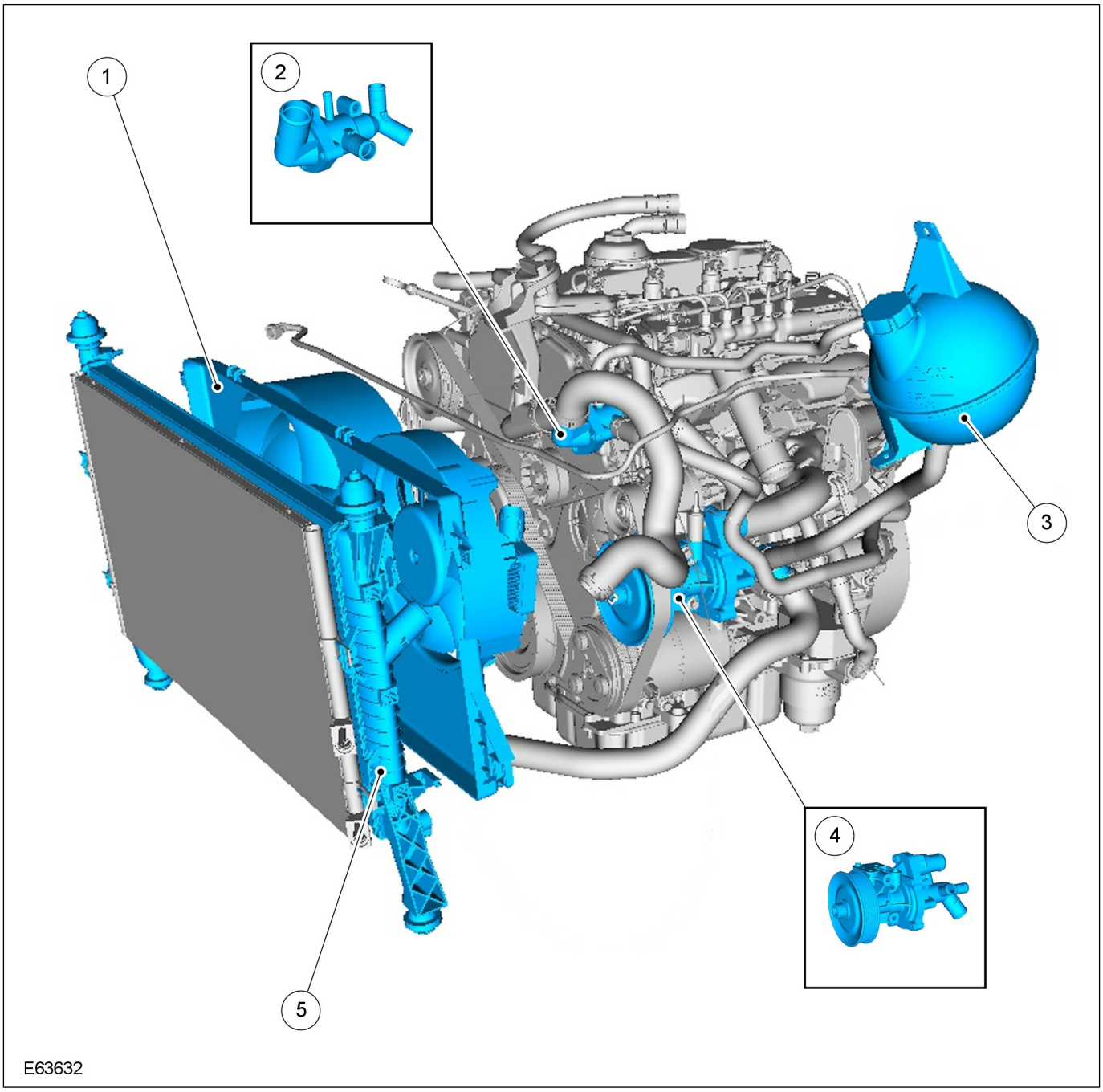


Item	Description
1	Cooling fan motor and shroud
2	Thermostat housing

Item	Description
3	Coolant expansion tank
4	Coolant pump
5	Radiator

DESCRIPTION AND OPERATION

Vehicles with 2.4L Duratorq-TDCi (Puma) diesel engine



Item	Description
1	Cooling fan motor and shroud
2	Thermostat housing
3	Coolant expansion tank
4	Coolant pump
5	Radiator

CAUTION:If the coolant concentration is insufficient, low temperature protection and corrosion resistance will be inadequate.

NOTE: Providing the coolant has not been contaminated with other fluids or foreign material, the robust corrosion resistance properties of this coolant means that it can be reused after changing an aluminium cooling system component. The concentration should always be checked and maintained within specification.

DESCRIPTION AND OPERATION

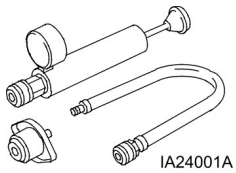
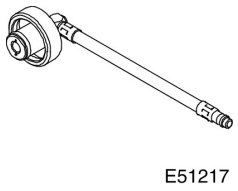
Coolant concentration should be checked through the neck of the coolant expansion tank with a hydrometer. The acceptable range of specific gravity (sg) must be maintained.

The coolant used is an orange colored Motorcraft Super Plus 2000 engine coolant. This is a non silicated organic acid technology (OAT) coolant that must not be mixed with other coolant types. For cooling system top up, only use coolant which meets the correct specification.

DIAGNOSIS AND TESTING

Engine Cooling — 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel

Special Tool(s)

 IA24001A	Pressure Tester, Cooling System 303-396 (24-001A)
 E51217	Adapter for 303-396 303-396-08

Visual Inspection Chart

Mechanical	Electrical
– Coolant hose(s) – Gaskets/seals – Coolant expansion tank cap and seal – Coolant expansion tank – Radiator – Coolant pump – Thermostat – Thermostat housing – Cooling fan and cooling fan clutch — vehicles with 2.4L diesel engine – Accessory drive belt — vehicles with 2.4L diesel engine – Power steering pump belt — vehicles with 2.2L diesel engine – Exhaust gas recirculation (EGR) cooler – Engine oil cooler	– Fuse(s) – Wiring harness – Electrical connector(s) – Cylinder head temperature (CHT) sensor – Engine cooling fan motor(s) – Powertrain control module (PCM)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• Loss of coolant	• Radiator.	• CARRY OUT the Pressure Test Component Test in this section. INSTALL a new radiator as necessary. REFER to: Radiator (303-03 Engine Cooling, Removal and Installation).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Coolant pump.	• CARRY OUT the Pressure Test Component Test in this section. INSTALL a new coolant pump as necessary. REFER to: Coolant Pump - 2.2L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation) / Coolant Pump - 2.4L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation).
	• Thermostat housing.	• CARRY OUT the Pressure Test Component Test in this section. INSTALL a new thermostat housing as necessary. REFER to: Thermostat Housing - 2.2L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation) / Thermostat Housing - 2.4L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation).
	• Coolant expansion tank cap.	• CARRY OUT the Coolant Expansion Tank Cap Pressure Test Component Test in this section.
	• Coolant expansion tank.	• CHECK the coolant expansion tank for damage. INSTALL a new coolant expansion tank as necessary.
	• EGR cooler (if equipped).	• CARRY OUT the Pressure Test Component Test in this section. INSTALL a new EGR cooler as necessary. REFER to: Exhaust Gas Recirculation (EGR) Cooler - 2.2L Duratorq-TDCi (Puma) Diesel (303-08 Engine Emission Control, Removal and Installation) / Exhaust Gas Recirculation (EGR) Cooler - 2.4L Duratorq-TDCi (Puma) Diesel (303-08 Engine Emission Control, Removal and Installation).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Engine oil cooler.	• CARRY OUT the Pressure Test Component Test in this section. INSTALL a new engine oil cooler as necessary.
	• Heater core.	• CHECK the heater core for leaks. REFER to: Heater Core - Vehicles Without: Air Conditioning (412-02 Heating and Ventilation, Removal and Installation) / Heater Core - Vehicles With: Air Conditioning (412-02A Heating and Ventilation, Removal and Installation) / Auxiliary Heater Core (412-02 Auxiliary Heating, Removal and Installation).
	• Engine.	• CHECK the engine, cylinder head, coolant manifold, cylinder block and cylinder head gasket.
• The engine overheats.	• Cooling system does not hold pressure.	• CARRY OUT the Coolant Expansion Tank Cap Pressure Test Component Test in this section. CHECK the coolant expansion tank for damage. INSTALL a new coolant expansion tank as necessary. CHECK the coolant pump for damage. INSTALL a new coolant pump as necessary. REFER to: Coolant Pump - 2.2L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation) / Coolant Pump - 2.4L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation). CHECK the engine, cylinder head, coolant manifold, cylinder block and cylinder head gasket.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Air in system.	• BLEED the cooling system. REFER to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures) / Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
	• Coolant expansion tank cap.	• CARRY OUT the Coolant Expansion Tank Cap Pressure Test Component Test in this section.
	• Coolant expansion tank.	• CHECK the coolant expansion tank for damage. INSTALL a new coolant expansion tank as necessary.
	• Coolant level/condition.	• CHECK the coolant level/condition. REFILL the cooling system. REFER to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures) / Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Coolant concentration.	• REFER to: Specifications (303-03 Engine Cooling, Specifications).
	• Radiator grille.	• CHECK the radiator grille for air restrictions/damage. REPAIR as necessary.
	• Coolant pump.	• CHECK the coolant pump for leaks. INSTALL a new coolant pump as necessary. REFER to: Coolant Pump - 2.2L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation) / Coolant Pump - 2.4L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation).
	• Thermostat.	• CARRY OUT the Thermostat Test Component Test in this section. INSTALL a new thermostat as necessary. REFER to: Thermostat - 2.2L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation) / Thermostat - 2.4L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation).
	• Accessory drive belt — vehicles with 2.4L diesel engine.	• CHECK the accessory drive belt for correct operation. REFER to: Accessory Drive (303-05 Accessory Drive, Diagnosis and Testing).
	• Power steering pump belt — vehicles with 2.2L diesel engine.	• CHECK the power steering pump belt for correct operation. REFER to: Power Steering Pump Belt - 2.2L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Cooling fan and cooling fan clutch.	• CHECK operation of the cooling fan and cooling fan clutch. INSTALL a new cooling fan and cooling fan clutch as necessary. REFER to: Cooling Fan - 2.4L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation).
	• Engine.	• CHECK the engine, cylinder head, coolant manifold, cylinder block and cylinder head gasket.
• The engine does not reach normal operating temperature.	• CHT sensor.	• CHECK the CHT sensor for correct operation. REFER to the WDS.
	• Thermostat.	• CARRY OUT the Thermostat Test Component Test in this section. INSTALL a new thermostat as necessary. REFER to: Thermostat - 2.2L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation) / Thermostat - 2.4L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation).
	• Circuit(s).	• CHECK the circuit(s). REFER to the WDS.
	• Oil cooler thermostatic valve.	• CHECK the oil cooler thermostatic valve for correct operation. INSTALL a new oil cooler thermostatic valve as necessary.

Component Tests

Pressure Test

WARNING:When releasing the system pressure, cover the coolant expansion tank cap with a thick cloth to prevent the possibility of coolant scalding. Failure to follow this instruction may result in personal injury.

1. Remove the coolant expansion tank cap.
2. Install the special tools to the coolant expansion tank.
3. Pressurize the system to the coolant expansion tank cap release pressure.

   REFER to: Specifications (303-03 Engine Cooling, Specifications).
4. Observe the cooling system pressure tester gauge reading for approximately two minutes. The pressure should not drop during this time. If the system holds pressure, proceed to step 7. If the system does not hold pressure, check it thoroughly for coolant leaks.
5. If a coolant leak cannot be found, check the EGR cooler (this may leak internally), engine oil cooler (this may produce oil in the coolant expansion tank) and the engine for cylinder

DIAGNOSIS AND TESTING

leakage. Drain the cooling system, repair any coolant leaks found and fill and bleed the cooling system as necessary.

REFER to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures) / Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

6. Recheck the system by repeating steps 3 and 4 at least twice.

Radiator Leak Test, Removed From Vehicle

CAUTION:Radiator internal pressure must not exceed 130 kpa (20 psi) or damage may result.

Clean the radiator thoroughly before leak testing it, to prevent contamination of the water in the test tank. Leak test the radiator in clean water with 138 kpa (20 psi) air pressure. Check it thoroughly for air leaks. INSTALL a new radiator if necessary.

REFER to: Radiator (303-03 Engine Cooling, Removal and Installation).

Coolant Expansion Tank Cap Pressure Test

WARNING:When releasing the system pressure, cover the coolant expansion tank cap with a thick cloth to prevent the possibility of coolant scalding. Failure to follow this instruction may result in personal injury.

1. Remove the coolant expansion tank cap.
2. Use water to clean the area of the rubber seal and pressure relief valve. Install the pressure tester and adapter and immerse the coolant expansion tank cap in water .

NOTE: If the plunger of the pump is depressed too quickly, an erroneous pressure reading will result.

3. Slowly depress the plunger of the pressure test pump until the pressure test gauge reading stops increasing, and note the highest pressure reading obtained.
4. Release pressure by turning the pressure relief screw counterclockwise. Tighten the pressure relief screw and repeat step 3 at least twice to make sure that the pressure test gauge reading is repeatable and within acceptable gauge reading limits of the coolant expansion tank cap.
5. If the pressure test gauge readings are not within the acceptable gauge reading limits, INSTALL a new coolant expansion tank cap.

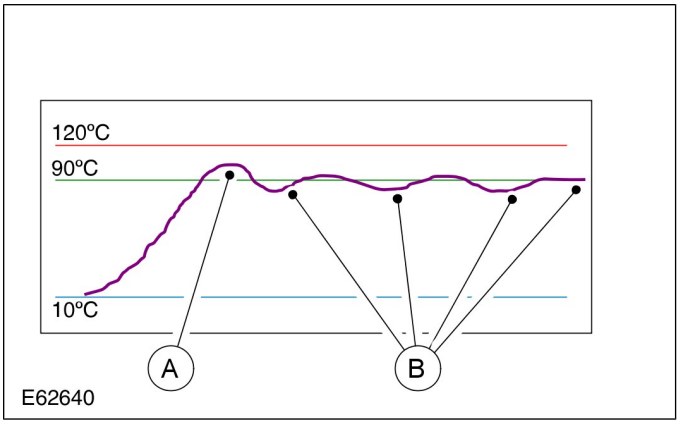
Thermostat Test

1. Connect the WDS to the data link connector (DLC).
2. Using the WDS datalogger function, SELECT the following sensors (as applicable to the application):

- IAT - intake air temperature (IAT) sensor
- ECT - engine coolant temperature (ECT) sensor
- CHT - cylinder head temperature (CHT) sensor
- LOAD - engine load
- VSS - vehicle speed sensor (VSS)
- RPM - engine speed
- DSRPM - desired engine speed

The IAT sensor output is useful if the engine being tested is cold or after an over-night cold soak. The ECT sensor or CHT sensor and the IAT sensor should either indicate the same value or be within 1 to 2 degrees Celsius of each other.

The ECT sensor output is important to display as it indicates the engine warm-up and opening temperature for the thermostat. It will initially indicate a slightly higher reading just before the thermostat opens and then drops back before settling to a near flat line output (see graphic below).



Item	Description
A	Thermostat opens
B	Thermostat settles into a cyclic open and closure pattern

DIAGNOSIS AND TESTING

CAUTION:If the ECT sensor output reaches the 120ºC default line under normal cooling system pressure, internal damage may be caused to the engine and a diagnostic trouble code (DTC) will be set in the PCM. The test should be stopped and the cause located and corrected. If the cooling system does not pressurize, the coolant will boil at 100ºC which may also damage the engine. CARRY OUT the Coolant Expansion Tank Cap Pressure Test Component Test in this section.

If the WDS only allows the ECT sensor to be displayed in volts, refer to the following table for corresponding Celsius values:

Volts	ºCelsius
1.33	60
1.02	70
0.78	80
0.60	90
0.46	100
0.35	110
0.27	120

The CHT sensor output is useful to examine the cylinder head temperature rise during the warm-up cycle and later during the normal light throttle cruise test. This sensor output may vary between vehicles with manual transmission and vehicles with automatic transmission and should be used for reference only.

The LOAD display is used for reference as it is necessary to maintain a stable load line during the test. It is necessary to carry out the test under normal light throttle cruise driving conditions and average loads, typically 40% to 70% of the load value.

The VSS output is used for reference but can help to identify misfires and sensors which fail during the warm-up cycle.

The RPM display indicates the engine speed and can be compared with the DSRPM.

The DSRPM is the desired or calculated idle speed which the PCM commands the engine to reach. If the thermostat opens too early (before the correct opening temperature has been reached), the engine will not reach this value.

When using the WDS in data logger mode, the signals recorded should remain within the DEFAULT values set by the WDS.

3. **WARNING:Make sure that the WDS is placed in the vehicle so that it does not interfere with the safe operation of the vehicle. Do not place the WDS in the deployment path of any air bag. Failure to follow these instructions may result in personal injury.**

NOTE: The road test is best carried out with the aid of another technician in the vehicle to enable the vehicle to be driven safely while the sensor outputs are monitored within datalogger. If there is only one technician available, the WDS can be set up (using the record/capture mode camera icon) before leaving the workshop to record a 16 km (10 mile) test.

NOTE: The results from the test are more conclusive if the engine is cold when the test is started.

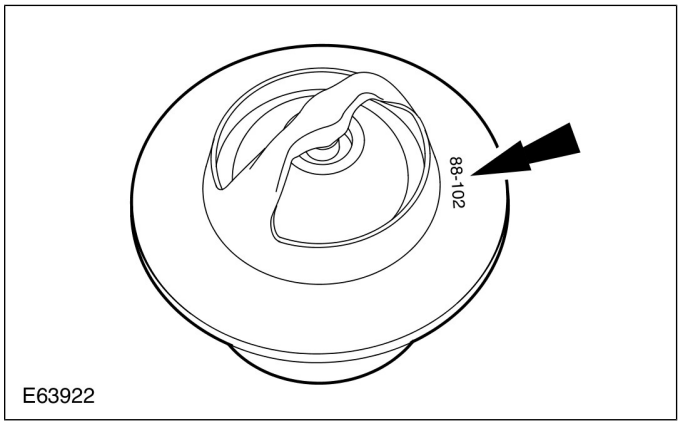
Carry out a road test.

REFER to: Road/Roller Testing (100-00 General Information, Description and Operation).

4. Drive the vehicle at a constant throttle opening and set speed until the ECT value settles into a shallow rise and fall signal, close to a straight line. This indicates that the thermostat is functioning correctly.

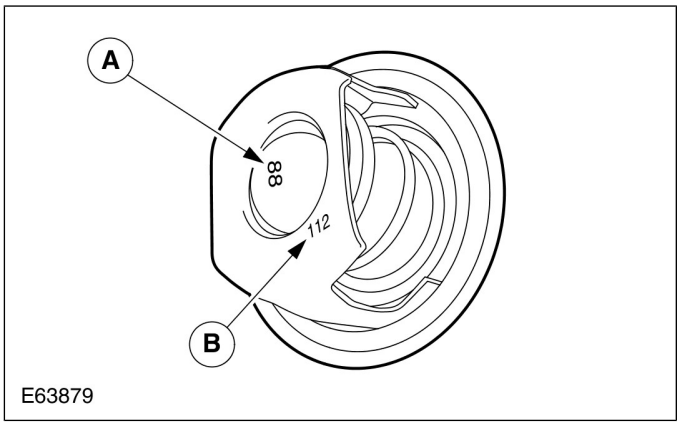
NOTE: Some thermostats indicate the temperature(s) in Celsius and Fahrenheit.

The graphic below shows the location and an example of the opening temperature (88ºC) and fully open temperature (102ºC) of a thermostat.



The graphic below shows an alternative method used to show the opening temperature (88ºC) and fully open temperature (112ºC) of a thermostat.

DIAGNOSIS AND TESTING



E63879

Item	Description
A	Opening temperature
B	Fully open temperature

NOTE: Generally, most thermostats maintain a coolant temperature between 88ºC (190ºF) and 92ºC (198ºF) although dual stage electric thermostats may increase the coolant temperature up to 100ºC (212ºF) under light engine load conditions.

The engine should start cleanly and the ECT value will rise quite quickly with smooth progression. If the ECT signal appears unstable or erratic, the ECT sensor, electrical connector and wiring harness to the PCM need to be visually inspected for damage, chafing or water ingress.

The temperature should rise to approximately 90ºC for a thermostat that has an 88ºC value. The signal value will then fall as cooler coolant enters the engine.

If the ECT value fails to maintain a constant value and falls back to lower figures, typically between 60ºC (140ºF) and 70ºC (150ºF), the thermostat and its sealing function within the thermostat housing must be checked.

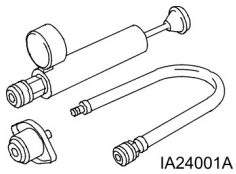
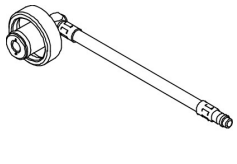
5. INSTALL a new thermostat.

   REFER to: Thermostat - 2.2L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation)
   / Thermostat - 2.4L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Removal and Installation).
6. Carry out another road test from step 1 using the same criteria to confirm that the concern has been rectified.
7. Using the WDS, clear the PCM keep alive memory (KAM) or electrically erasable programmable read only memory (EEPROM) so that new drive values can be learnt.

DIAGNOSIS AND TESTING

Engine Cooling — 2.3L Duratec-HE (MI4)

Special Tool(s)

 IA24001A	Pressure Tester, Cooling System 303-396 (24-001 A)
 E51217	Adaptor for 303-396 303-396-08

Visual Inspection Chart

Mechanical	Electrical
• Coolant leak(s) • Coolant level • Gasket(s) or seal(s) • Core plug(s) • Hose(s) or hose joints • Coolant expansion tank cap and seal • Coolant expansion tank • Radiator • Coolant pump • Thermostat housing • Heater core • Accessory drive belt • Coolant outlet connector	• Fuse(s) • Relay(s) • Wiring harness • Electrical connector(s) • Engine coolant temperature (ECT) sensor • Cooling fan motor • Powertrain control module (PCM)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• Loss of coolant	• Hose(s) or hose joint(s).	• INSPECT the hoses and hose joints. INSTALL a new hose(s) as necessary.
	• Radiator.	• INSPECT the radiator for leaks. CARRY OUT the Pressure Test Component Test in this section. INSTALL a new radiator as necessary. REFER to: Radiator (303-03 Engine Cooling, Removal and Installation).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Coolant pump.	• INSPECT the coolant pump for leaks. CARRY OUT the Pressure Test Component Test in this section. INSTALL a new coolant pump or coolant pump gasket as necessary. REFER to: Coolant Pump - 2.3L Duratec-HE (MI4) (303-03 Engine Cooling, Removal and Installation).
	• Thermostat housing.	• INSPECT the thermostat housing for leaks. CARRY OUT the Pressure Test Component Test in this section. INSTALL a new thermostat housing and thermostat housing gasket as necessary. REFER to: Thermostat - 2.3L Duratec-HE (MI4) (303-03 Engine Cooling, Removal and Installation).
	• Coolant expansion tank cap or seal(s).	• CHECK the coolant expansion tank cap for tightness and damage. INSTALL a new coolant expansion cap as necessary.
	• Coolant expansion tank.	• INSPECT the coolant expansion tank for damage. INSTALL a new coolant expansion tank as necessary.
	• Heater core.	• CHECK the heater core for leaks.
	• Engine.	• INSPECT the engine, cylinder head, cylinder block and cylinder head gasket. REFER to: Cylinder Head (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• The engine overheats (signs of coolant boiling)	• Cooling system does not hold pressure.	• INSPECT the coolant expansion tank for damage. INSTALL a new coolant expansion tank as necessary. • INSPECT the coolant pump or coolant pump gasket for damage. INSTALL a new coolant pump or coolant pump gasket as necessary. REFER to: Coolant Pump - 2.3L Duratec-HE (MI4) (303-03 Engine Cooling, Removal and Installation). • INSPECT the engine, cylinder head, cylinder block and cylinder head gasket. REFER to: Cylinder Head (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).
	• Air in cooling system.	• BLEED the cooling system. REFER to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures) / Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
	• Coolant expansion tank cap or seal(s).	• CHECK the coolant expansion tank cap for tightness and damage. INSTALL a new coolant expansion cap as necessary.
	• Coolant expansion tank.	• INSPECT the coolant expansion tank for damage. INSTALL a new coolant expansion tank as necessary.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Coolant level or condition.	• CHECK the coolant level. REFILL the cooling system as necessary. REFER to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures) / Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures). • CHECK the coolant condition and concentration REFER to: Specifications (303-03 Engine Cooling, Specifications). If the coolant is contaminated or the concentration is below specifications, drain and refill with new coolant. REFER to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures) / Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
	• Radiator grille.	• INSPECT the radiator grille for air restrictions or damage. REPAIR or INSTALL new parts as necessary.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Coolant pump.	• CARRY OUT the Pressure Test Component Test in this section. INSPECT the coolant pump for leaks. INSTALL a new coolant pump or coolant pump gasket as necessary. REFER to: Coolant Pump - 2.3L Duratec-HE (MI4) (303-03 Engine Cooling, Removal and Installation).
	• Thermostat.	• CARRY OUT the Thermostat Test Component Test in this section. INSTALL a new thermostat housing and thermostat housing gasket as necessary. REFER to: Thermostat - 2.3L Duratec-HE (MI4) (303-03 Engine Cooling, Removal and Installation).
	• Accessory drive belt.	• CHECK the condition of the accessory drive belt. REFER to: Accessory Drive (303-05 Accessory Drive, Diagnosis and Testing).
	• Cooling fan.	• CHECK the operation of the cooling fan. REFER to WDS.
	• Engine.	• INSPECT the engine, cylinder head, cylinder block and cylinder head gasket. REFER to: Cylinder Head (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).
• The engine does not reach normal operating temperature.	• ECT sensor.	• CHECK the ECT sensor. REFER to the WDS.
	• Temperature gauge.	• CHECK the instrument cluster engine temperature gauge. REFER to: Instrument Cluster (413-01 Instrument Cluster, Diagnosis and Testing).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Thermostat.	• CARRY OUT the Thermostat Test Component Test in this section. INSTALL a new thermostat housing and thermostat housing gasket as necessary. REFER to: Thermostat - 2.3L Duratec-HE (MI4) (303-03 Engine Cooling, Removal and Installation).

Component Tests

Pressure Test

WARNING:When releasing the cooling system pressure, cover the coolant expansion tank cap with a thick cloth to prevent the possibility of coolant scalding. Failure to follow this instruction may result in personal injury.

NOTE: If the coolant expansion tank cap is rotated counterclockwise by 1/2 a full turn, the pressurized coolant will be vented to the underside of the coolant expansion tank cap.

1. Remove the coolant expansion tank cap.
2. Install the special tools 303-396 and 303-396-01 to the coolant expansion tank.
3. Pressurize the system to the coolant expansion tank cap release pressure.

   REFER to: Specifications (303-03 Engine Cooling, Specifications).
4. Observe the cooling system pressure tester gauge reading for approximately two minutes. The pressure should not drop during this time. If the system holds pressure, proceed to Step 7. If the system does not hold pressure, check it thoroughly for coolant leaks.
5. Check the engine for coolant leaks. Drain the cooling system, repair any coolant leaks found and fill and bleed the cooling system as necessary.

   REFER to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures) / Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
6. Recheck the system by repeating Steps 3 and 4 at least twice.

Radiator Leak Test, Removed From Vehicle

CAUTION:Radiator internal pressure must not exceed 130 kpa (20 psi) or damage may result.

Clean the radiator thoroughly before leak testing it, to prevent contamination of the water in the test tank. Leak test the radiator in clean water with 138 kpa (20 psi) air pressure. Check it thoroughly for air leaks. INSTALL a new radiator if necessary.

REFER to: Radiator (303-03 Engine Cooling, Removal and Installation).

Coolant Expansion Tank Cap Pressure Test

WARNING:When releasing the system pressure, cover the expansion tank cap with a thick cloth to prevent the possibility of coolant scalding, Failure to follow this instruction may result in personal injury.

1. Remove the coolant expansion tank cap.
2. Use water to clean the area of the rubber seal and pressure relief valve. Install the pressure tester and adapter and immerse the coolant expansion tank cap in water .

NOTE: If the plunger of the pump is depressed too quickly, an erroneous pressure reading will result.

3. Slowly depress the plunger of the pressure test pump until the pressure gauge reading stops increasing, and note the highest pressure reading obtained.
4. Release pressure by turning the pressure relief screw counterclockwise. Tighten the pressure relief screw and repeat step 3 at least twice to

DIAGNOSIS AND TESTING

make sure the pressure test reading is repeatable and within acceptable gauge reading limits of the coolant expansion tank cap.

5. If the pressure test gauge readings are not within the acceptable gauge reading limits, INSTALL a new coolant expansion tank cap.

Thermostat Test

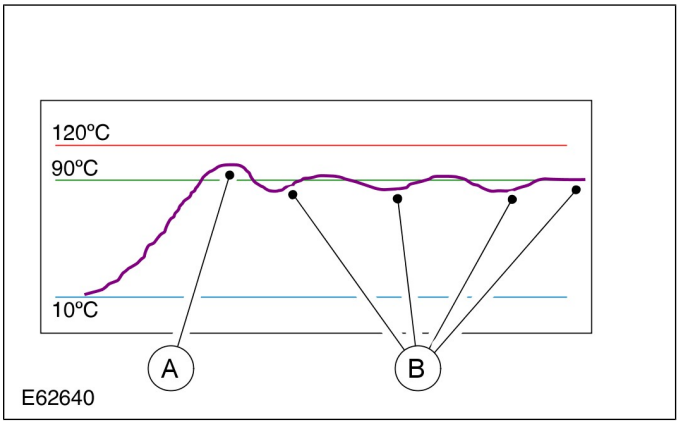
NOTE: For this test make sure that all cabin heaters are set to the cold position and blowers are switched off.

1. Connect the WDS to the data link connector (DLC).
2. Using the WDS datalogger function, SELECT the following sensors:

- IAT - intake air temperature (IAT) sensor
- ECT - engine coolant temperature (ECT) sensor
- LOAD - engine load
- VSS - vehicle speed sensor (VSS)
- RPM - engine speed
- DSRPM - desired engine speed

The IAT sensor output is useful if the engine being tested is cold or after an over-night cold soak. The ECT sensor and the IAT sensor should either indicate the same value or be within 1 to 2 degrees Celsius of each other.

The ECT sensor output is important to display as it indicates the engine warm-up and opening temperature for the thermostat. It will initially indicate a slightly higher reading just before the thermostat opens and then drops back before settling to a near flat line output (see graphic below).



Item	Description
A	Thermostat opens
B	Thermostat settles into a cyclic open and closure pattern

CAUTION:If the ECT sensor output reaches the 120ºC default line under normal cooling system pressure, internal damage may be caused to the engine and a diagnostic trouble code (DTC) will be set in the PCM. The test should be stopped and the cause located and corrected. If the cooling system does not pressurize, the coolant will boil at 100ºC which may also damage the engine. CARRY OUT the Coolant Expansion Tank Cap Pressure Test Component Test in this section.

If the WDS only allows the ECT sensor to be displayed in volts, refer to the following table for corresponding Celsius values:

Volts	ºCelsius
1.33	60
1.02	70
0.78	80
0.60	90
0.46	100
0.35	110
0.27	120

The LOAD display is used for reference as it is necessary to maintain a stable load line during the test. It is necessary to carry out the test under normal light throttle cruise driving conditions and average loads, typically 40% to 70% of the load value.

DIAGNOSIS AND TESTING

The VSS output is used for reference but can help to identify misfires and sensors which fail during the warm-up cycle.

The RPM display indicates the engine speed and can be compared with the DSRPM.

The DSRPM is the desired or calculated idle speed which the PCM commands the engine to reach. If the thermostat opens too early (before the correct opening temperature has been reached), the engine will not reach this value.

When using the WDS in data logger mode, the signals recorded should remain within the DEFAULT values set by the WDS.

3. **WARNING:Make sure that the WDS is placed in the vehicle so that it does not interfere with the safe operation of the vehicle. Do not place the WDS in the deployment path of any air bag. Failure to follow these instructions may result in personal injury.**

NOTE: The road test is best carried out with the aid of another technician in the vehicle to enable the vehicle to be driven safely while the sensor outputs are monitored within datalogger. If there is only one technician available, the WDS can be set up (using the record/capture mode camera icon) before leaving the workshop to record a 16 km (10 mile) test.

The results from the test are more conclusive if the engine is cold when the test is started.

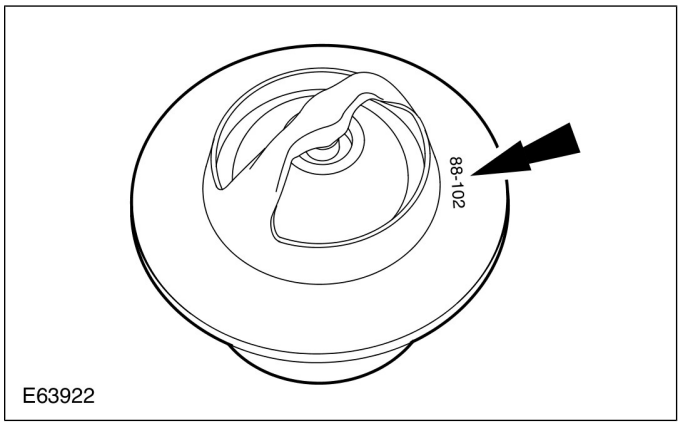
Carry out a road test.

REFER to: Road/Roller Testing (100-00 General Information, Description and Operation).

4. Drive the vehicle at a constant throttle opening and set speed until the ECT value settles into a shallow rise and fall signal, close to a straight line. This indicates that the thermostat is functioning correctly.

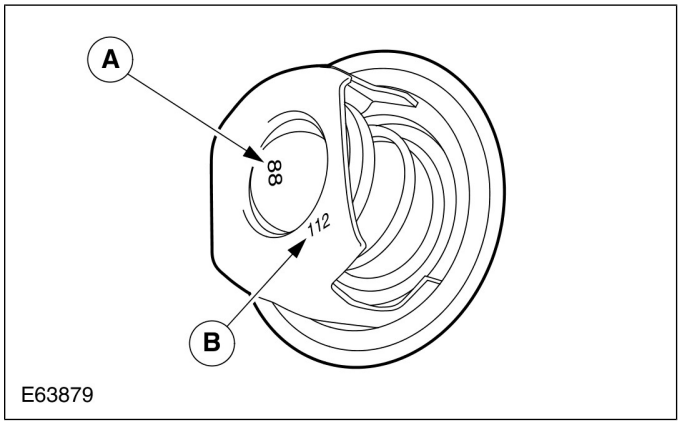
NOTE: Some thermostats indicate the temperature(s) in Celsius and Fahrenheit.

The graphic below shows the location and an example of the opening temperature (88ºC) and fully open temperature (102ºC) of a thermostat.



E63922

The graphic below shows an alternative method used to show the opening temperature (88ºC) and fully open temperature (112ºC) of a thermostat.



E63879

Item	Description
A	Opening temperature
B	Fully open temperature

NOTE: Generally, most thermostats maintain a coolant temperature between 88ºC (190ºF) and 92ºC (198ºF) although dual stage electric thermostats may increase the coolant temperature up to 100ºC (212ºF) under light engine load conditions.

The engine should start cleanly and the ECT value will rise quite quickly with smooth progression. If the ECT signal appears unstable or erratic, the ECT sensor, electrical connector and wiring harness to the PCM need to be visually inspected for damage, chafing or water ingress.

The temperature should rise to approximately 90ºC for a thermostat that has an 88ºC value. The signal value will then fall as cooler coolant enters the engine.

If the ECT value fails to maintain a constant value and falls back to lower figures, typically between 60ºC (140ºF) and 70ºC (150ºF), the thermostat and its sealing function within the thermostat housing must be checked.

DIAGNOSIS AND TESTING

5. INSTALL a new thermostat housing and thermostat housing gasket as necessary.

   REFER to: Thermostat - 2.3L Duratec-HE (MI4) (303-03 Engine Cooling, Removal and Installation).
6. Carry out another road test from step 1 using the same criteria to confirm that the concern has been rectified.
7. Using the WDS, clear the PCM keep alive memory (KAM) or electrically erasable programmable read only memory (EEPROM) so that new drive values can be learnt.

GENERAL PROCEDURES

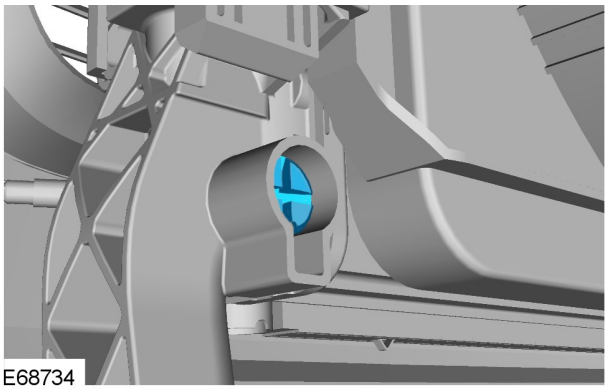
Cooling System Draining, Filling and Bleeding — 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater

Draining

WARNING:When releasing the cooling system pressure, cover the coolant expansion tank cap with a thick cloth.

1. Release the cooling system pressure by slowly turning the coolant expansion tank cap between 2 and 3 turns.
2. Raise and support the vehicle.

   Refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).
3. Allow the coolant to drain into a suitable container.



4. Install the radiator drain plug.
5. Lower the vehicle.

Filling and Bleeding

1. Fill the coolant expansion tank coolant level to 15 mm over the MAX mark.
2. Install the coolant expansion tank cap.
3. Start and run the engine at 2000 RPM and maintain it for 20 minutes.
4. Increase the engine speed to 4000 RPM and maintain it for 5 seconds.
5. Decrease the engine speed to 2000 RPM and maintain it for 10 minutes.
6. Switch the engine off.
7. Check the cooling system for leaks.
8. Allow the engine to cool.
9. Fill the coolant expansion tank level to the MAX mark.

GENERAL PROCEDURES

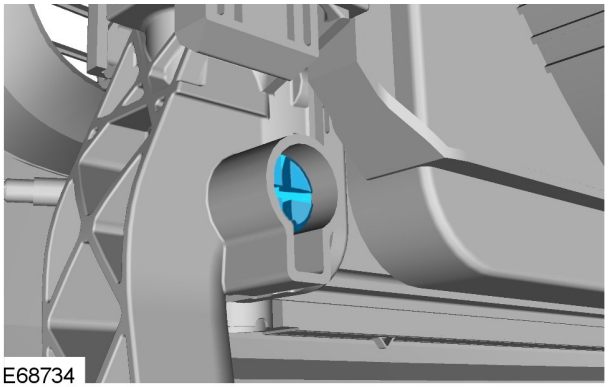
Cooling System Draining, Filling and Bleeding — 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater

Draining

WARNING:When releasing the cooling system pressure, cover the coolant expansion tank cap with a thick cloth.

1. Release the cooling system pressure by slowly turning the coolant expansion tank cap between 2 and 3 turns.
2. Raise and support the vehicle.

   Refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).
3. Allow the coolant to drain into a suitable container.



4. Install the radiator drain plug.
5. Lower the vehicle.

Filling and Bleeding

1. Fill the coolant expansion tank coolant level to 15 mm over the MAX mark.
2. Install the coolant expansion tank cap.
3. Start and run the engine at 2000 RPM and maintain it for 20 minutes.
4. Increase the engine speed to 4000 RPM and maintain it for 5 seconds.
5. Decrease the engine speed to 2000 RPM and maintain it for 10 minutes.
6. Switch the engine off.
7. Check the cooling system for leaks.
8. Allow the engine to cool.
9. Fill the coolant expansion tank level to the MAX mark.

REMOVAL AND INSTALLATION

Thermostat — 2.4L Duratorq-TDCi (Puma) Diesel

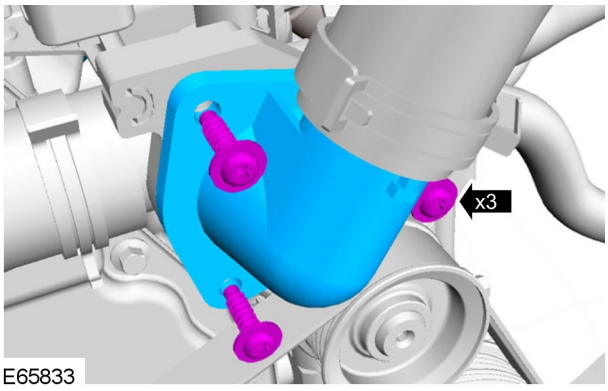
Removal

NOTE: Removal steps in this procedure may contain installation details.

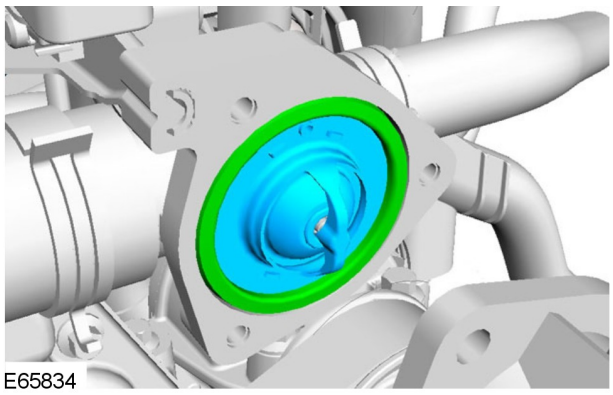
1. Drain the cooling system.

   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

2. Torque: 10 Nm



3.



Installation

1. To install, reverse the removal procedure.

2. Bleed the cooling system. For additional information, refer to

   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

REMOVAL AND INSTALLATION

Thermostat Housing — 2.4L Duratorq-TDCi (Puma) Diesel

General Equipment
Cable ties

General Equipment
Coolant hose clamp remover/installer

Removal

NOTE: Removal steps in this procedure may contain installation details.

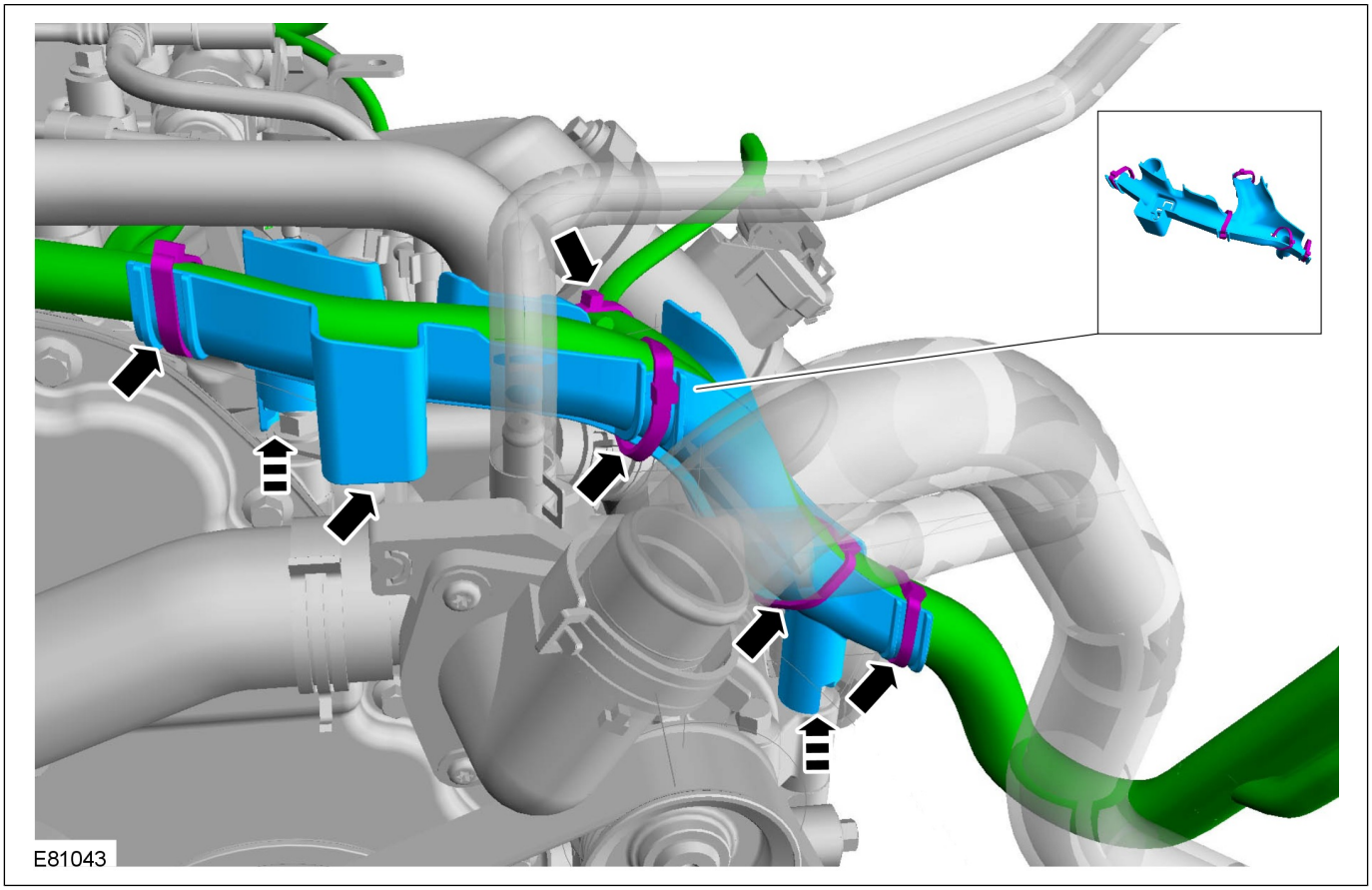
1. Drain the cooling system.

   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

2. **NOTE:**Make sure that a new component is installed.

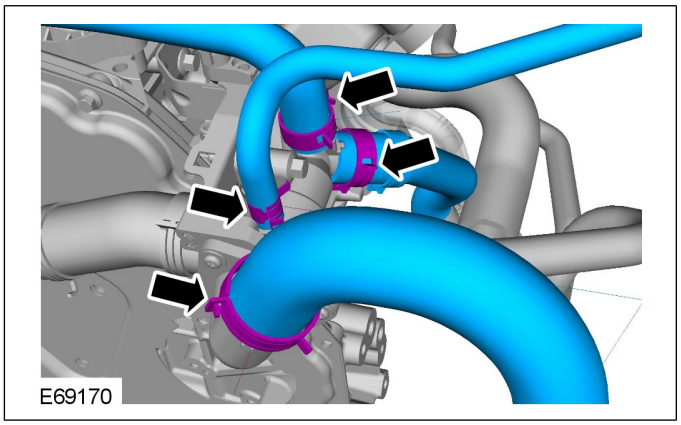
   Discard the wiring harness support bracket.

   General Equipment: Cable ties

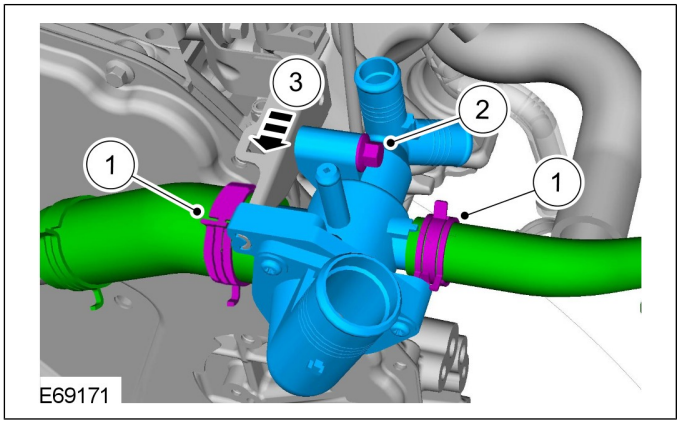


REMOVAL AND INSTALLATION

3. General Equipment: Coolant hose clamp remover/installer



4. 1. General Equipment: Coolant hose clamp remover/installer
   2. Torque: 23 Nm



Installation

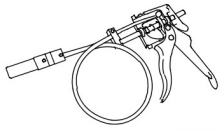
1. To install, reverse the removal procedure.
2. Bleed the cooling system.

   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

REMOVAL AND INSTALLATION

Coolant Pump — 2.4L Duratorq-TDCi (Puma) Diesel(24 404 0)

Special Tool(s)

 24003	Remover/Installer, Cooling Hose Clamp 303-397 (24-003)

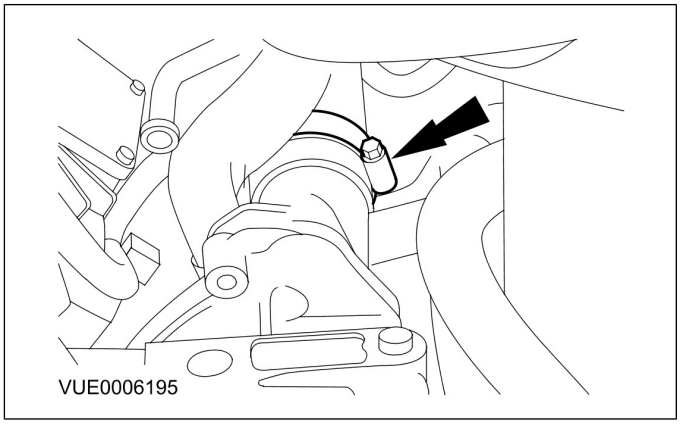
Removal

1. **Drain the cooling system.**

   For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

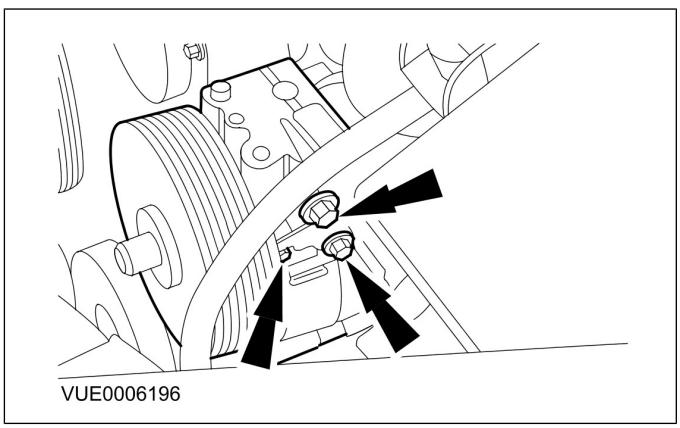
2. **Remove the brake vacuum pump. For additional information, refer to Section 206-07 [Power Brake Actuation].**

3. **Disconnect the coolant hose from the water pump.**

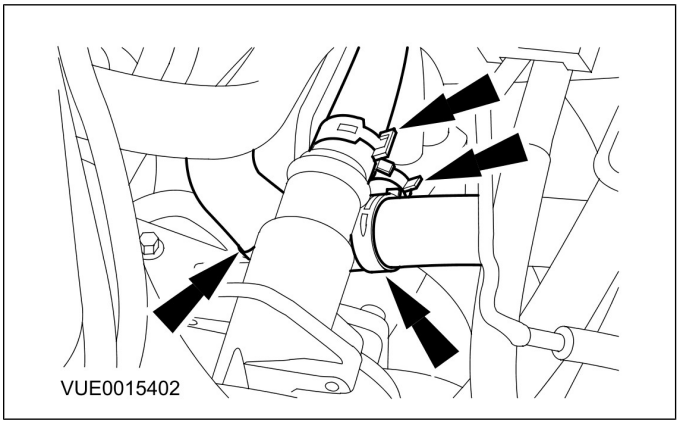

VUE0006195

4. **NOTE:The water pump is located on dowels.**

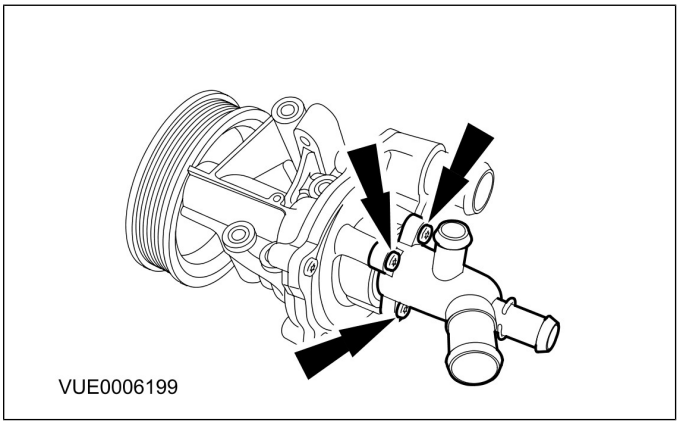
   Detach the water pump from the engine.


VUE0006196

5. **Disconnect the coolant hoses and remove the water pump.**
   - Discard the gasket.


VUE0015402

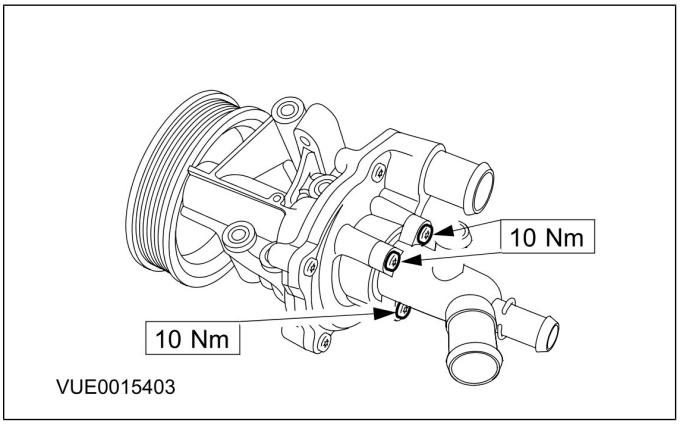
6. **Remove the coolant pipe from the water pump.**
   - Discard the O-ring seal.


VUE0006199

Installation

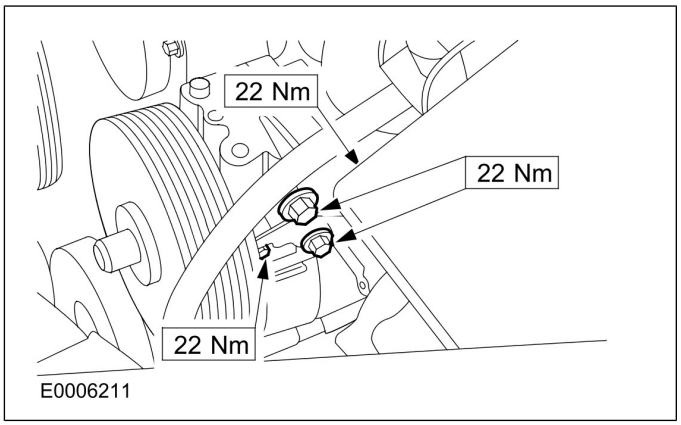
1. **NOTE:Install a new coolant pipe O-ring seal and a new water pump gasket.**

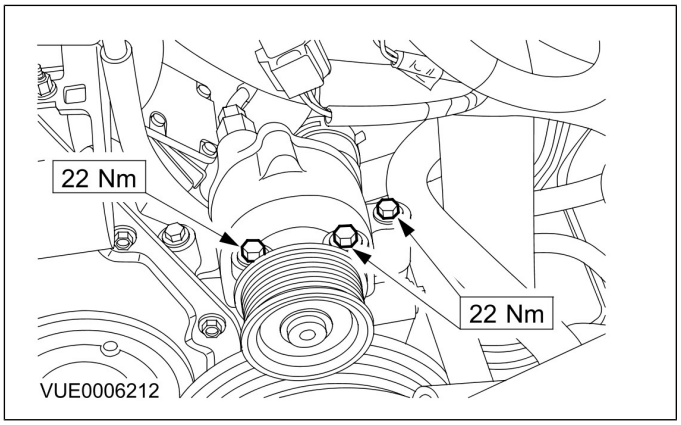
   To install, reverse the removal procedure.



VUE0015403

REMOVAL AND INSTALLATION

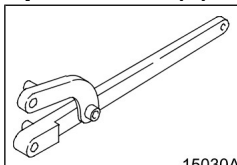




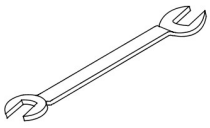
REMOVAL AND INSTALLATION

Cooling Fan — 2.4L Duratorq-TDCi (Puma) Diesel

Special Tool(s)

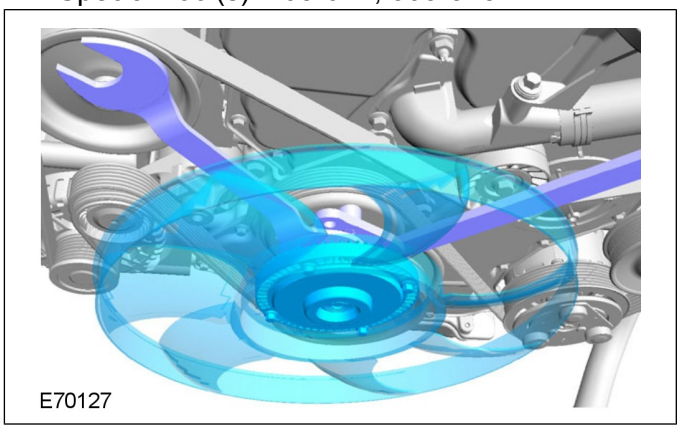
 15030A	Universal Flange Holding Wrench 205-072

Special Tool(s)

 24002	Wrench, Fan Hub 303-378

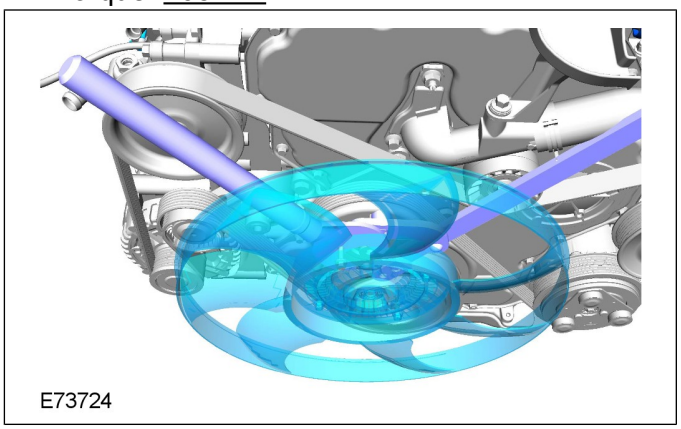
Removal

1. **NOTE:** The component has a right-hand thread.
   Special Tool(s): 205-072, 303-378


E70127

Installation

1. Special Tool(s): 205-072
   Torque: 105 Nm


E73724

REMOVAL AND INSTALLATION

Coolant Pump — 2.3L Duratec-HE (MI4)

Materials	
Name	**Specification**
Grease	ESE-M99B144-A

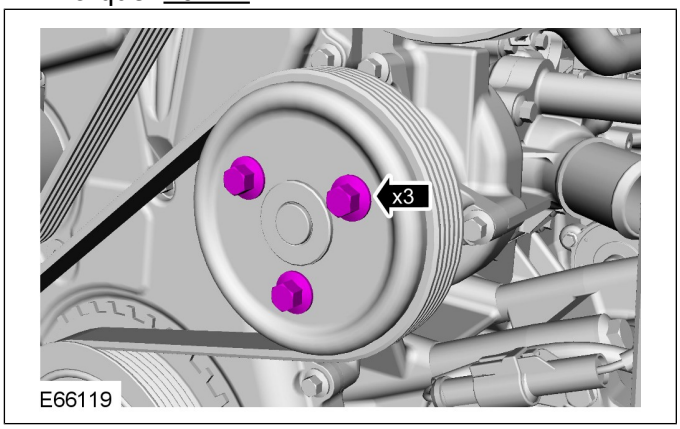
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Drain the cooling system.

   Refer to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

2. Loosen the coolant pump pulley bolts.
   Torque: 20 Nm

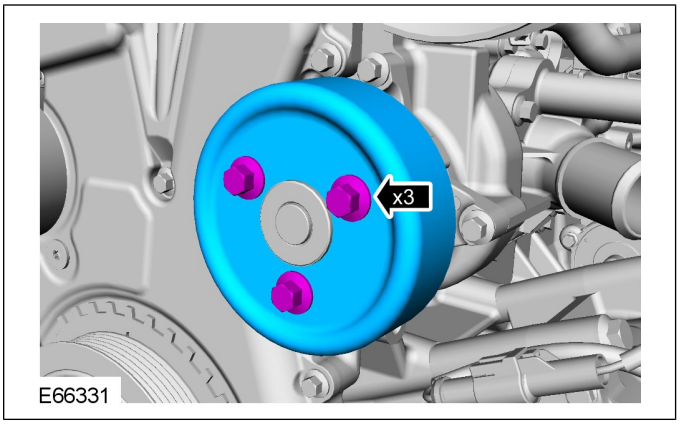


3. Remove the accessory drive belt.

   Refer to: Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

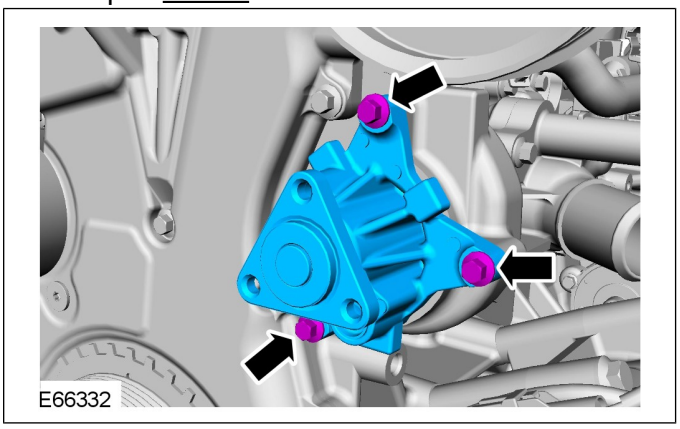
4. Lower the vehicle.

5.



6. **NOTE:**The O-ring seal is to be reused unless damaged

   Material: Grease
   Torque: 10 Nm



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Thermostat — 2.3L Duratec-HE (MI4)

General Equipment

Coolant hose clamp remover/installer

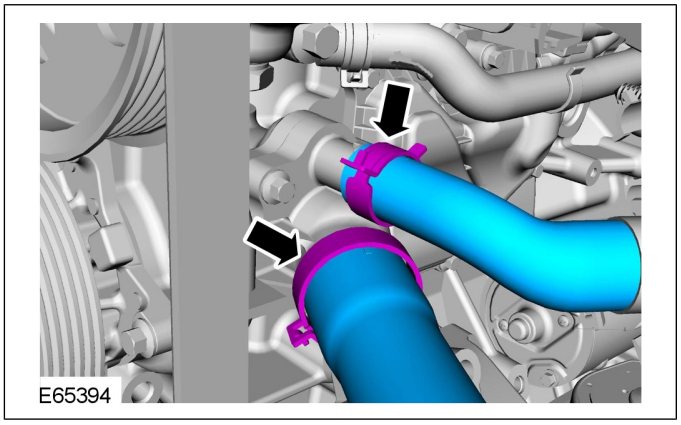
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Drain the cooling system.

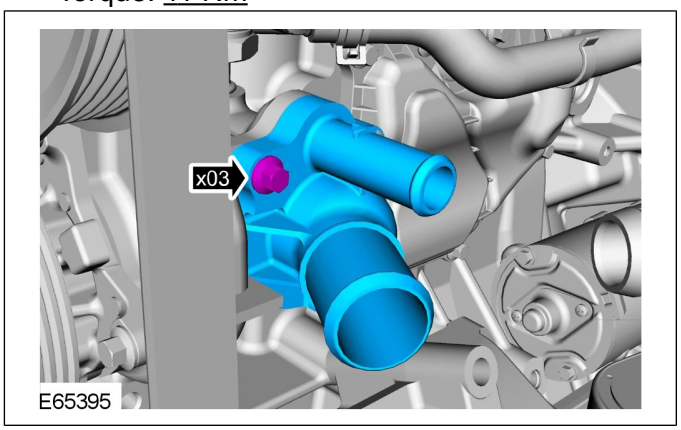
   Refer to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

2. General Equipment: Coolant hose clamp remover/installer



3. **NOTE:**The O-ring seal is to be reused unless damaged

   Torque: 11 Nm



Installation

1. Make sure that the sealing faces of the engine block and the thermostat housing are free from oil and foreign material.
2. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Coolant Outlet Connector — 2.3L Duratec-HE (MI4)

Materials	
Name	**Specification**
Grease	ESE-M99B144-A

General Equipment

Coolant hose clamp remover/installer

Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Drain the cooling system.

   Refer to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

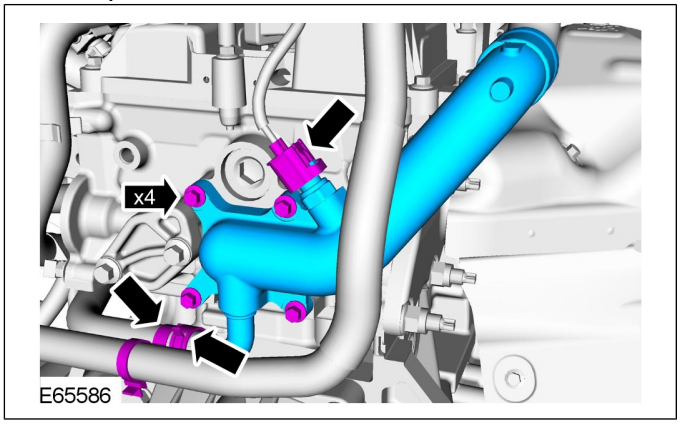
2. Raise and support the vehicle.

   Refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

3. **NOTE:**Make sure that these components are installed to the noted removal position.

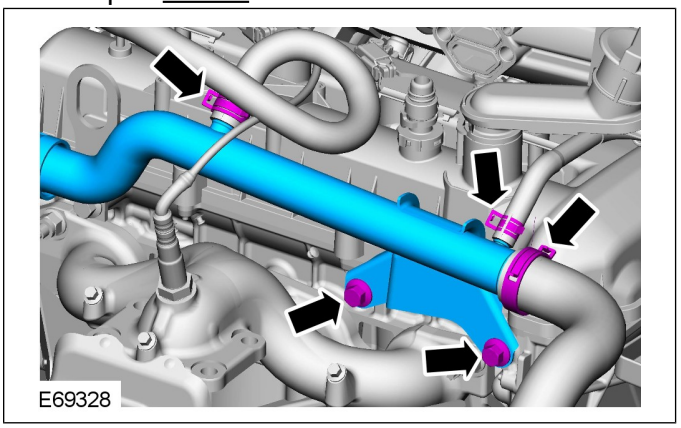
   NOTE: The gasket is to be reused unless damaged.

   Torque: 10 Nm

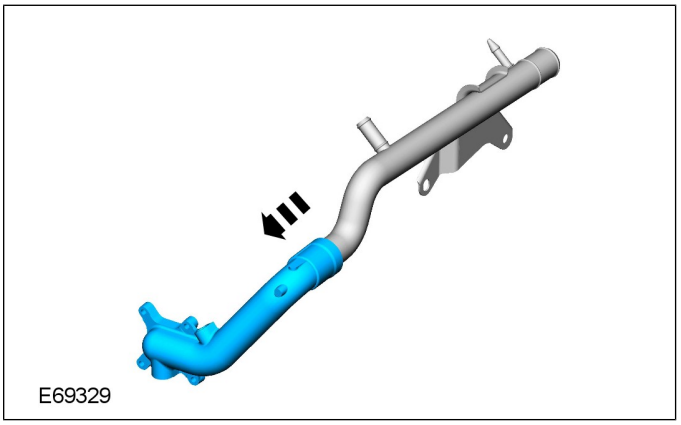


4. Lower the vehicle.

5. General Equipment: Coolant hose clamp remover/installer
   Torque: 32 Nm



6.

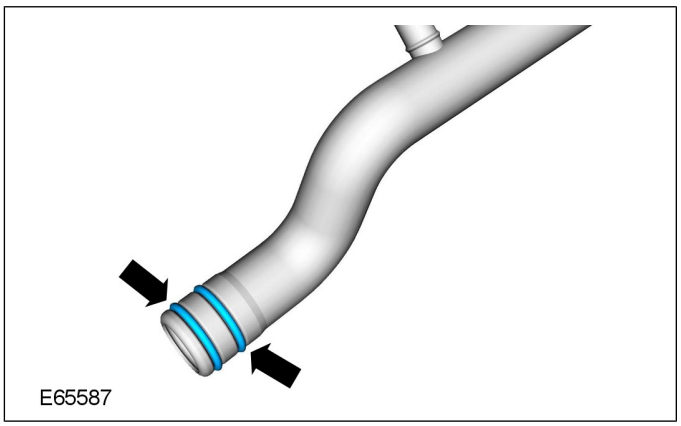


7. **NOTE:**Make sure that the mating faces are clean and free of foreign material.

REMOVAL AND INSTALLATION

NOTE: The O-ring seals are to be reused unless damaged.

Material: Grease



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Radiator

General Equipment

Coolant hose clamp remover/installer

Removal

All vehicles

WARNING:

Refer to: Engine Cooling System Health and Safety Precautions (100-00 General Information, Description and Operation).

NOTE: Removal steps in this procedure may contain installation details.

1. Drain the cooling system.

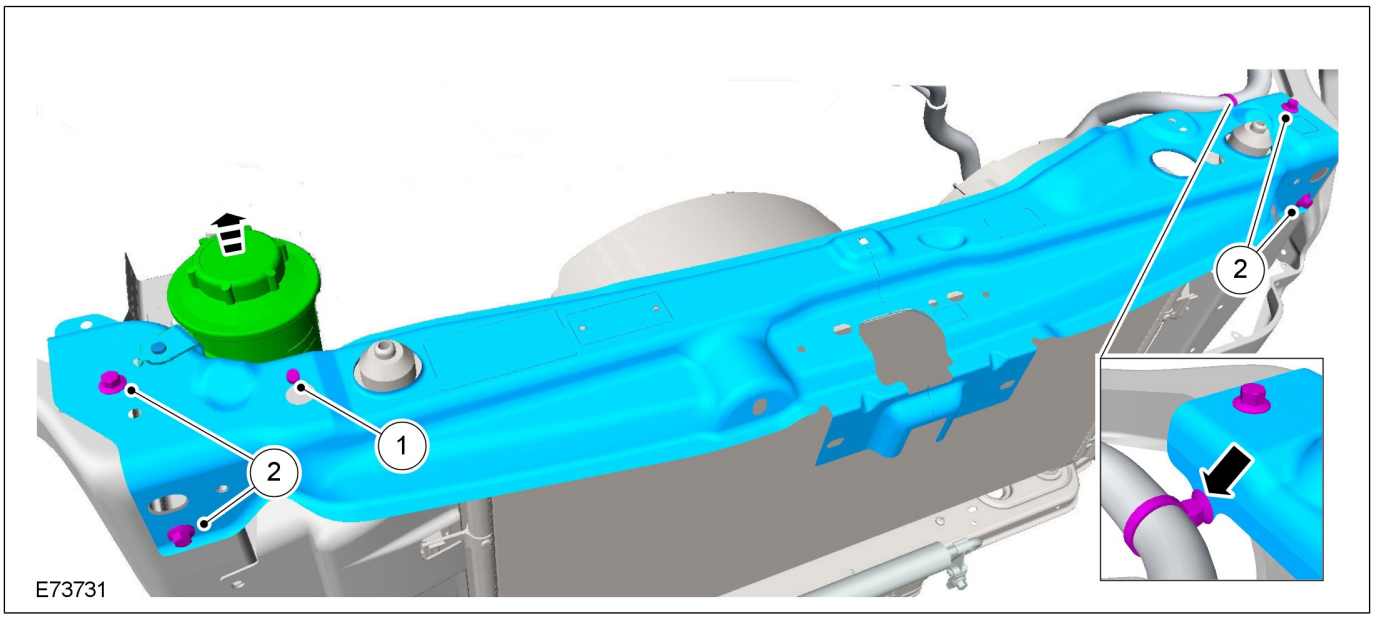
   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to: Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

2. Remove the front bumper.

   Refer to: Front Bumper (501-19 Bumpers, Removal and Installation).

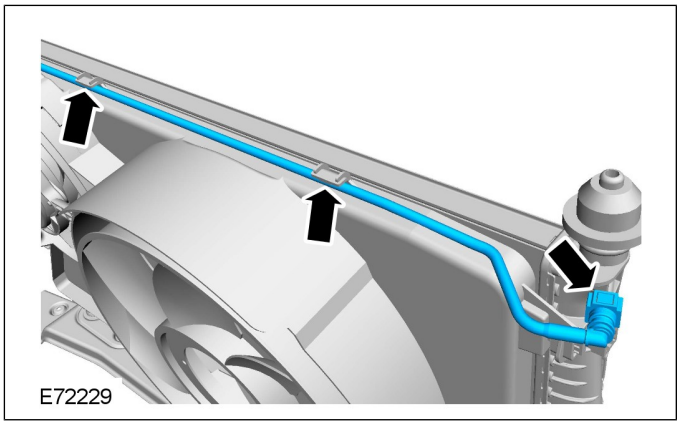
3. 1. Support the hood in the open position using a suitable length of wood.

4. 2. Torque: 25 Nm

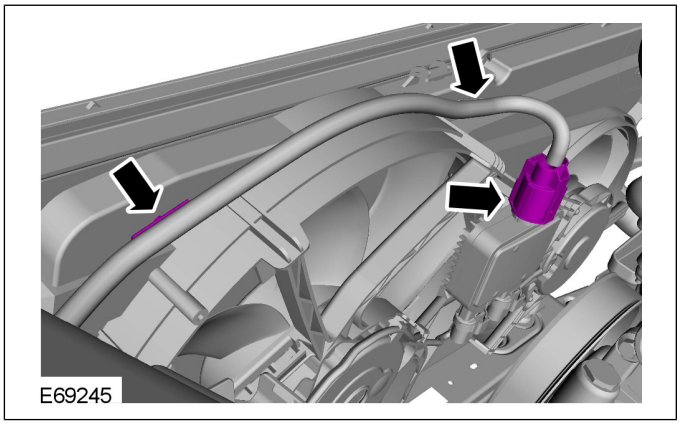


REMOVAL AND INSTALLATION

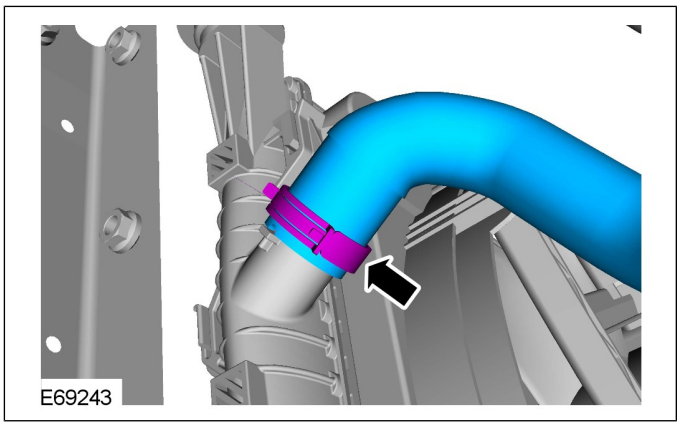
5.



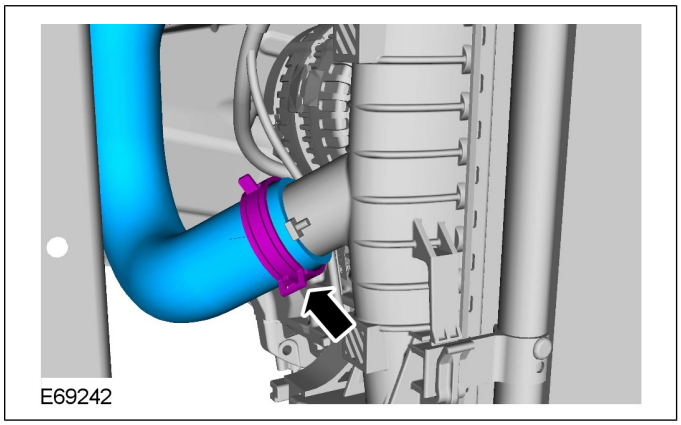
6.



7. General Equipment: Coolant hose clamp remover/installer

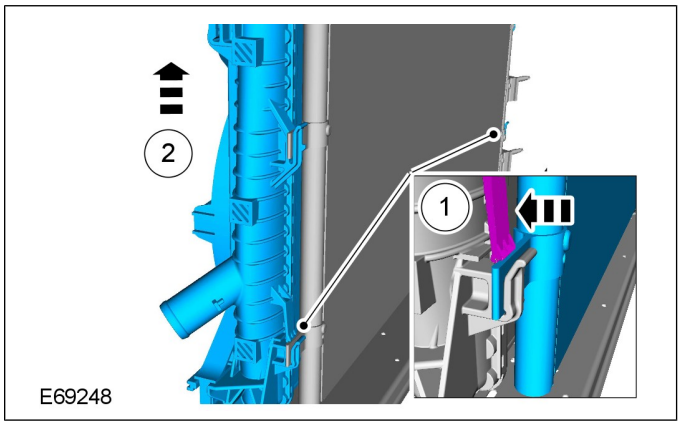


8. General Equipment: Coolant hose clamp remover/installer



Vehicles with air conditioning

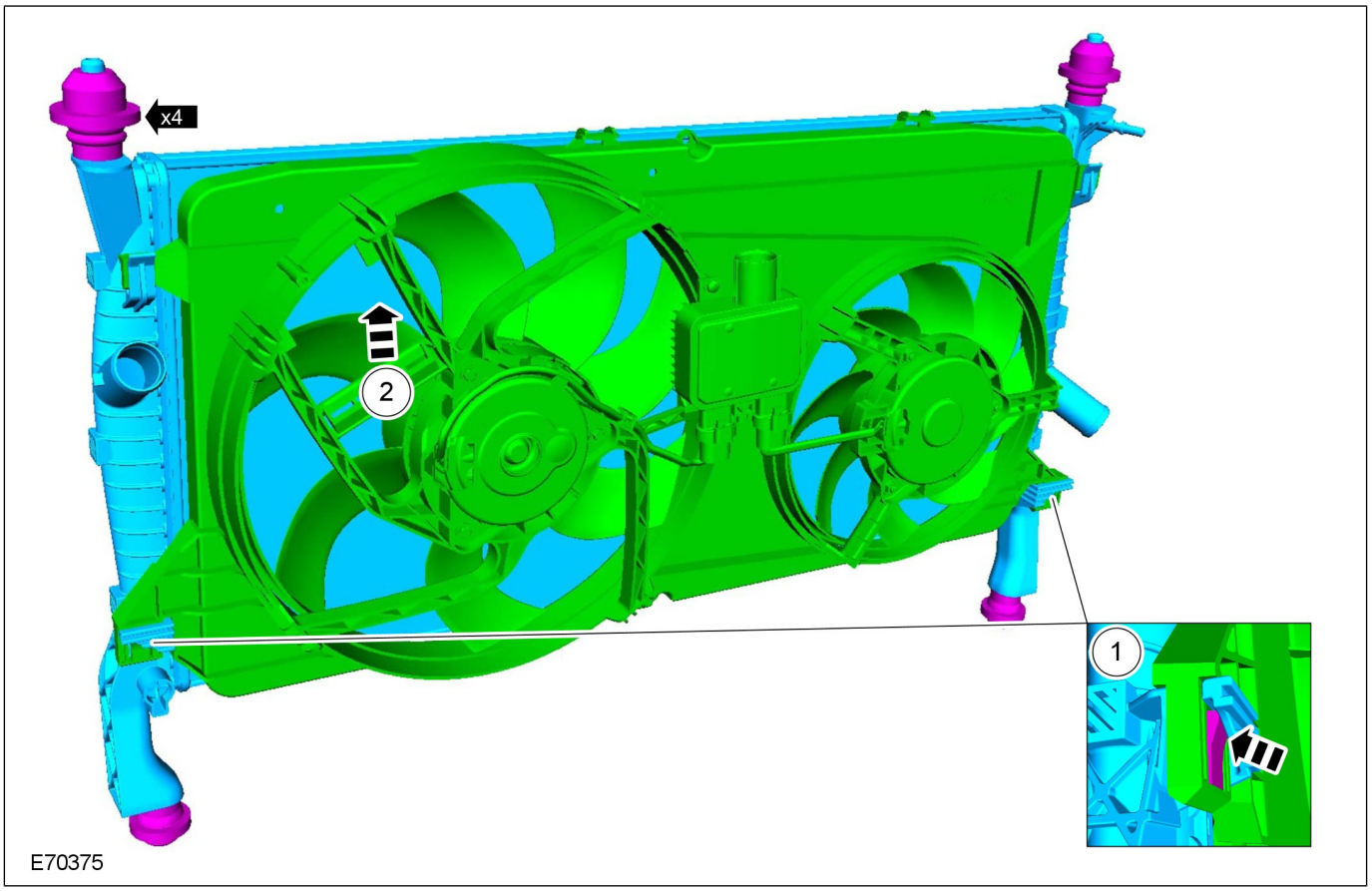
9. Secure the air conditioning (A/C) condensor to one side.



All vehicles

10.

REMOVAL AND INSTALLATION



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Cooling Fan Motor and Shroud

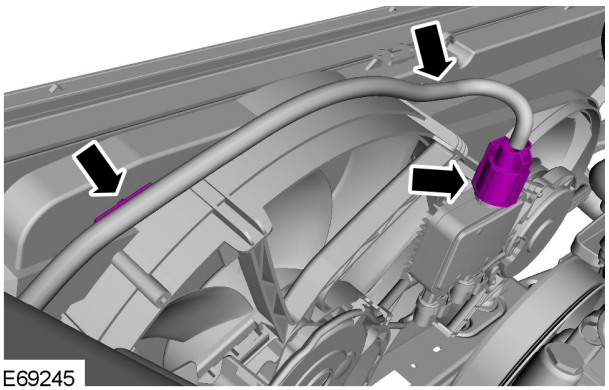
Removal

NOTE: Removal steps in this procedure may contain installation details.

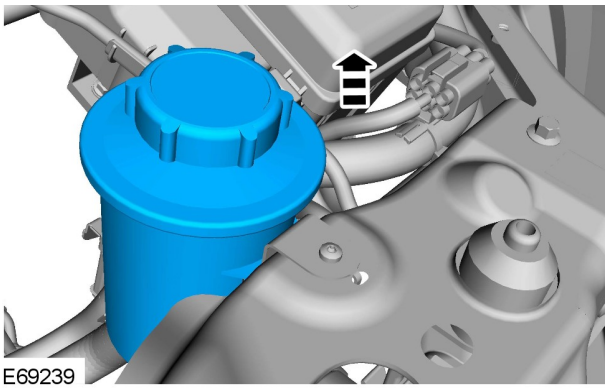
1. Remove the front bumper.

   Refer to: Front Bumper (501-19 Bumpers, Removal and Installation).

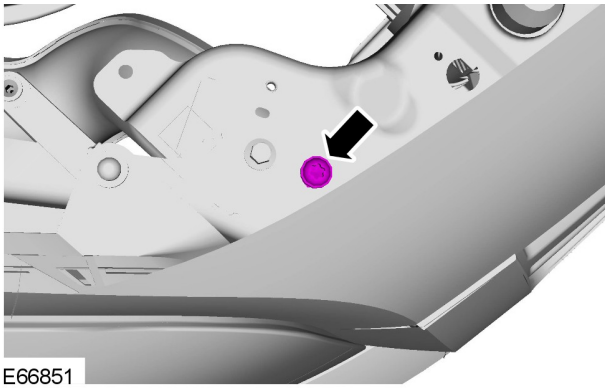
2.



3.

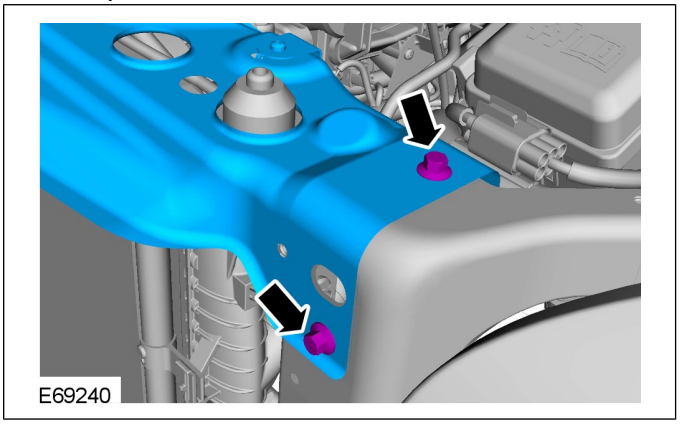


4.

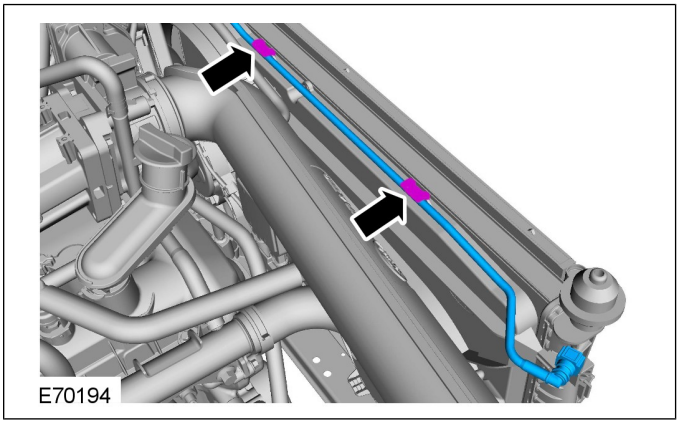


5. Support the hood in the open position using a suitable length of wood.

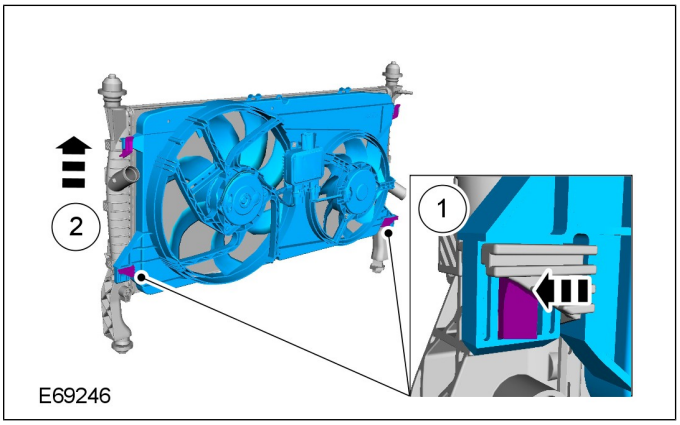
6. On both sides.
   Torque: 25 Nm



7.



8.



Installation

1. To install, reverse the removal procedure.

SECTION 303-04A Fuel Charging and Controls — 2.3L Duratec-HE (MI4)

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 303-04A-2

DESCRIPTION AND OPERATION

Fuel Charging and Controls 303-04A-3

DIAGNOSIS AND TESTING

Fuel Charging and Controls 303-04A-5
Inspection and Verification 303-04A-5
Symptom Chart 303-04A-5

REMOVAL AND INSTALLATION

Fuel Rail 303-04A-18
Throttle Body 303-04A-19

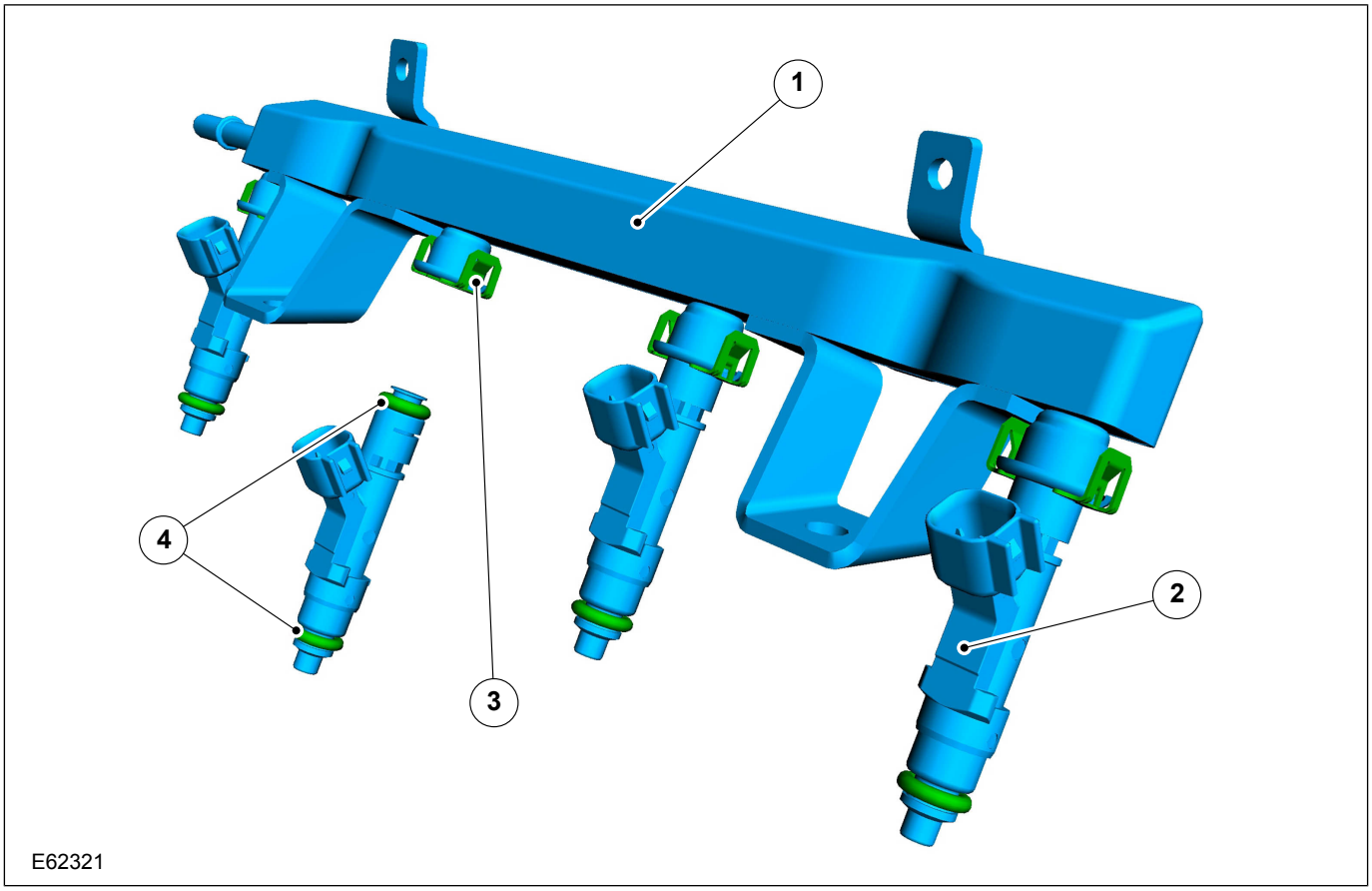
SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Accelerator cable retaining bracket bolts	10	–	89
Throttle body retaining bolts	10	–	89
Fuel injection supply manifold retaining bolts	23	17	–
Fuel injector retaining bolts	6	–	53
Fuel pressure regulator retaining bolts	6	–	53

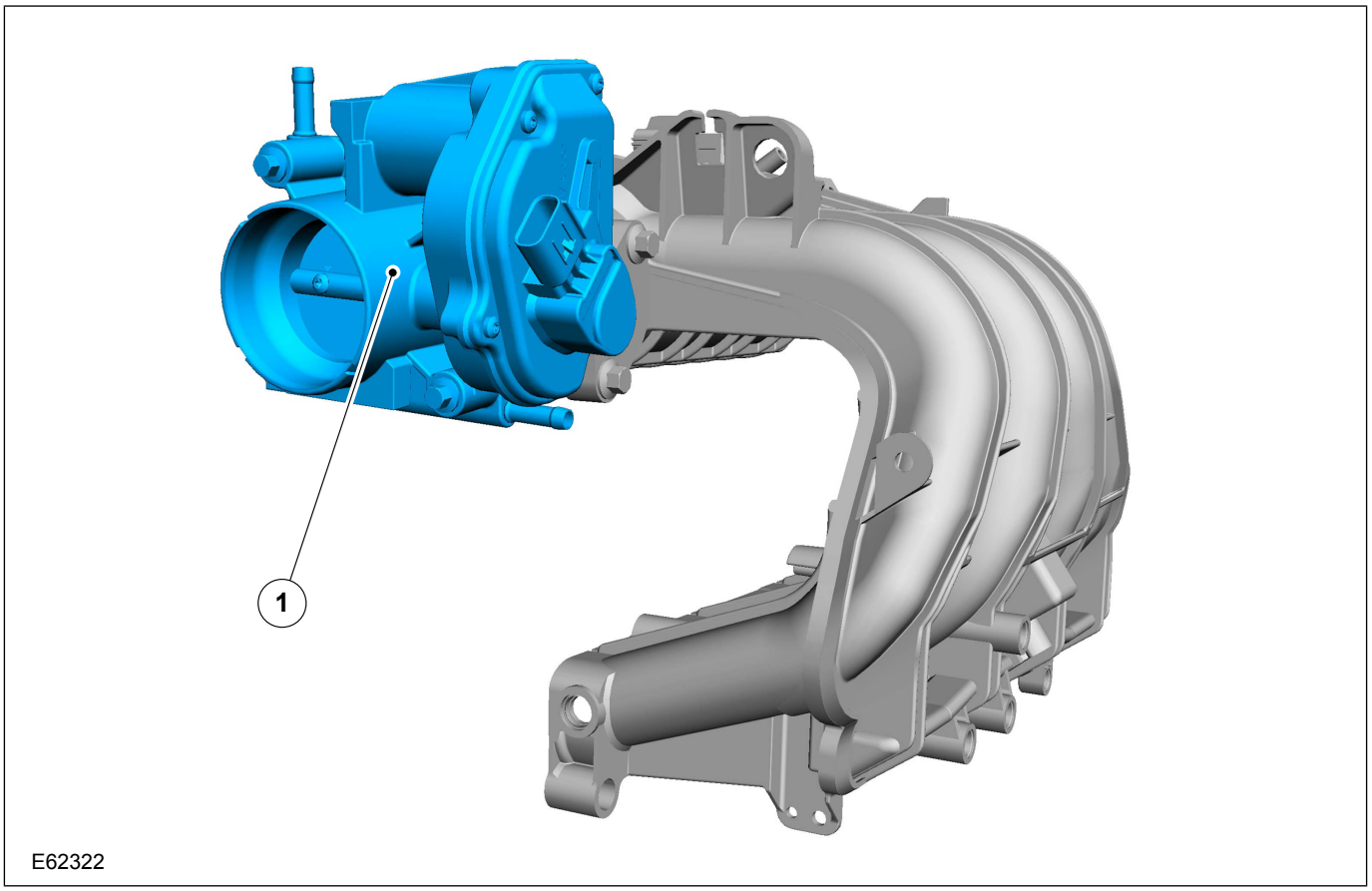
DESCRIPTION AND OPERATION

Fuel Charging and Controls



Item	Part Number	Description
1		Fuel rail
2		Fuel injector
3		Fuel injector retaining clip
4	-	Fuel injector O-ring seals

DESCRIPTION AND OPERATION



Item	Description
1	Throttle body

Throttle Body

The throttle plate position is controlled by a signal from the powertrain control module (PCM) which receives an input from the accelerator pedal position (APP) sensor. The system is fully electronic and does not use any cables. The signal from the PCM is used to control a DC motor within the throttle body which is connected to the throttle plate through gears. The throttle body also gives inputs back to the PCM. This information allows the PCM to compensate for factors such as carbon build up within the throttle body and throttle body wear. The throttle body also provides information to the PCM to enable the flagging of a diagnostic trouble code (DTC).

DIAGNOSIS AND TESTING

Fuel Charging and Controls

General Equipment

Worldwide Diagnostic System (WDS)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Fuel leak(s) – Vacuum line(s) – Gasket(s) – Seal(s) – Fuel injector(s) – Throttle body – Fuel rail – Fuel supply line	– Powertrain control module (PCM) – Wiring harness – Electrical connector(s) – Throttle body – Fuel injector(s)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• Engine does not crank	• Passive anti-theft system (PATS)	• CHECK the PATS LED extinguishes within 3 seconds when the ignition is turned on. REFER to:Anti-Theft - Passive (419-01 Anti-Theft - Passive, Diagnosis and Testing).
	• Starting system.	• REFER to:Starting System (303-06 Starting System, Diagnosis and Testing).
	• Ignition switch.	• REFER to the Wiring Diagrams.
	• Powertrain control module (PCM).	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
• Engine cranks but does not start	• Inertia fuel shutoff (IFS) switch.	• RESET the IFS switch.
	• Low fuel system pressure.	• CHECK the fuel system pressure. REFER to:Fuel System Pressure Check - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Fuel lines damaged or blocked.	• INSPECT the fuel lines. INSTALL new components as necessary. TEST the system for normal operation.
	• Fuel filter blocked.	• INSTALL a new fuel filter. REFER to:Fuel Filter - 2.3L Duratec-HE (MI4) (310-01 Fuel Tank and Lines, Removal and Installation).
	• Fuel pump module.	• REMOVE and INSPECT the fuel pump module.
	• Crankshaft position (CKP) sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Camshaft position (CMP) sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• PCM.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Fuel injectors.	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.
	• Incorrect valve timing.	• CHECK the valve timing.
	• Low cylinder compression.	• TEST the cylinder compression.
• Poor starting	• Low fuel system pressure.	• CHECK the fuel system pressure. REFER to:Fuel System Pressure Check - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).
	• Fuel system leak.	• CHECK the system for fuel leak(s). REPAIR the system as necessary.
	• Fuel system restriction.	• INSPECT the fuel system. INSTALL new components as necessary. TEST the system for normal operation.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Fuel filter blocked.	• INSTALL a new fuel filter. REFER to:Fuel Filter - 2.3L Duratec-HE (MI4) (310-01 Fuel Tank and Lines, Removal and Installation).
	• Air cleaner element blocked.	• INSTALL a new air cleaner element.
	• Incorrect engine oil.	• INSTALL a new engine oil filter and engine oil.
	• Incorrect power steering fluid.	• DRAIN and REFILL the power steering system with the correct fluid. REFER to:Power Steering System Filling (211-00 Steering System - General Information, General Procedures) / Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).
	• CKP sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Engine coolant temperature (ECT) sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Fuel injector(s).	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.
	• Catalytic converter blocked.	• REMOVE and visually INSPECT the catalytic converter as necessary. REFER to:Catalytic Converter - 2.3L Duratec-HE (MI4) (309-00 Exhaust System, Removal and Installation).
	• Low cylinder compression.	• TEST the engine cylinder compression.
• Engine starts but immediately stops	• Air cleaner element blocked.	• INSTALL a new air cleaner element.
	• CKP sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• CMP sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• PCM.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Low fuel system pressure.	• CHECK the fuel system pressure. REFER to:Fuel System Pressure Check - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).
	• Fuel system restriction.	• INSPECT the fuel system. INSTALL new components as necessary. TEST the system for normal operation.
	• Fuel filter blocked.	• INSTALL a new fuel filter. REFER to:Fuel Filter - 2.3L Duratec-HE (MI4) (310-01 Fuel Tank and Lines, Removal and Installation).
• Poor idling	• Air cleaner element blocked.	• INSTALL a new air cleaner element.
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean gasoline. INSTALL a new fuel filter. • INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out. • INSTALL a new fuel rail.
	• Low fuel system pressure.	• Check the fuel system pressure. REFER to:Fuel System Pressure Check - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Fuel filter blocked.	• INSTALL a new fuel filter. REFER to:Fuel Filter - 2.3L Duratec-HE (MI4) (310-01 Fuel Tank and Lines, Removal and Installation).
	• Fuel injectors.	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.
	• CKP sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Knock sensor (KS).	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
• Engine stumbling	• Engine ignition.	• REFER to:Engine Ignition (303-07 Engine Ignition - 2.3L Duratec-HE (MI4), Diagnosis and Testing).
	• Fuel injectors.	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.
	• Low fuel system pressure.	• Check the fuel system pressure. REFER to:Fuel System Pressure Check - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).
• Engine lacks power	• Engine ignition.	• REFER to:Engine Ignition (303-07 Engine Ignition - 2.3L Duratec-HE (MI4), Diagnosis and Testing).
	• Brakes binding.	• CHECK the braking system. REFER to:Brake System - Vehicles Built Up To: 04/2006 (206-00 Brake System - General Information, Diagnosis and Testing).
	• Vehicle overloaded, or excessive wind resistance (roof racks, towing etc).	• ADVISE the customer about the effects of overloading the vehicle and wind resistance on the fuel consumption.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Air cleaner element blocked.	• INSTALL a new air cleaner element as necessary.
	• Low fuel system pressure.	• Check the fuel system pressure. REFER to:Fuel System Pressure Check - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).
	• Kinked or restricted fuel lines.	• INSPECT the fuel lines. INSTALL new components as necessary. TEST the system for normal operation.
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean gasoline. INSTALL a new fuel filter. • INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out. • INSTALL a new fuel rail.
	• Fuel filter blocked.	• INSTALL a new fuel filter. REFER to:Fuel Filter - 2.3L Duratec-HE (MI4) (310-01 Fuel Tank and Lines, Removal and Installation).
	• Vehicle speed sensor (VSS).	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• ECT sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Fuel injectors.	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.
	• Incorrect valve timing.	• CHECK the valve timing.
	• Low cylinder compression.	• CHECK the cylinder compression.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Catalytic converter blocked.	• REMOVE and visually INSPECT the catalytic converter for damage. INSTALL a new catalytic converter as necessary. REFER to:Catalytic Converter - 2.3L Duratec-HE (MI4) (309-00 Exhaust System, Removal and Installation).
• Black smoke at idle	• Air cleaner element blocked.	• INSTALL a new air cleaner element as necessary.
	• Fuel injectors.	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.
	• ECT sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Catalytic converter blocked.	• REMOVE and visually INSPECT the catalytic converter for damage. INSTALL a new catalytic converter as necessary. REFER to:Catalytic Converter - 2.3L Duratec-HE (MI4) (309-00 Exhaust System, Removal and Installation).
	• Incorrect valve timing.	• CHECK the valve timing.
• Excessive black smoke during acceleration	• Air cleaner element blocked.	• INSTALL a new air cleaner element as necessary.
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean gasoline. INSTALL a new fuel filter. • INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out. • INSTALL a new fuel rail.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• CKP sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• KS.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Fuel injectors.	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.
	• Catalytic converter blocked.	• REMOVE and visually INSPECT the catalytic converter for damage. INSTALL a new catalytic converter as necessary. REFER to:Catalytic Converter - 2.3L Duratec-HE (MI4) (309-00 Exhaust System, Removal and Installation).
• Black smoke at cruising speeds	• Air cleaner element blocked.	• INSTALL a new air cleaner element.
	• ECT sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Fuel injectors.	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.
	• Catalytic converter blocked.	• REMOVE and visually INSPECT the catalytic converter for damage. INSTALL a new catalytic converter as necessary. REFER to:Catalytic Converter - 2.3L Duratec-HE (MI4) (309-00 Exhaust System, Removal and Installation).
• Blue smoke	• Engine burning oil.	• CARRY OUT a controlled oil consumption test over 1000 km (600 miles). CONFIRM that the oil consumption is less than 0.1 litre per 1000 km (600 miles).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean gasoline. INSTALL a new fuel filter. • INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out. • INSTALL a new fuel rail.
	• Positive crankcase ventilation (PCV) system.	• INSPECT for visible signs of damage or blockage. CLEAN, REPAIR or INSTALL new parts as necessary.
	• Worn or damaged valve guide(s), piston ring(s), cylinder bore(s), cylinder head or gasket.	• REMOVE the cylinder head. INSPECT the cylinder head, pistons and cylinder bores for signs of wear or damage.
• White smoke	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean gasoline. INSTALL a new fuel filter. • INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out. • INSTALL a new fuel injection supply manifold.
	• Coolant in the combustion chamber.	• CARRY OUT a cooling system pressure test. REMOVE the cylinder head. INSPECT the cylinder head, cylinder head gasket and cylinder bores for wear or damage.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Engine misfire	• Engine ignition.	• REFER to:Engine Ignition (303-07 Engine Ignition - 2.3L Duratec-HE (MI4), Diagnosis and Testing).
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean gasoline. INSTALL a new fuel filter. • INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out. • INSTALL a new fuel rail.
	• Low fuel system pressure.	• Check the fuel system pressure. REFER to:Fuel System Pressure Check - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).
	• Engine operating temperature too high.	• REFER to:Engine Cooling - 2.3L Duratec-HE (MI4) (303-03 Engine Cooling, Diagnosis and Testing).
	• ECT sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• CKP sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• CMP sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• KS.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Fuel injectors.	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Low cylinder compression.	• CHECK the engine compression.
	• Worn or damaged valve(s), tappet(s) or camshaft(s).	• REMOVE the cylinder head. INSPECT the cylinder head, valves, tappets and camshafts for signs of wear or damage.
	• Damaged cylinder head gasket.	• REMOVE the cylinder head. INSPECT the cylinder head gasket and cylinder bores for wear or damage.
• Engine knock at idle	• Low engine oil level.	• CHECK the engine oil level. REFILL as necessary.
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean gasoline. INSTALL a new fuel filter. • INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out. • INSTALL a new fuel rail.
	• KS.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• CKP sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Fuel injector(s).	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.
	• Incorrect valve timing.	• CHECK the valve timing.
	• Excessive carbon build up.	• REMOVE the cylinder head. INSPECT the cylinder head and pistons for signs carbon build up.
	• Worn or damaged oil pump. • Worn or damaged timing chain or sprocket. • Major mechanical engine failure.	• INSPECT the engine components.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Engine knock during acceleration	• KS.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Fuel injectors.	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.
	• Major mechanical engine failure.	• REFER to:Engine (303-00 Engine System - General Information, Diagnosis and Testing).
NOTE: Before proceeding with any of the actions in relation to the possible sources for excessive fuel consumption, a fuel consumption test located in the toolbox menu of the WDS must be carried out • Excessive fuel consumption	• Brakes binding.	• CHECK the braking system. REFER to:Brake System - Vehicles Built Up To: 04/2006 (206-00 Brake System - General Information, Diagnosis and Testing).
	• Vehicle overloaded, or excessive wind resistance (roof racks, towing etc).	• ADVISE the customer about the effects of overloading the vehicle and wind resistance on the fuel consumption.
	• Air cleaner element blocked.	• INSTALL a new air cleaner element.
	• Fuel system leak(s).	• CHECK the system for fuel leak(s). REPAIR or INSTALL new parts as necessary.
	• Fuel filter blocked.	• INSTALL a new fuel filter. REFER to:Fuel Filter - 2.3L Duratec-HE (MI4) (310-01 Fuel Tank and Lines, Removal and Installation).
	• Incorrect engine oil.	• INSTALL a new oil filter and engine oil.
	• Generator.	• REFER to WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Slipping clutch.	• REFER to:Manual Transmission and Clutch - Vehicles With: MT-75 (308-00 Manual Transmission/Transaxle and Clutch - General Information, Diagnosis and Testing) / Manual Transaxle and Clutch - Vehicles With: VXT-75 (308-00 Manual Transmission/Transaxle and Clutch - General Information, Diagnosis and Testing) / Manual Transmission and Clutch - Vehicles With: MT82 (308-00 Manual Transmission/Transaxle and Clutch - General Information, Diagnosis and Testing).
	• ECT sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in WDS.
	• Fuel injectors.	• INSPECT the fuel injectors. CLEAN the fuel injectors or INSTALL a new set of fuel injectors as required only after the checks have been carried out.
	• PCM calibration.	• Using the WDS, CHECK for the availability of a calibration update.
	• Incorrect valve timing.	• CHECK the valve timing.
	• Low cylinder compression.	• CHECK the engine compression.
• Engine cuts out during hard acceleration	• CMP sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• CKP sensor.	• Carry out a full engine diagnosis using the guided diagnostic menu in the WDS.
	• Low fuel system pressure.	• Check the fuel system pressure. REFER to:Fuel System Pressure Check - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).

REMOVAL AND INSTALLATION

Fuel Rail

Removal

WARNING:

Refer to:Health and Safety Precautions (100-00 General Information, Description and Operation).

NOTE: Removal steps in this procedure may contain installation details.

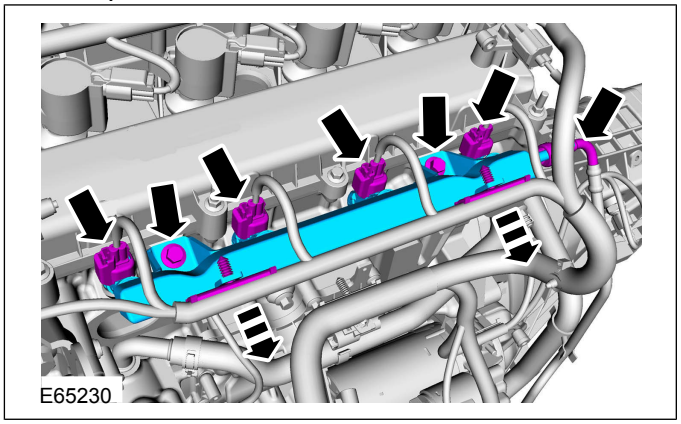
1. Release the fuel system pressure.

   Refer to:Fuel System Pressure Release - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).

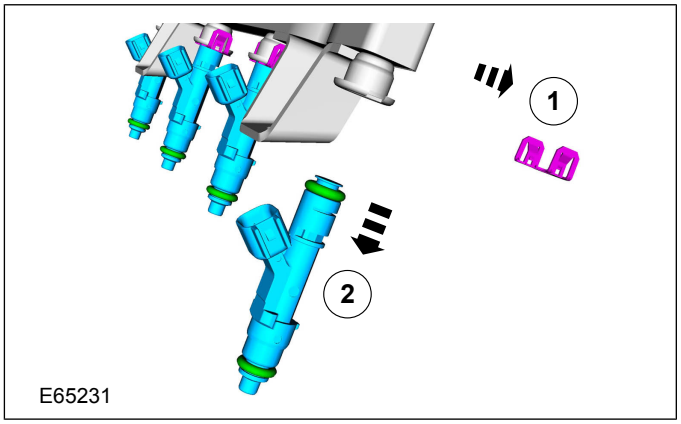
2. Disconnect the battery ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

3. Torque: 26 Nm



4. **NOTE:**The O-ring seals are to be reused unless damaged



Installation

1. Lubricate the O-ring seals with clean engine oil.
2. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Throttle Body

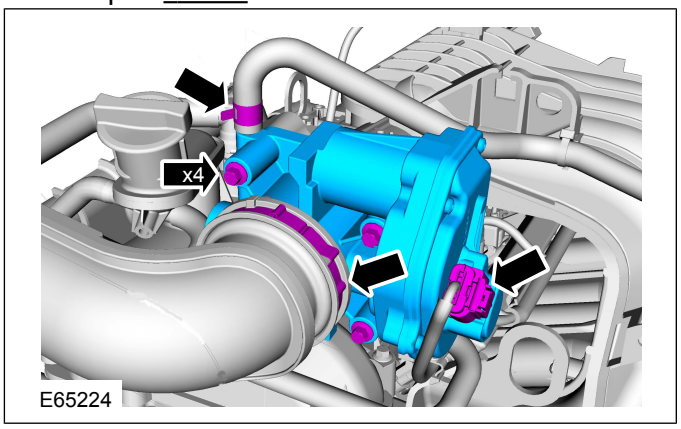
General Equipment

Coolant hose clamp remover/installer

Removal

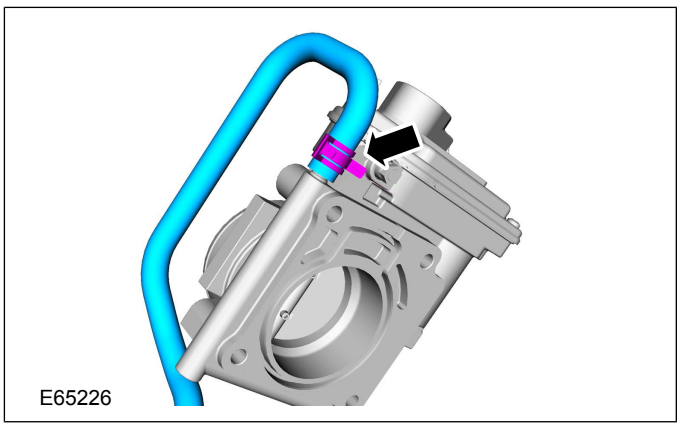
NOTE: Removal steps in this procedure may contain installation details.

1. General Equipment: Coolant hose clamp remover/installer
   Torque: 11 Nm



2. **NOTE:**The O-ring seal is to be reused unless damaged.

   General Equipment: Coolant hose clamp remover/installer



Installation

1. To install, reverse the removal procedure.
2. **NOTE:**Make sure that the pedals remain in the rest position during the initialization.

   Turn the ignition key to position II and wait for one minute to initialize the throttle body.
3. Turn the ignition key to the OFF position.

SECTION 303-04B Fuel Charging and Controls - Turbocharger

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Turbocharger 303-04B-2
2.2L Duratorq-TDCi (Puma) diesel engine 303-04B-2
2.4L Duratorq-TDCi (Puma) diesel engine 303-04B-4

DIAGNOSIS AND TESTING

Turbocharger 303-04B-6
Principles of Operation - Vehicles with fixed vane turbocharger (2.2L Duratorq-TDCi (Puma) Diesel (85 PS/110 PS)/2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS)..... 303-04B-6
Principles of Operation - Vehicles with variable vane turbocharger (2.2L Duratorq-TDCi (Puma) Diesel (130 PS)/2.4L Duratorq-TDCi (Puma) Diesel (140 PS)..... 303-04B-6
Inspection and Verification 303-04B-6
Symptom Chart 303-04B-7
Pinpoint Tests 303-04B-8

REMOVAL AND INSTALLATION

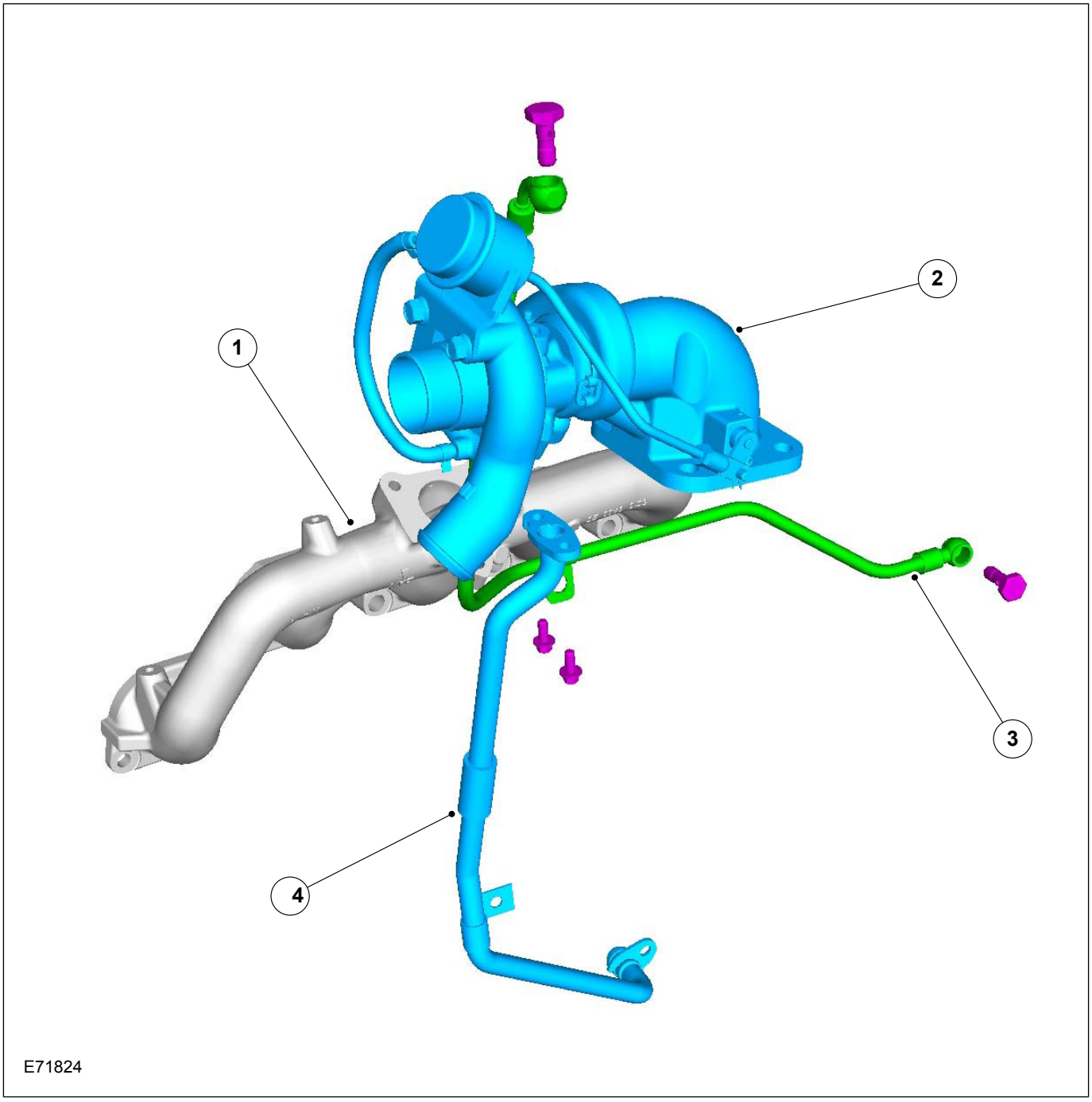
Turbocharger — 2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS) 303-04B-18
Turbocharger — 2.4L Duratorq-TDCi (Puma) Diesel (140 PS) 303-04B-20

DESCRIPTION AND OPERATION

Turbocharger

2.2L Duratorq-TDCi (Puma) diesel engine

Vehicles with 2.2L Duratorq-TDCi (Puma) (85 PS/110 PS) diesel engine

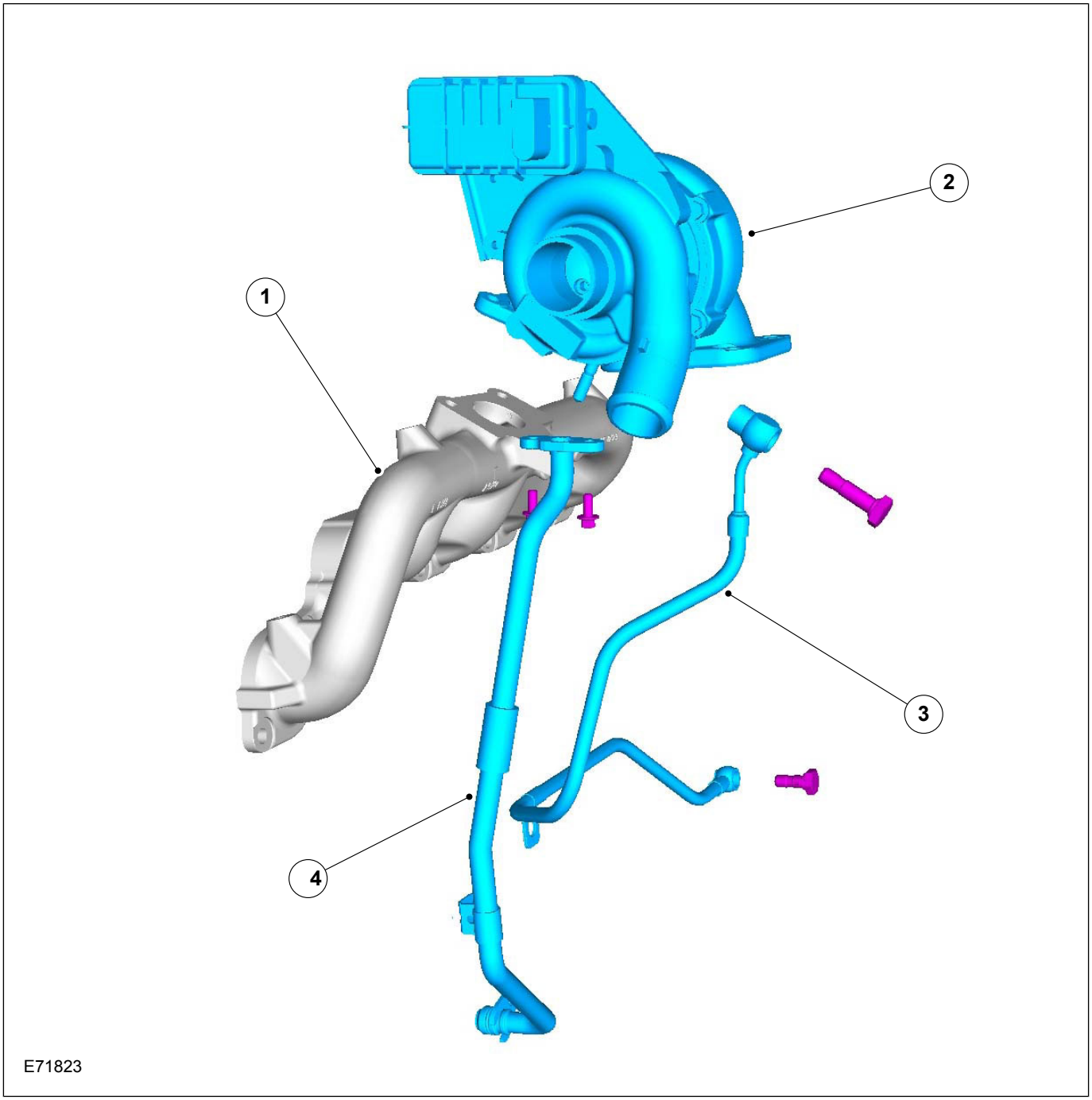


Item	Description
1	Exhaust manifold
2	Turbocharger

Item	Description
3	Oil supply tube
4	Oil drain tube

DESCRIPTION AND OPERATION

Vehicles with 2.2L Duratorq-TDCi (Puma) (130 PS) diesel engine



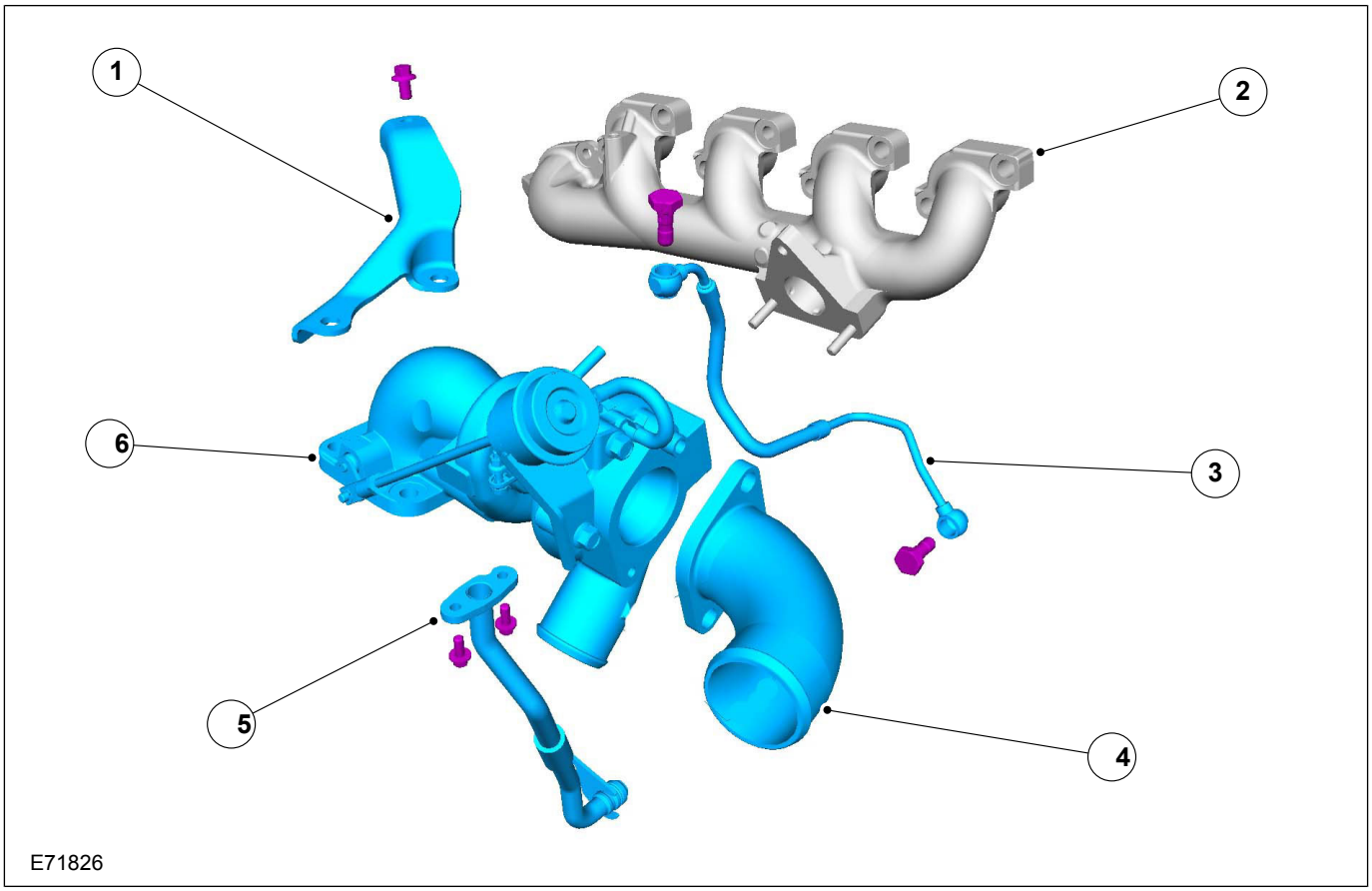
Item	Description
1	Exhaust manifold
2	Turbocharger

Item	Description
3	Oil supply tube
4	Oil drain tube

DESCRIPTION AND OPERATION

2.4L Duratorq-TDCi (Puma) diesel engine

Vehicles with 2.4L Duratorq-TDCi (Puma) (100 PS/115 PS) diesel engine

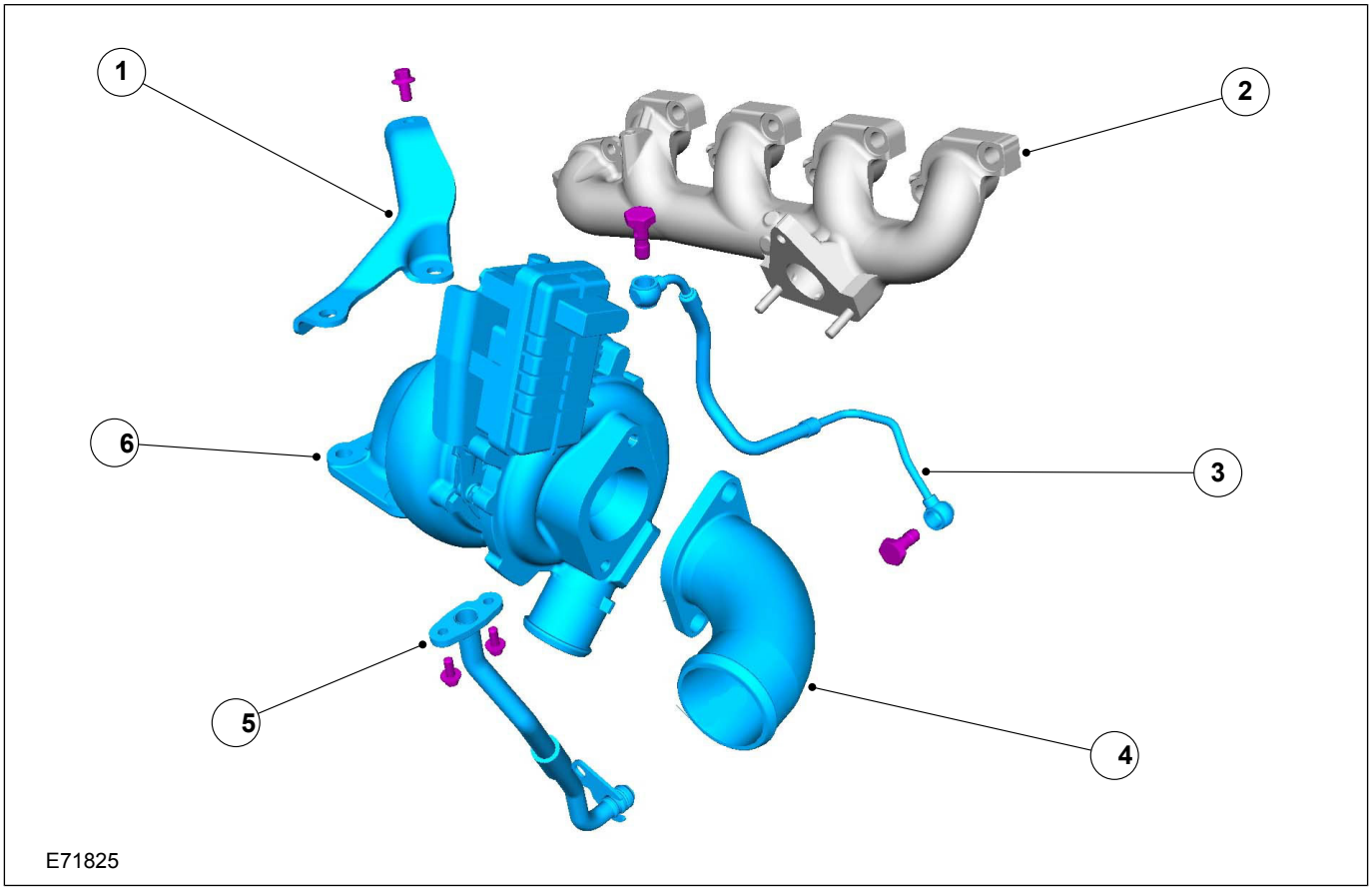


Item	Description
1	Turbocharger to exhaust manifold bracket
2	Exhaust manifold
3	Oil supply tube

Item	Description
4	Charge cooler to turbocharger intake pipe
5	Oil drain tube
6	Turbocharger

DESCRIPTION AND OPERATION

Vehicles with 2.4L Duratorq-TDCi (Puma) (140 PS) diesel engine

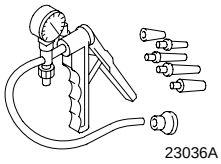


Item	Description
1	Turbocharger to exhaust manifold bracket
2	Exhaust manifold
3	Oil supply tube
4	Charge air cooler to turbocharger intake pipe
5	Oil drain tube
6	Turbocharger

DIAGNOSIS AND TESTING

Turbocharger

Special Tool(s)

 23036A	Hand Vacuum/Pressure Pump 416-D001 (23-036A)

General Equipment

Worldwide Diagnostic System (WDS)

Principles of Operation - Vehicles with fixed vane turbocharger (2.2L Duratorq-TDCi (Puma) Diesel (85 PS/110 PS)/2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS)

The turbocharger is governed by a wastegate control valve. The wastegate control valve redirects some of the exhaust gas past the turbine and therefore acts as a governor. The wastegate control valve is preset during manufacture and must not be tampered with.

Principles of Operation - Vehicles with variable vane turbocharger (2.2L Duratorq-TDCi (Puma) Diesel (130 PS)/2.4L Duratorq-TDCi (Puma) Diesel (140 PS)

The turbocharger is designed to improve engine induction and engine performance. The list below details the concerns relating to turbocharger performance.

- High engine speed produces excessive turbine speed and therefore creates excessive turbocharger boost pressure.
- Low engine speed does not produce sufficient turbine speed and therefore not enough turbocharger boost pressure is achieved.

The variable vane turbocharger does not have a wastegate control valve. Instead, it has variable turbocharger vanes which are located in the turbocharger turbine housing. The turbocharger vanes act as the control for the turbocharger boost pressure.

The variable turbocharger produces its full turbocharger boost pressure over the entire engine speed range, not just at high engine speed. This is achieved through the adjustment of the vanes and the resulting change in the velocity of the exhaust gas.

The speed of flow of the stream of exhaust gas is increased independent of engine speed by varying the intake cross section in front of the turbocharger turbine.

The variable vanes are controlled by the PCM. A duty cycle signal from the powertrain control module (PCM), controls the variable vane electric actuator.

Inspection and Verification

NOTE: The turbocharger uses engine oil as a lubricant and coolant. Due to the high operating temperatures of the turbocharger and with the expansion and contraction of the internal components a proportion of engine oil may enter the air intake system. This is not an indication that the turbocharger oil seal has failed. The turbocharger oil seal will not fail unless the bearings fail first, which will cause the turbocharger to become noisy. Do not install a new turbocharger due to oil inside the turbocharger or the air intake components. If a leak is detected in the supply or return tubes or connections, locate and rectify the source. Do not install a new turbocharger due to an oil leak.

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

DIAGNOSIS AND TESTING

Visual Inspection Chart

Mechanical	Electrical
– Oil leak(s) – Air cleaner element – Air cleaner outlet pipe – Air cleaner intake pipe – Turbocharger oil supply tube – Turbocharger oil return tube – Wastegate control valve - vehicles with fixed vane turbocharger – Turbocharger housing – Charge air cooler – Charger air cooler intake pipe – Charger air cooler outlet pipe	– Wiring harness(es) – Electrical connector(s) – Variable vane electric actuator – PCM

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

CAUTIONS:

The variable vane electric actuator must not be transferred between the old and new turbochargers. Failure to follow this instruction may result in incorrect calibration, exhaust emissions and engine operation.

On vehicles with a fixed vane turbocharger the wastegate control valve and actuator rod are fixed parts of the turbocharger and must not be adjusted or renewed separately.

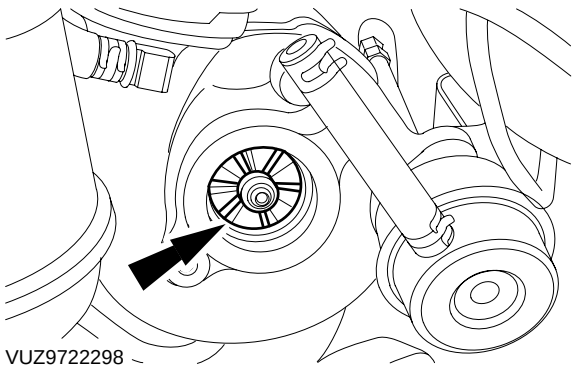
Symptom	Possible Sources	Action
• Blue smoke with excessive turbocharger noise	• Turbocharger compressor rubbing on housing walls. • Turbocharger turbine rubbing on housing walls. • Turbocharger bearings and oil seal(s). • Turbocharger oil supply tube blocked or damaged.	• Vehicles with fixed vane turbocharger. GO to Pinpoint Test A. Vehicles with variable vane turbocharger. GO to Pinpoint Test B.
• Blue smoke without excessive turbocharger noise	• Turbocharger oil return tube blocked or damaged.	• GO to Pinpoint Test C.
• Poor engine performance	• Charge air cooler system.	• CHECK the charge air cooler and charge air cooler pipe(s) for leaks and obstructions. REPAIR as necessary.
	• Air cleaner intake pipe.	• CHECK the air cleaner intake pipe for obstructions. REPAIR as necessary.

DIAGNOSIS AND TESTING

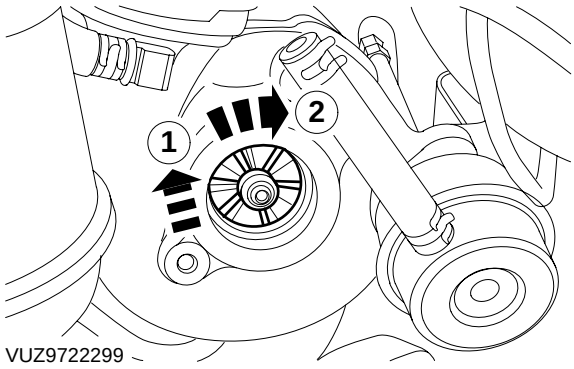
Symptom	Possible Sources	Action
	• Unauthorized adjustment of the wastegate control valve actuator rod - vehicles with fixed vane turbocharger.	• The wastegate control valve actuator rod is factory set and must not be adjusted. CHECK the paint seal on the wastegate control valve actuator rod has not been broken. If the paint seal has been broken, INSTALL a new turbocharger. REFER to:Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (110 PS/85 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation).
	• Wastegate control valve actuator - vehicles with fixed vane turbocharger.	• GO to Pinpoint Test D.
	• Variable vane electric actuator.	• REFER to the WDS.

Pinpoint Tests

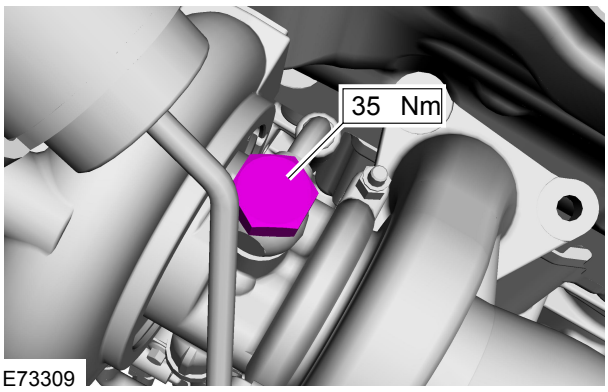
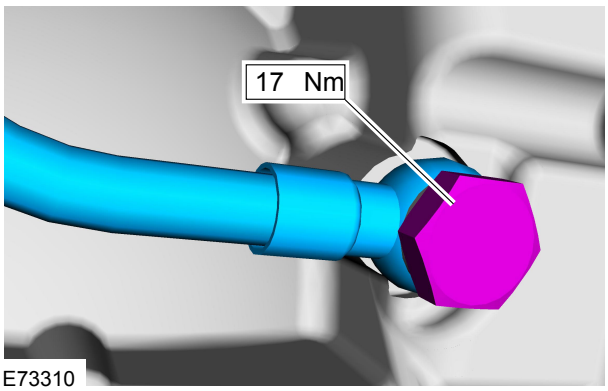
PINPOINT TEST A : BLUE SMOKE WITH EXCESSIVE TURBOCHARGER NOISE - VEHICLES WITH FIXED VANE TURBOCHARGER

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: INSPECT THE TURBOCHARGER ROTOR VANES FOR DAMAGE	
	1 Disconnect the air cleaner outlet pipe from the turbocharger.
 VUZ9722298	2 Inspect the turbocharger rotor vanes for damage. • Is there visible damage to the rotor vanes? → **Yes** GO to A2. → **No** GO to A3.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A2: CHECK FOR FOREIGN MATERIAL IN THE INTAKE AIR SYSTEM COMPONENTS	
	1 Check the intake air system components for signs of foreign material. • Are there any signs of foreign material? → **Yes** CLEAN the intake air system components. INSTALL a new turbocharger. REFER to: Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (110 PS/85 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation). TEST the system for normal operation. → **No** GO to A4.
A3: CHECK THE TURBOCHARGER BEARINGS FOR EXCESSIVE MOVEMENT	
NOTE: A small amount of movement in the bearings is normal.	
NOTE: The initial rotor rotation of a cold turbocharger may feel rough and uneven but should rotate freely after a few turns.	
 VUZ9722299	1 Make sure that the turbocharger rotor spins freely within the housing. – 1. With the turbocharger stationary, gently lift the shaft (the shaft will naturally lay in the bottom of the bearings). – 2. Make sure that the rotor spins freely within the housing. • Does the rotor spin freely within the housing? → **Yes** GO to A4. → **No** INSTALL a new turbocharger. REFER to: Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (110 PS/85 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation). TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A4: CHECK THE TURBOCHARGER OIL SUPPLY TUBE FOR BLOCKAGE	
 E73309	1 Disconnect the turbocharger oil supply tube from the turbocharger.
 E73310	2 Remove the turbocharger oil supply tube.
	3 Using workshop compressed air and a compressed air nozzle, check the oil supply tube for blockage. • Is there any signs of blockage? → **Yes** GO to A5. → **No** INSTALL a new turbocharger and turbocharger oil supply tube. REFER to:Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (110 PS/85 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation). TEST the system for normal operation.

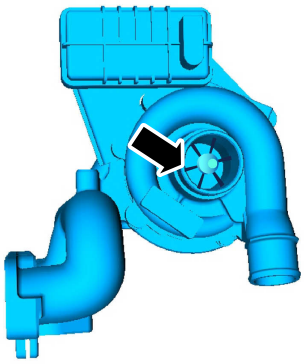
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A5: CHECK THE TURBOCHARGER OIL SUPPLY TUBE OIL GALLERY FOR BLOCKAGE	
	1 Visually inspect the oil supply tube oil gallery in the cylinder block for blockage. • Is the oil supply tube oil gallery free from blockage? → **Yes** INSTALL a new turbocharger and turbocharger oil supply tube. REFER to:Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (110 PS/85 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation). TEST the system for normal operation. → **No** REMOVE the blockage. INSTALL a new turbocharger. REFER to:Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (110 PS/85 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation). TEST the system for normal operation.

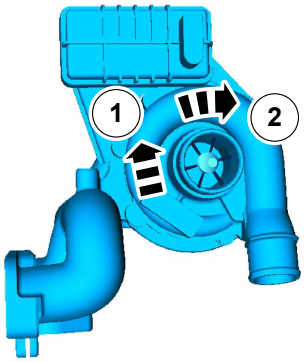
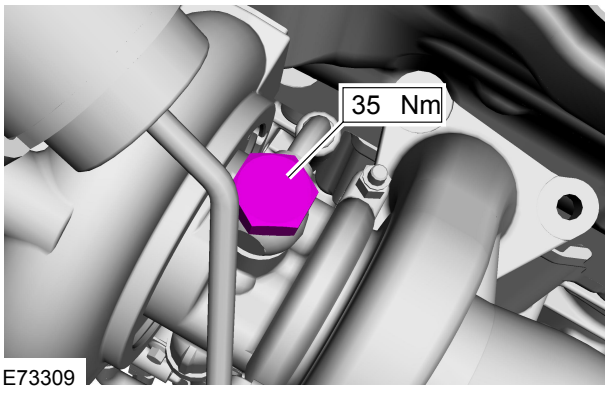
PINPOINT TEST B : BLUE SMOKE WITH EXCESSIVE TURBOCHARGER NOISE - VEHICLES WITH VARIABLE VANE TURBOCHARGER

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: INSPECT THE TURBOCHARGER ROTOR VANES FOR DAMAGE	
	1 Disconnect the air cleaner outlet pipe from the turbocharger.

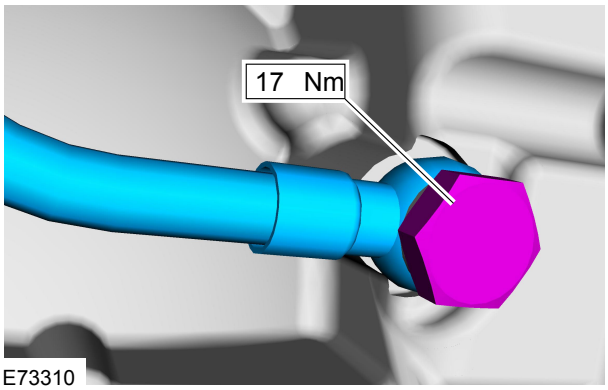
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Inspect the turbocharger rotor vanes for damage. • Is there visible damage to the rotor vanes? → **Yes** GO to B2. → **No** GO to B3.
B2: CHECK FOR FOREIGN MATERIAL IN THE INTAKE AIR SYSTEM COMPONENTS	
	1 Check the intake air system components for signs of foreign material. • Are there any signs of foreign material? → **Yes** CLEAN the intake air system components. INSTALL a new turbocharger. REFER to:Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (130 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (140 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation). TEST the system for normal operation. → **No** GO to B4.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B3: CHECK THE TURBOCHARGER BEARINGS FOR EXCESSIVE MOVEMENT	
NOTE: A small amount of movement in the bearings is normal.	
NOTE: The initial rotor rotation of a cold turbocharger may feel rough and uneven but should rotate freely after a few turns.	
	1 Make sure the turbocharger rotor spins freely within the housing. – 1. With the turbocharger stationary, gently lift the shaft (the shaft will naturally lay in the bottom of the bearings). – 2. Make sure the rotor spins freely within the housing. • Does the rotor spin freely within the housing? → **Yes** GO to B4. → **No** INSTALL a new turbocharger. REFER to: Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (130 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (140 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation). TEST the system for normal operation.
B4: CHECK THE TURBOCHARGER OIL SUPPLY TUBE FOR BLOCKAGE	
 E73309	1 Disconnect the turbocharger oil supply tube from the turbocharger.

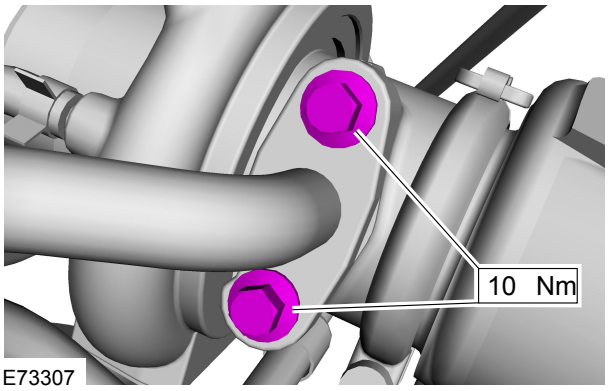
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73310	2 Remove the turbocharger oil supply tube.
	3 Using workshop compressed air and a compressed air nozzle, check the oil supply tube for blockage. • Is the oil supply tube free from blockage? → **Yes** GO to B5. → **No** INSTALL a new turbocharger and turbocharger oil supply tube. REFER to:Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (130 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (140 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation). TEST the system for normal operation.

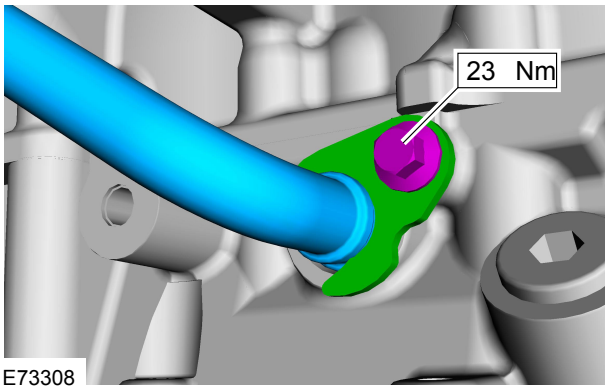
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B5: CHECK THE TURBOCHARGER OIL SUPPLY TUBE OIL GALLERY FOR BLOCKAGE	
	1 Visually inspect the oil supply tube oil gallery in the cylinder block for blockage. • Is the oil supply tube oil gallery free from blockage? → **Yes** INSTALL a new turbocharger and turbocharger oil supply tube. REFER to:Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (130 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (140 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation). TEST the system for normal operation. → **No** REMOVE the blockage. INSTALL a new turbocharger. REFER to:Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (130 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (140 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation). TEST the system for normal operation.

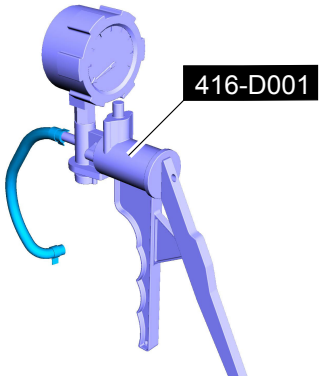
PINPOINT TEST C : BLUE SMOKE WITHOUT EXCESSIVE TURBOCHARGER NOISE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CHECK THE TURBOCHARGER OIL RETURN TUBE	
 E73307	1 Disconnect the turbocharger oil return tube from the turbocharger.

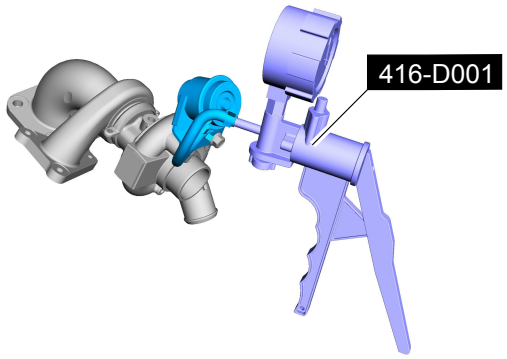
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73308	2 Remove the turbocharger oil return tube.
	3 Check the turbocharger oil return tube for a blockage or signs of damage. • Is the turbocharger oil return tube blocked? → **Yes** GO to Fuel Charging and Controls for further blue smoke diagnostics. REFER to:Fuel Charging and Controls (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, Diagnosis and Testing) / Fuel Charging and Controls (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Diagnosis and Testing). → **No** INSTALL a new turbocharger oil return tube. TEST the system for normal operation.

PINPOINT TEST D : POOR ENGINE PERFORMANCE - VEHICLES WITH FIXED VANE TURBOCHARGER.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: CHECK THE WASTEGATE ACTUATOR CONTROL LINE FOR BLOCKAGE	
	1 Remove the wastegate actuator control line.
 E73312	2 Install the special tool to one end of the wastegate actuator control line.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Operate the hand vacuum pump and observe the reading. • Is a reading present? → **Yes** INSTALL a new wastegate actuator control line. TEST the system for normal operation. → **No** GO to D2.
D2: CHECK THE WASTEGATE ACTUATOR DIAPHRAGM FOR LEAKS	
 E73311	1 Connect the free end of the wastegate control line to the wastegate actuator.
	2 Operate the hand vacuum pump and observe the reading. • Does the pump hold vacuum? → **Yes** GO to Fuel Charging and Controls for further diagnostics. REFER to:Fuel Charging and Controls (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, Diagnosis and Testing) / Fuel Charging and Controls (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Diagnosis and Testing). → **No** INSTALL a new turbocharger. REFER to:Turbocharger - 2.2L Duratorq-TDCi (Puma) Diesel (110 PS/85 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation) / Turbocharger - 2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS) (303-04 Fuel Charging and Controls - Turbocharger, Removal and Installation). TEST the system for normal operation.

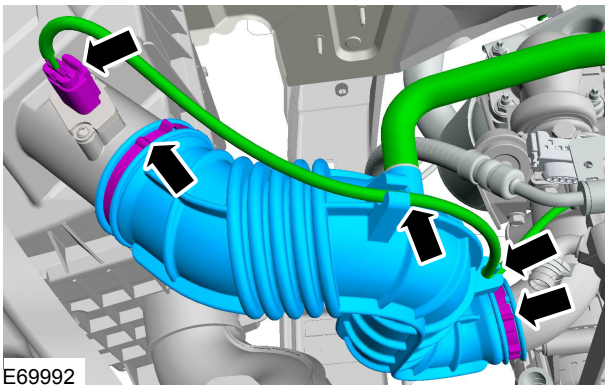
REMOVAL AND INSTALLATION

Turbocharger — 2.4L Duratorq-TDCi (Puma) Diesel (100 PS/115 PS)

Removal

NOTE: Removal steps in this procedure may contain installation details.

1.

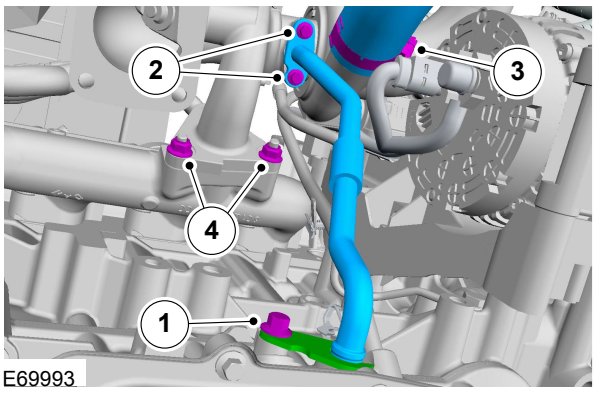


2. Remove the catalytic converter.

Refer to:Catalytic Converter - 2.2L Duratorq-TDCi (Puma) Diesel (309-00 Exhaust System, Removal and Installation).

3. ⚠ **CAUTION:Make sure that the inside of the pipe ends are clean and free of oil residue.**

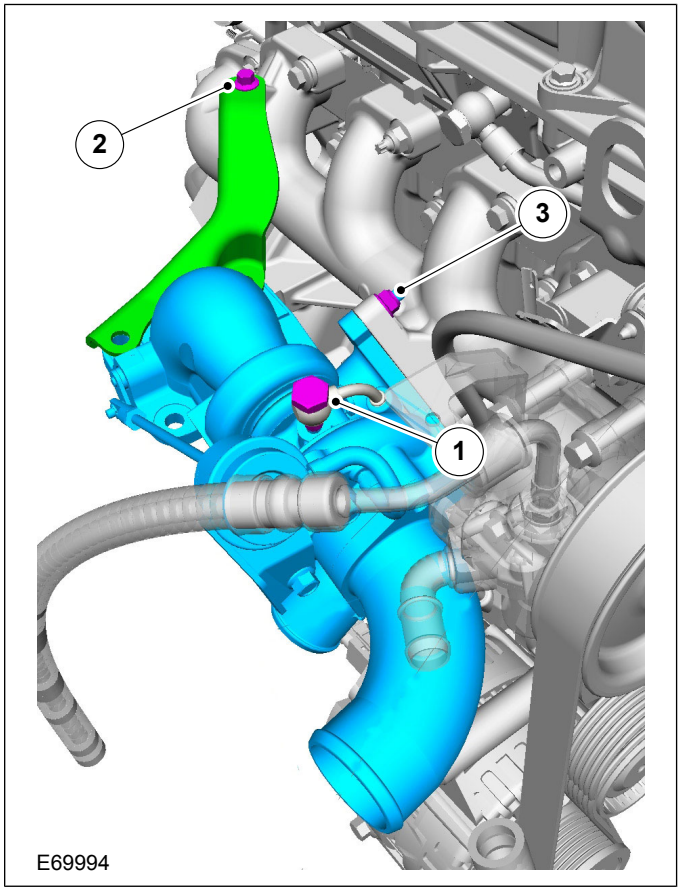
1. Torque: 23 Nm
2. Torque: 10 Nm
3. Torque: 6 Nm
4. Discard the nuts.
   Torque: 23 Nm



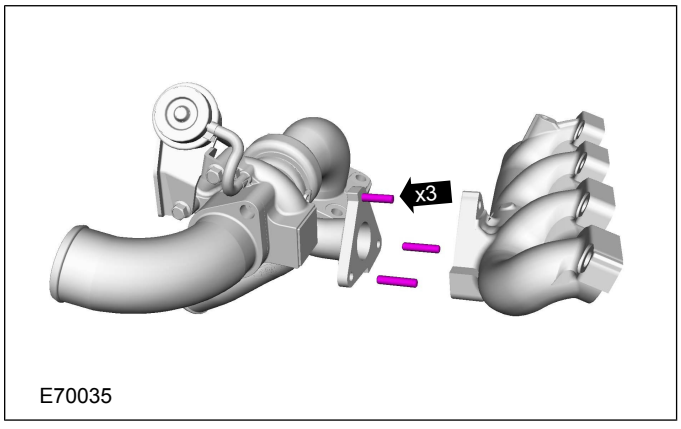
4. Lower the vehicle.

5.

1. Torque: 35 Nm
2. Torque: 25 Nm
3. Discard the nut.
   Torque: 23 Nm



6. Discard the studs.



REMOVAL AND INSTALLATION

Installation

1. To install, reverse the removal procedure.

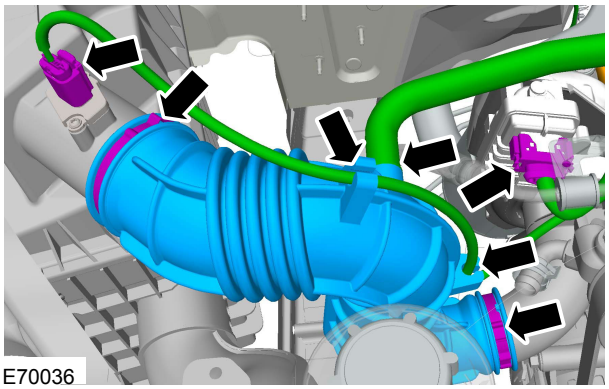
REMOVAL AND INSTALLATION

Turbocharger — 2.4L Duratorq-TDCi (Puma) Diesel (140 PS)

Removal

NOTE: Removal steps in this procedure may contain installation details.

1.

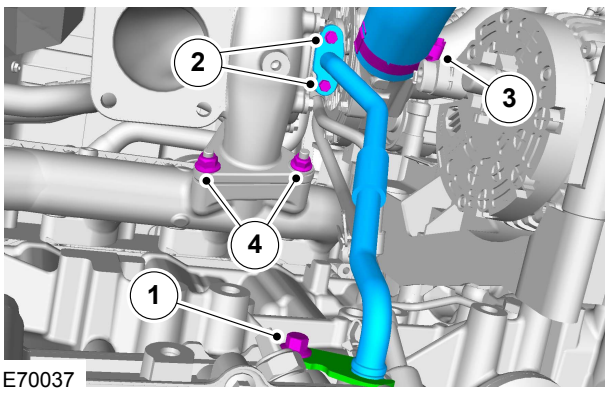


2. Remove the catalytic converter.

Refer to:Catalytic Converter - 2.2L Duratorq-TDCi (Puma) Diesel (309-00 Exhaust System, Removal and Installation).

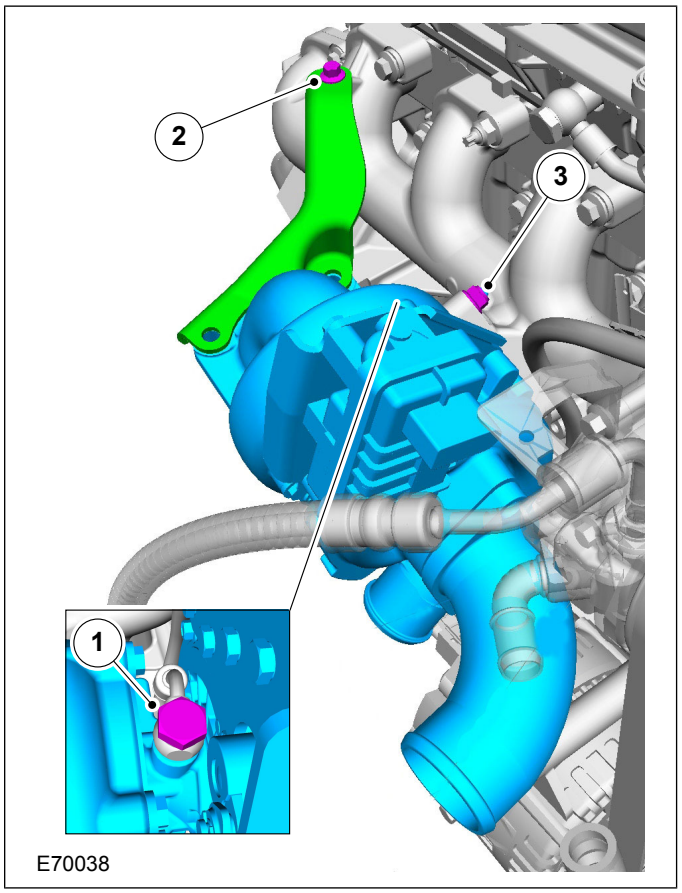
3. ⚠ **CAUTION:Make sure that the inside of the pipe ends are clean and free of oil residue.**

1. Torque: 23 Nm
2. Torque: 10 Nm
3. Torque: 6 Nm
4. Discard the nuts
   Torque: 23 Nm

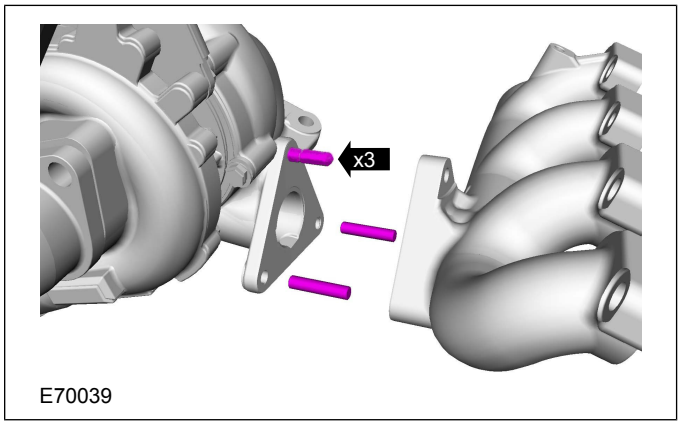


4. Lower the vehicle.

5.
1. Torque: 35 Nm
2. Torque: 25 Nm
3. Discard the nut.
   Torque: 23 Nm



6. Discard the studs.



Installation

1. To install, reverse the removal procedure.

SECTION 303-04C Fuel Charging and Controls — 2.4L Duratorq-TDCi (Puma) Diesel

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Fuel Charging and Controls 303-04C-2
Overview 303-04C-2
General 303-04C-3
Fuel pump 303-04C-3
Fuel rail 303-04C-4
Fuel injectors 303-04C-5

DIAGNOSIS AND TESTING

Fuel Charging and Controls 303-04C-6
Principles of Operation 303-04C-7
Symptom Chart 303-04C-20

GENERAL PROCEDURES

Fuel Injection Component Cleaning 303-04C-54

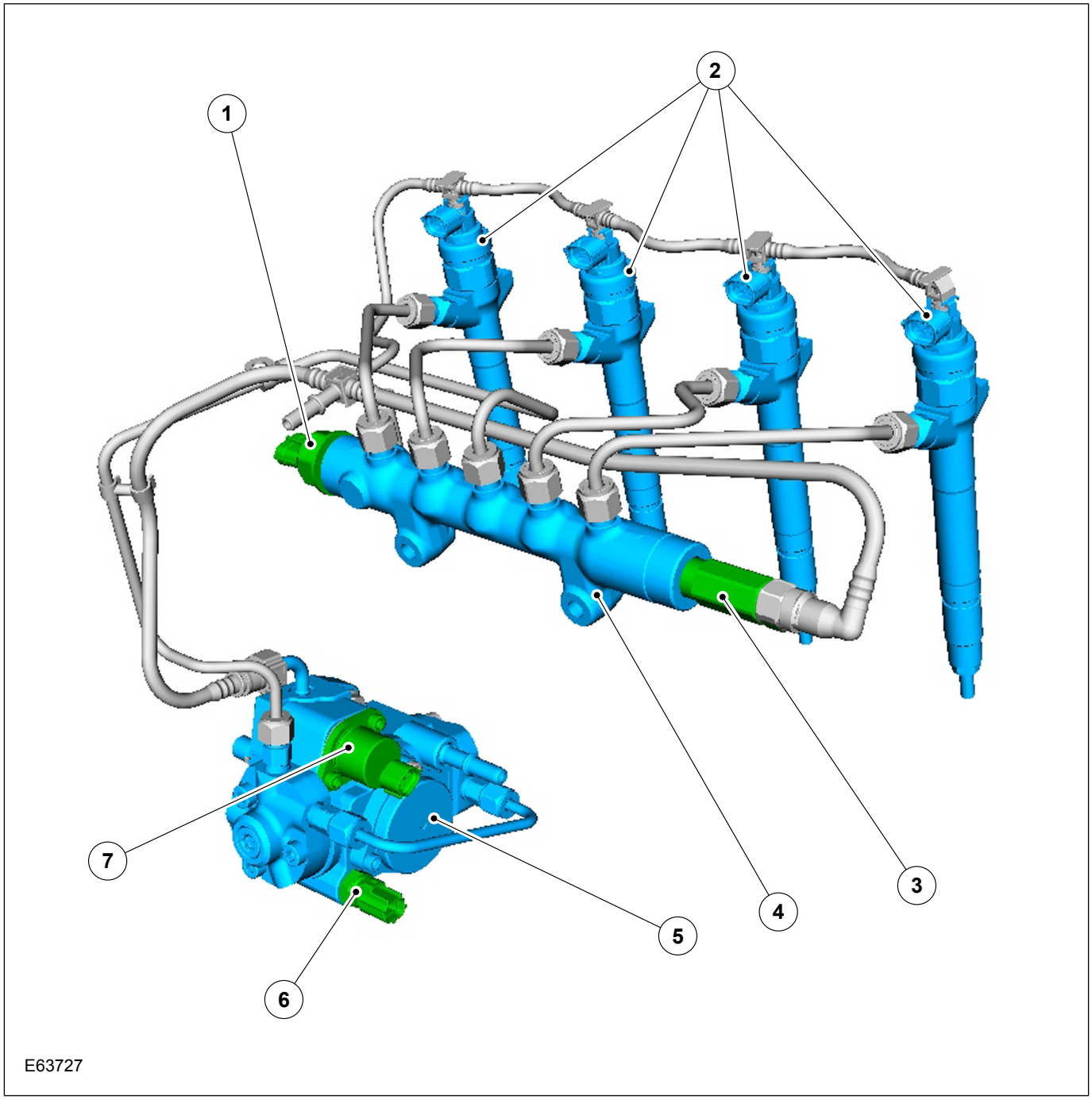
REMOVAL AND INSTALLATION

Fuel Pump 303-04C-55
Fuel Rail 303-04C-60
Fuel Pressure Relief Valve 303-04C-64
Fuel Injectors 303-04C-66

DESCRIPTION AND OPERATION

Fuel Charging and Controls

Overview



Item	Description
1	Fuel rail pressure (FRP) sensor
2	Fuel injector(s)
3	Fuel pressure relief valve
4	Fuel rail
5	Fuel pump

Item	Description
6	Fuel temperature sensor
7	Fuel metering valve

DESCRIPTION AND OPERATION

General

A Denso common rail fuel injection system is used on the 2.4L Duratorq-TDCi (Puma) diesel engine.

Within the fuel pump there is an integral fuel transfer pump which draws the fuel from the fuel tank to the fuel pump.

A fuel metering valve is located in the supply port to the high-pressure chamber of the fuel pump. The fuel metering valve varies the quantity of fuel supplied to the fuel rail and fuel injector(s), in relation to the driving conditions.

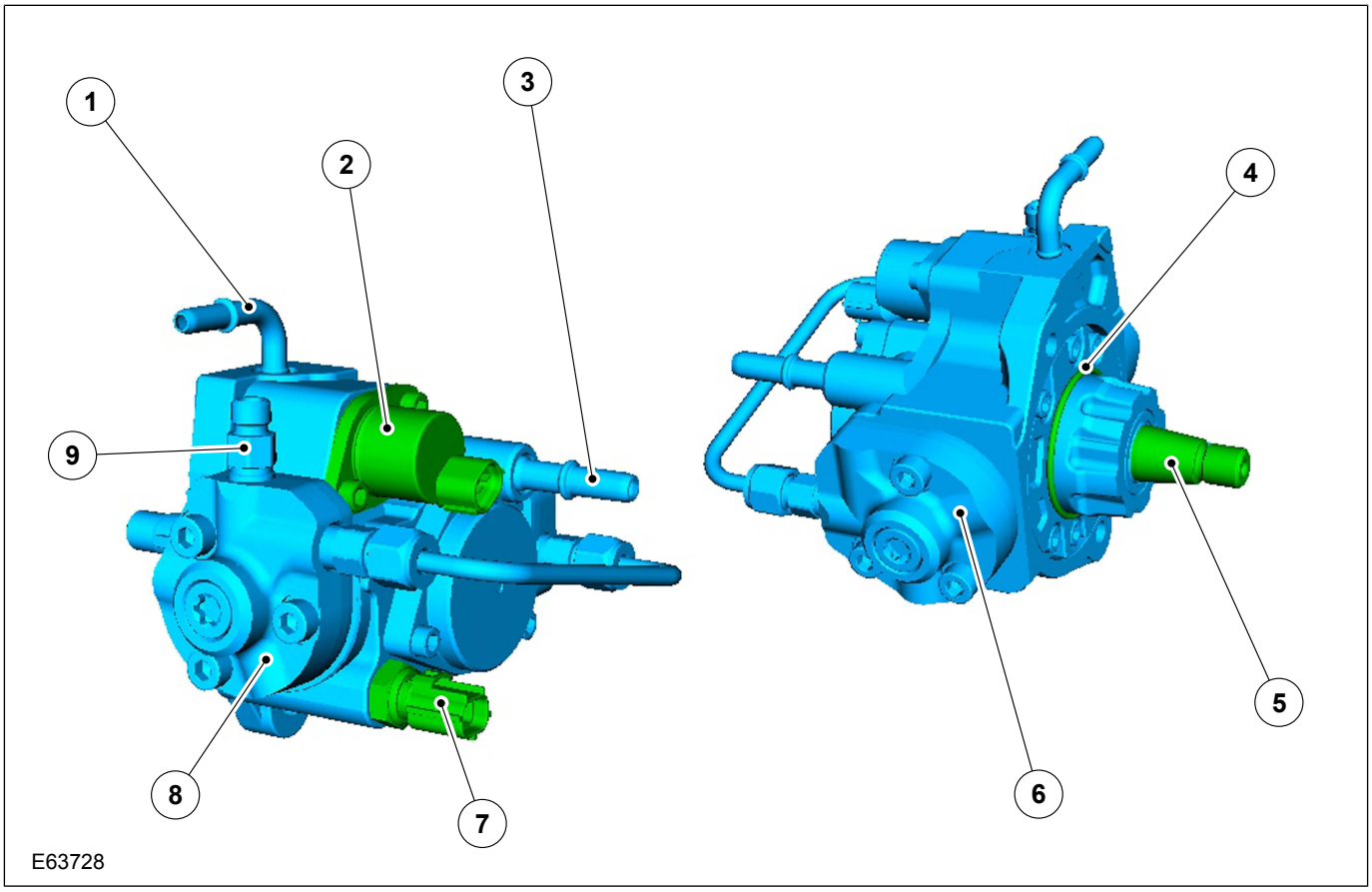
The fuel is supplied at high-pressure to the fuel rail and to the fuel injectors ready for injection. Depending on engine operating conditions, the fuel injection pressure varies between 230 bar and 1600 bar.

Fuel system pressure is measured using an FRP sensor located in the fuel rail. The FRP sensor converts the fuel system pressure into a voltage signal. This voltage signal acts as an input signal to the powertrain control module (PCM) for calculation of the fuel injection quantity.

The power train control module (PCM) calculates the time of fuel injection and the fuel injection quantity depending on various input variables. The specified quantity of fuel is injected into the respective combustion chamber through the solenoid actuated fuel injector(s). In doing so, a pre-injection and a main injection occur each time.

The excess fuel is returned to the fuel tank through the fuel return line.

Fuel pump



Item	Description
1	Fuel pump fuel return union
2	Fuel metering valve
3	Fuel pump fuel supply line union
4	Fuel pump O-ring seal

Item	Description
5	Fuel pump input shaft
6	High-pressure fuel pump chamber
7	Fuel temperature sensor

DESCRIPTION AND OPERATION

Item	Description
8	High-pressure fuel pump chamber
9	Fuel pump high-pressure outlet union

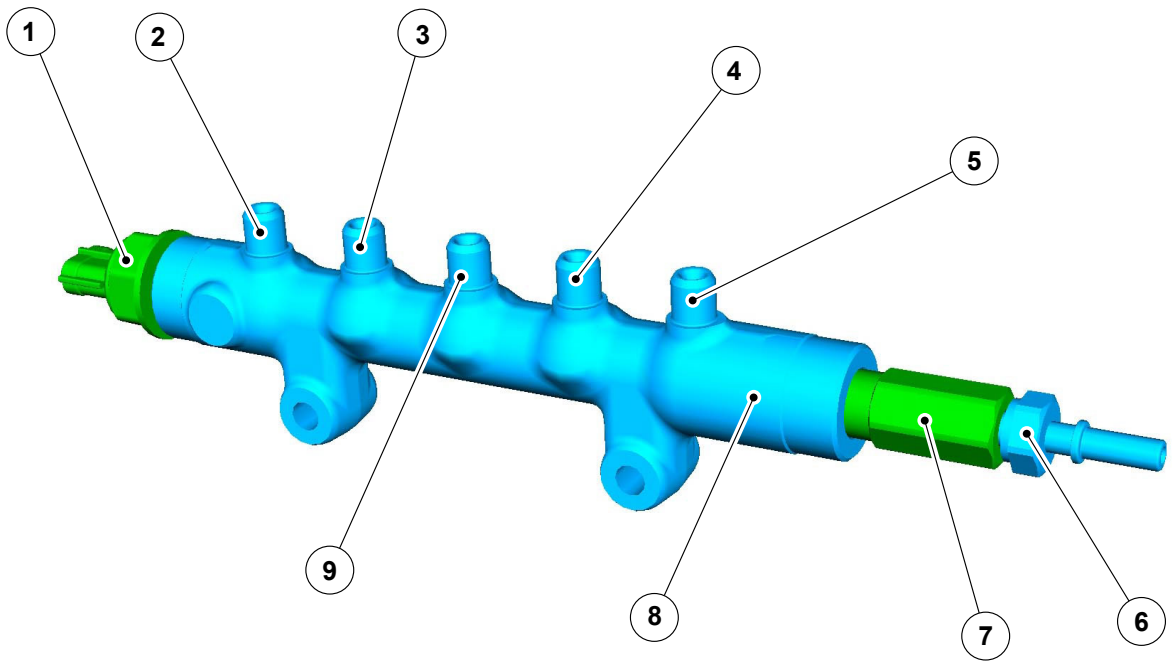
The fuel pump is driven directly by the timing belt.

The fuel pump has two pump elements, each offset from each other by 180 degrees.

The fuel transfer pump is incorporated into the fuel pump and is located on the drive flange. The fuel transfer pump is a cycloid type pump.

The fuel metering valve is actuated by the PCM using pulse width modulation.

Fuel rail



E63729

Item	Description
1	FRP sensor
2	Fuel rail to fuel injector number 1 high-pressure fuel supply line union
3	Fuel rail to fuel injector number 2 high-pressure fuel supply line union
4	Fuel rail to fuel injector number 3 high-pressure fuel supply line union
5	Fuel rail to fuel injector number 4 high-pressure fuel supply line union
6	Fuel pump to fuel rail high-pressure fuel supply line union
7	Fuel pressure relief valve

Item	Description
8	Fuel rail
9	Fuel pump to fuel rail high-pressure fuel supply line union

CAUTION:The FRP sensor must not be detached or removed from the fuel rail.

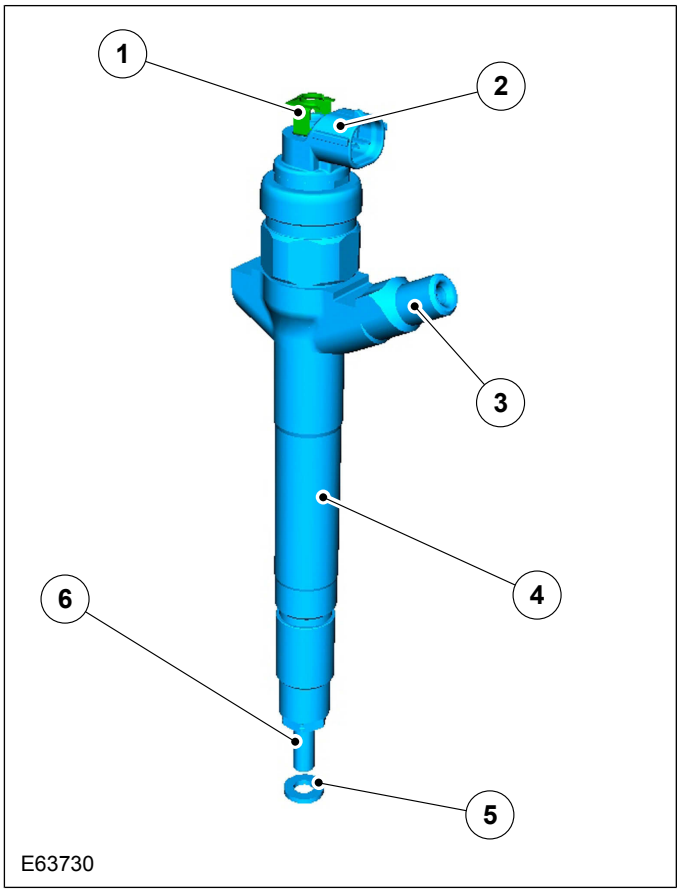
The fuel rail is made from forged steel and is retained by a support bracket located on the camshaft carrier.

The fuel is delivered by one high-pressure fuel supply line from the fuel pump to the fuel rail.

From the fuel rail, the fuel travels through the high-pressure fuel supply line(s) to the fuel injector(s).

DESCRIPTION AND OPERATION

Fuel injectors



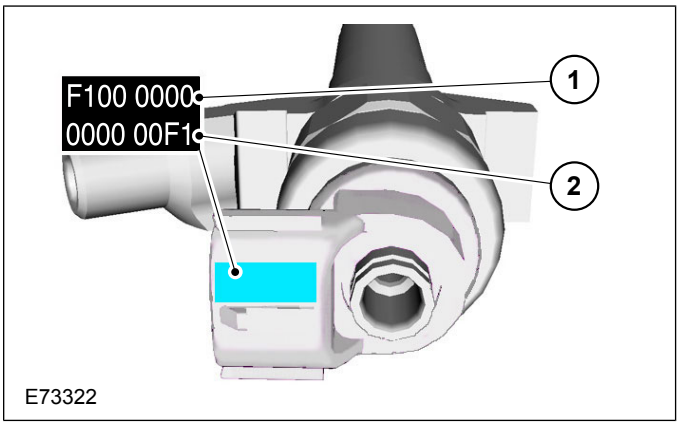
Item	Description
1	Fuel injector fuel return line clip
2	Fuel injector electrical connector
3	Fuel injector high-pressure fuel supply line union
4	Fuel injector
5	Fuel injector sealing washer
6	Fuel injector nozzle

The fuel injector(s) are located centrally on the cylinder head upper section and are attached by means of retaining clamps.

The fuel injector(s) are sealed from the combustion chamber by means of a copper sealing washer located between the fuel injector and the cylinder head. A new sealing washer must always be installed when carrying out installation work.

The fuel injectors are controlled directly by the PCM.

The fuel return line(s) are attached to the top of the fuel injector and are connected in series.



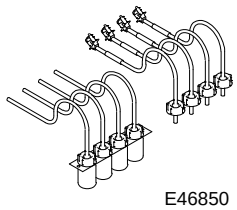
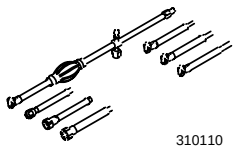
Item	Description
1	Eight digit injector correction factor (example only shown)
2	Eight digit serial code (For manufacturer use only)

When installing new fuel injectors, the injector correction factor from the new fuel injector(s) must be recorded and uploaded using the Worldwide Diagnostic System (WDS).

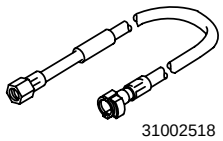
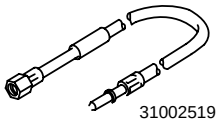
DIAGNOSIS AND TESTING

Fuel Charging and Controls

Special Tool(s)

 E46850	Diagnostic Tool, Common Rail Fuel Injection 310-129
 310110	Hand Pressure Pump with Adapter Kit 310-110

Special Tool(s)

 31002518	Test Hose for 310-025 310-025-18
 31002519	Test Hose for 310-025 310-025-19A

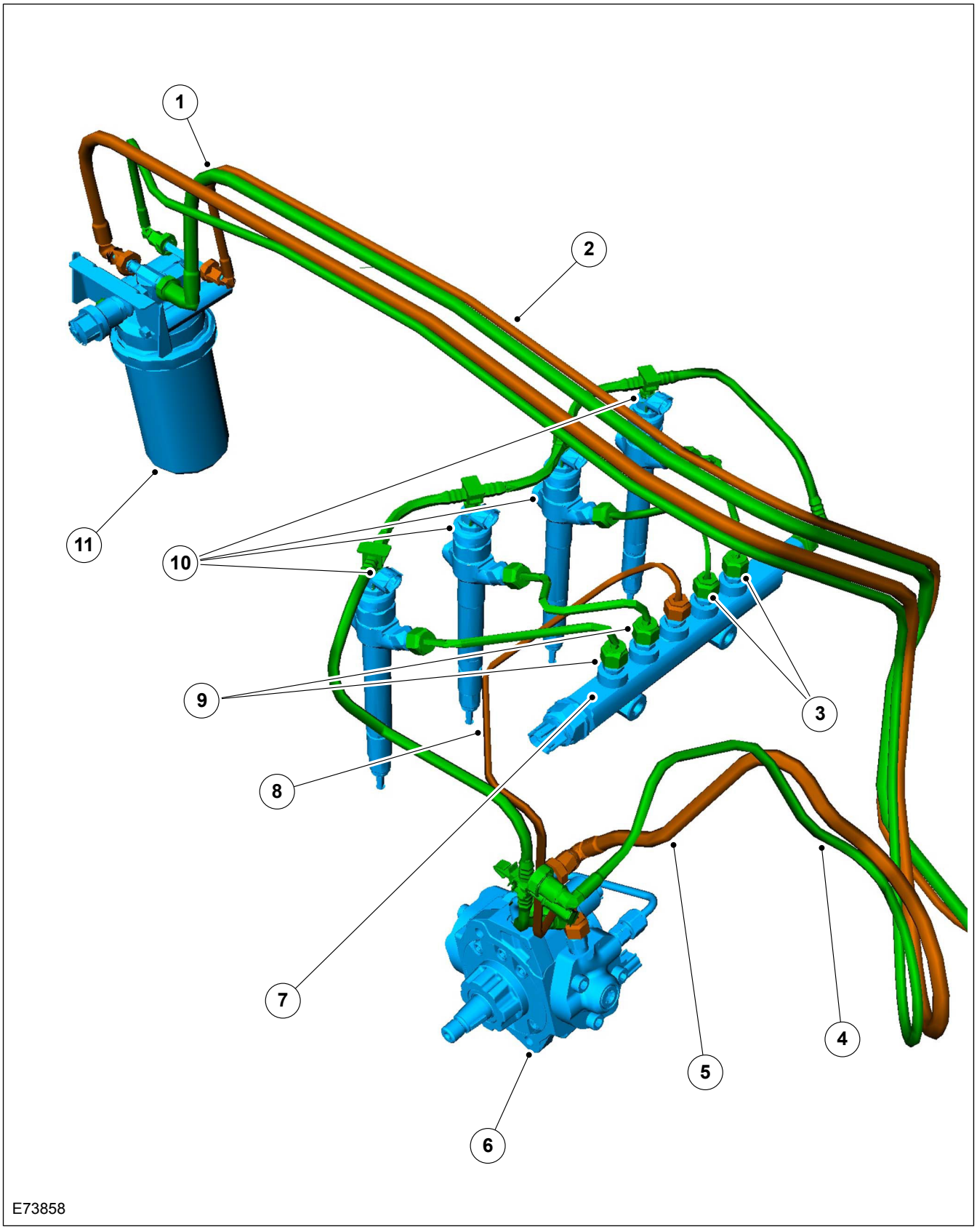
General Equipment

Worldwide Diagnostic System (WDS)
Pneumatic vacuum gun

DIAGNOSIS AND TESTING

Principles of Operation

System overview



DIAGNOSIS AND TESTING

Item	Description
1	Fuel tank to fuel filter fuel supply line
2	Fuel filter to fuel tank fuel return line
3	Fuel injector numbers 3 and 4 high-pressure fuel supply lines
4	Fuel pump, fuel rail and fuel injectors fuel return line
5	Fuel filter to fuel pump fuel supply line
6	Fuel pump
7	Fuel rail
8	Fuel pump to fuel rail high-pressure fuel supply line
9	Fuel injector numbers 1 and 2 high-pressure fuel supply lines

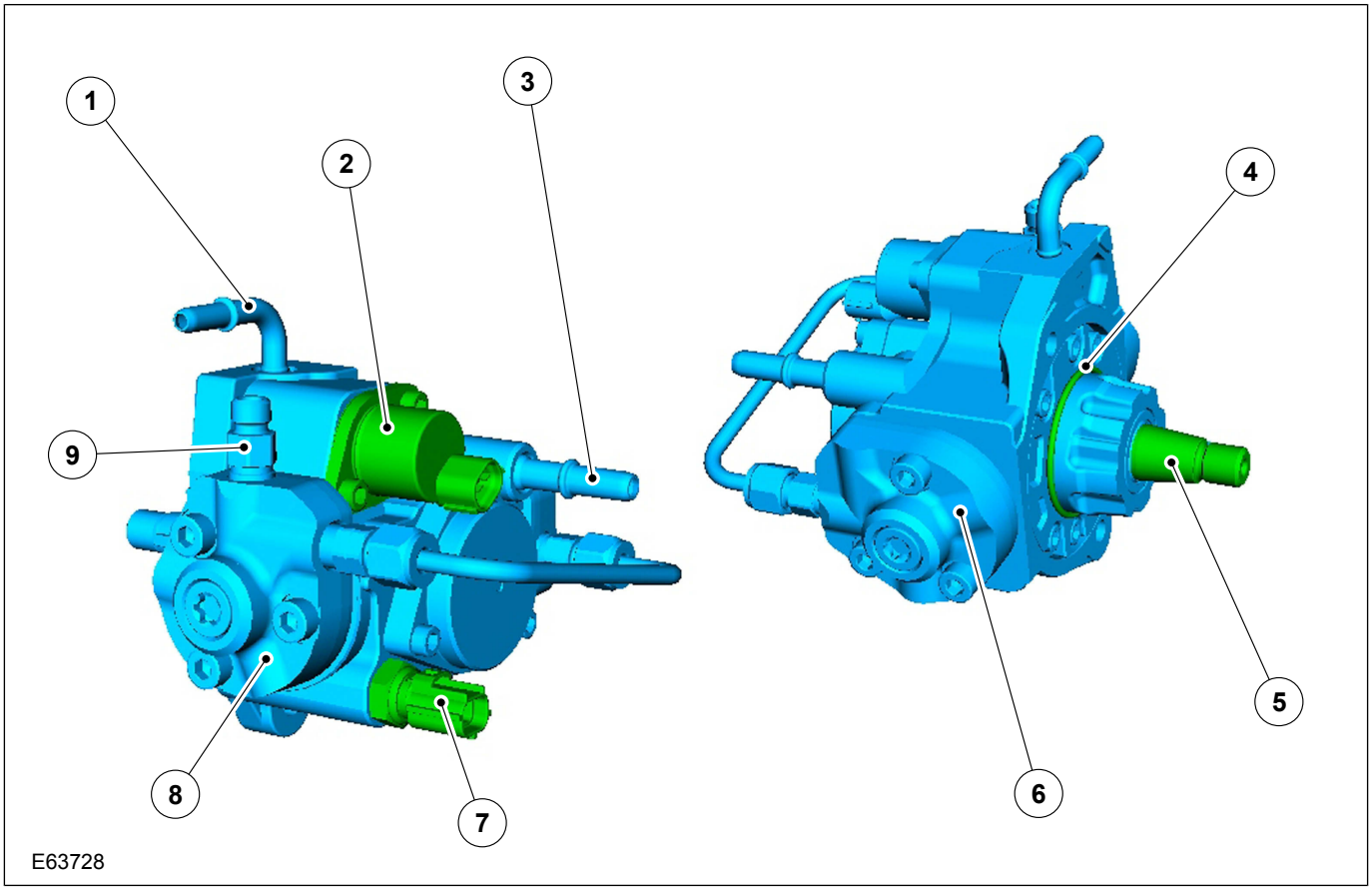
Item	Description
10	Fuel injectors
11	Fuel filter element

To meet the increasing demands for lower exhaust emissions, greater economy, improved driving characteristics, lower noise output and increased power output from modern diesel engines, the vehicle requires a fuel supply system which can deliver small fuel droplets at high speed with refined control. The common rail fuel injection system has been introduced to the diesel engine to meet these demands.

The Denso system installed to the 2.4L Duratorq-TDCi (Puma) diesel engine fulfills this role by using controlled high-pressure fuel delivery to individually electronically controlled injectors.

Fuel pump

Vehicles with 2.4L Duratorq-TDCi (Puma) diesel engine



Item	Description
1	Fuel pump fuel return union
2	Fuel metering valve

Item	Description
3	Fuel pump fuel supply union
4	Fuel pump O-ring seal

DIAGNOSIS AND TESTING

Item	Description
5	Fuel pump input shaft
6	High-pressure fuel pump chamber
7	Fuel temperature sensor
8	High-pressure fuel pump chamber
9	Fuel pump high-pressure outlet union

The fuel pump installed to the 2.4L Duratorq-TDCi (Puma) diesel engine is driven by the crankshaft by means of a timing chain. The fuel pump is located at the front end of the cylinder block.

Fuel is drawn from the fuel tank through the fuel filter by means of a transfer pump. The transfer pump is built into the high-pressure pump and driven by the high-pressure pump input shaft.

Fuel from the transfer pump is pushed through the fuel pump low-pressure fuel intake channel passing through the fuel metering valve into the high-pressure fuel pump chamber.

Any excess fuel drawn by the transfer pump is dispersed through the fuel pump fuel return union and returned to the fuel tank.

A fuel metering valve is situated in the high-pressure pump low pressure fuel intake channel. The fuel metering valve is controlled by the powertrain control module (PCM). A fuel pressure sensor input signal is used by the PCM to calculate the position required by the fuel metering valve to achieve the desired fuel rail pressure. The fuel metering valve reduces the cross sectional area of the high-pressure pump low pressure fuel intake channel and so decreases the quantity of fuel allowed to reach the high-pressure fuel pump chamber.

If a concern occurs with the operation of the fuel metering valve, the fuel metering valve will default to the open position, until the concern is corrected or a new fuel pump is installed. The fuel pump will over-pressurize and the engine will run but with reduced power.

Located in the rear of the fuel pump is a fuel temperature sensor which monitors the fuel transfer pump fuel return temperature. The fuel temperature sensor information is used by the PCM to adjust the fuel metering valve to compensate for cold fuel charge values.

If the fuel temperature sensor or its related circuits become shorted to ground, the PCM will initiate the limited operating strategy.

If the fuel temperature sensor or its related circuits become open circuit, the PCM will revert to a default value and cold start characteristics will be impaired.

If a new fuel pump is to be installed to the vehicle, use the WDS to initiate the fuel pump learning process. Failure to carry out the fuel pump learning process will result in rough idling of the engine and incorrect engine emissions.

REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).

Fuel pump high-pressure fuel development

CAUTION:The fuel pump relies on the fuel in the fuel pump for lubrication. The fuel pump input shaft should not be allowed to rotate above hand cranking speed unless the air has been bled from the fuel pump fuel supply lines and fuel is present in the fuel transfer pump. Failure to follow this instruction may result in damage to the internal components of the fuel pump.

Fuel enters the fuel pump chamber through a fuel intake valve. The intake valve will only allow fuel to enter the fuel pump chamber, if the fuel pressure in the chamber is lower than the pressure in the fuel pump low pressure fuel intake channel.

The fuel pump input shaft rotates an eccentric cam clockwise, which allows the plungers to be moved in and out (like pistons) to produce the high-pressure fuel inside the high-pressure chambers.

The fuel in the current compression chamber (dependent on the fuel pump input shaft position) is subjected to high-pressure.

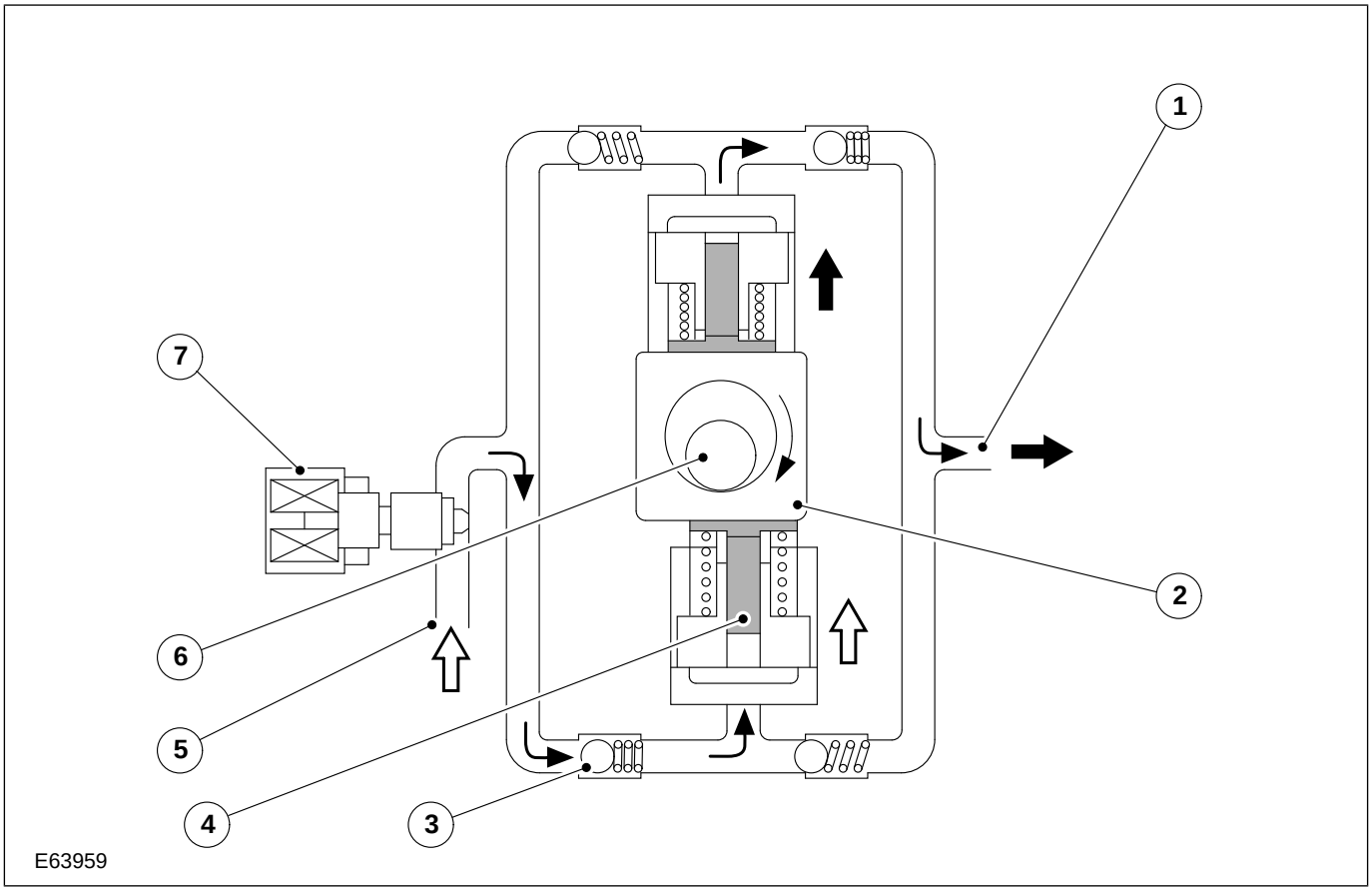
The fuel pump fuel outlet valve will remain closed until the fuel pressure inside the chamber exceeds the pressure in the fuel rail.

When the fuel outlet valve opens, due to the high-pressure of the fuel, the fuel is released to the fuel rail through the fuel pump high-pressure outlet union.

The fuel pump input shaft rotates 360 degrees (two stages of high-pressure fuel development) to complete one full cycle.

DIAGNOSIS AND TESTING

First stage of high-pressure fuel development

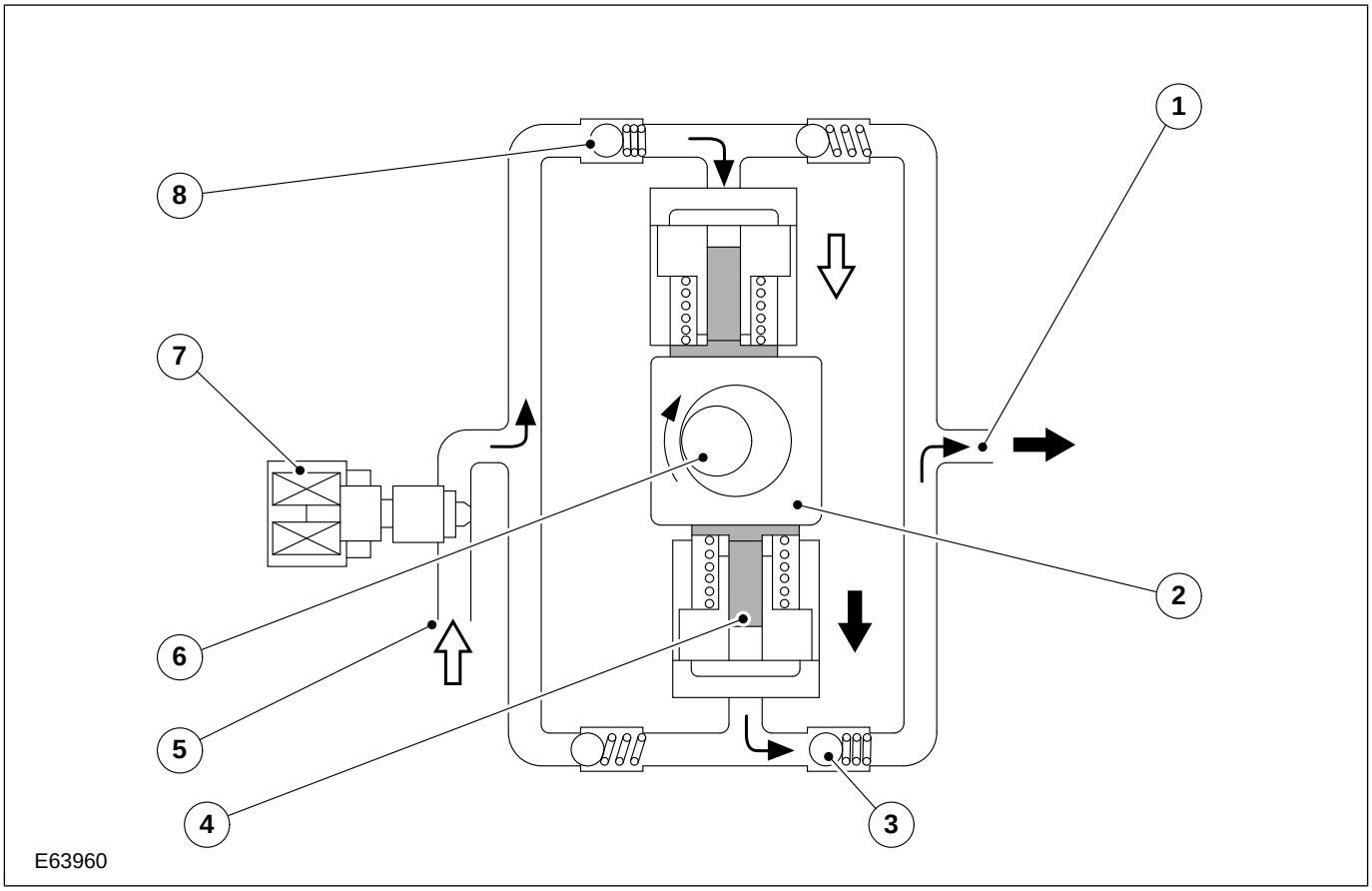


Item	Description
1	Fuel outlet port
2	High-pressure fuel pump cam ring
3	Fuel intake valve

Item	Description
4	High-pressure fuel pump chamber
5	Fuel intake port
6	Eccentric cam
7	Fuel metering valve

DIAGNOSIS AND TESTING

Second stage of high-pressure fuel development

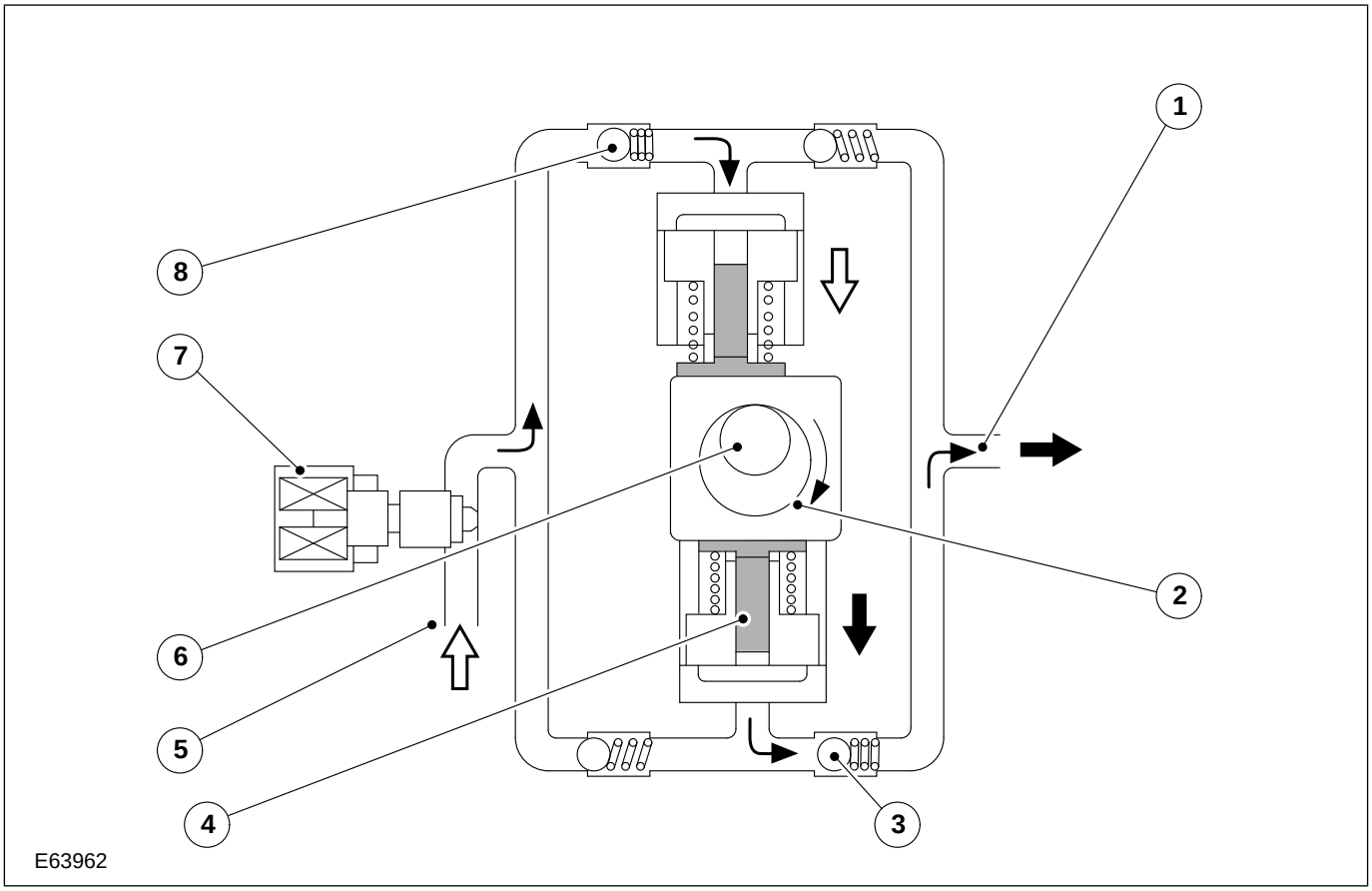


Item	Description
1	Fuel outlet port
2	High-pressure fuel pump cam ring
3	Fuel outlet valve
4	High-pressure fuel pump chamber

Item	Description
5	Fuel intake port
6	Eccentric cam
7	Fuel metering valve
8	Fuel intake valve

DIAGNOSIS AND TESTING

Third stage of high-pressure fuel development

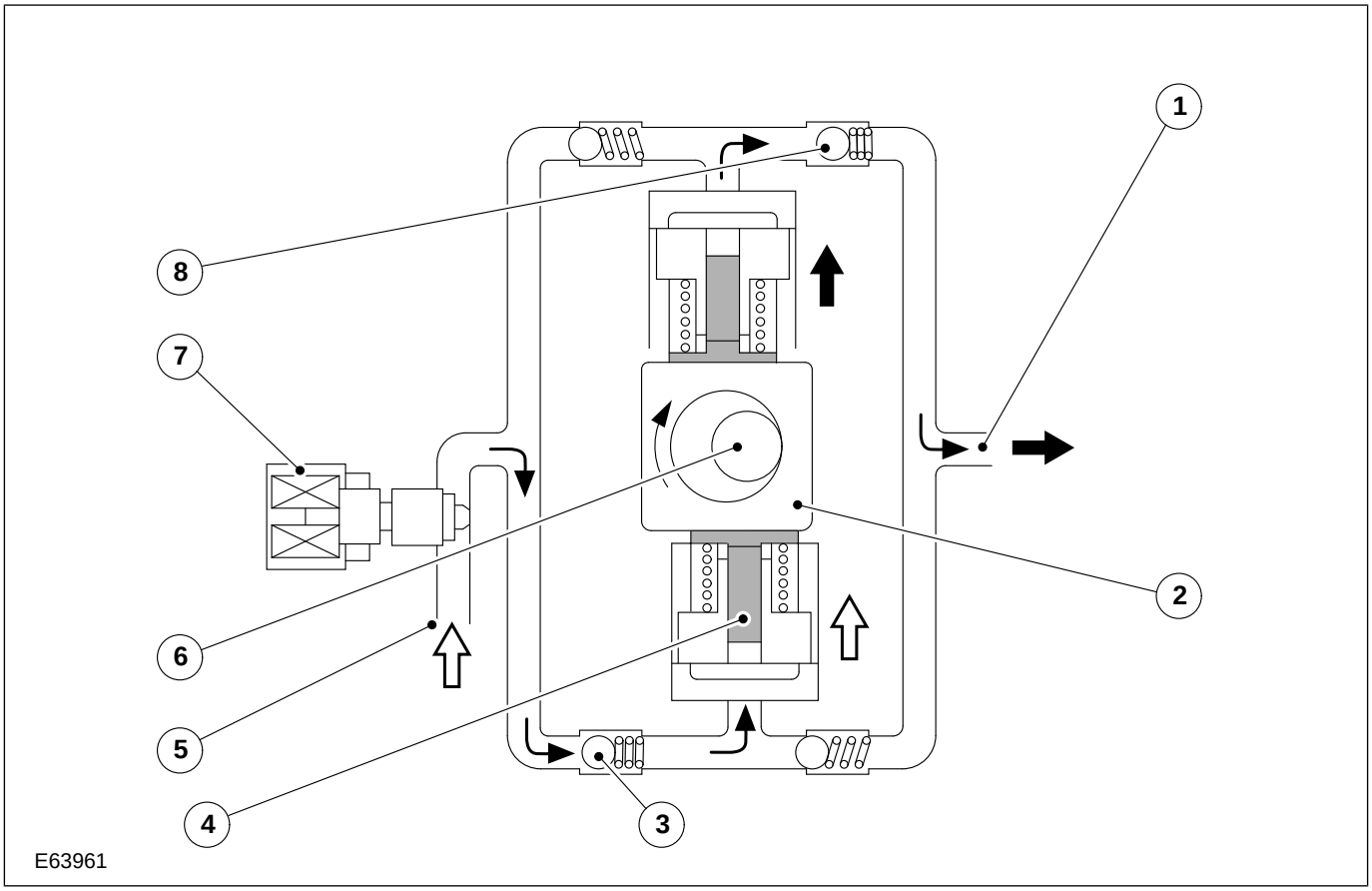


Item	Description
1	Fuel outlet port
2	High-pressure fuel pump cam ring
3	Fuel outlet valve
4	High-pressure fuel pump chamber

Item	Description
5	Fuel intake port
6	Eccentric cam
7	Fuel metering valve
8	Fuel intake valve

DIAGNOSIS AND TESTING

Fourth stage of high-pressure fuel development



Item	Description
1	Fuel outlet port
2	High-pressure fuel pump cam ring
3	Fuel intake valve
4	High-pressure fuel pump chamber
5	Fuel intake port
6	Eccentric cam
7	Fuel metering valve
8	Fuel outlet valve

Fuel pump fuel flow and control

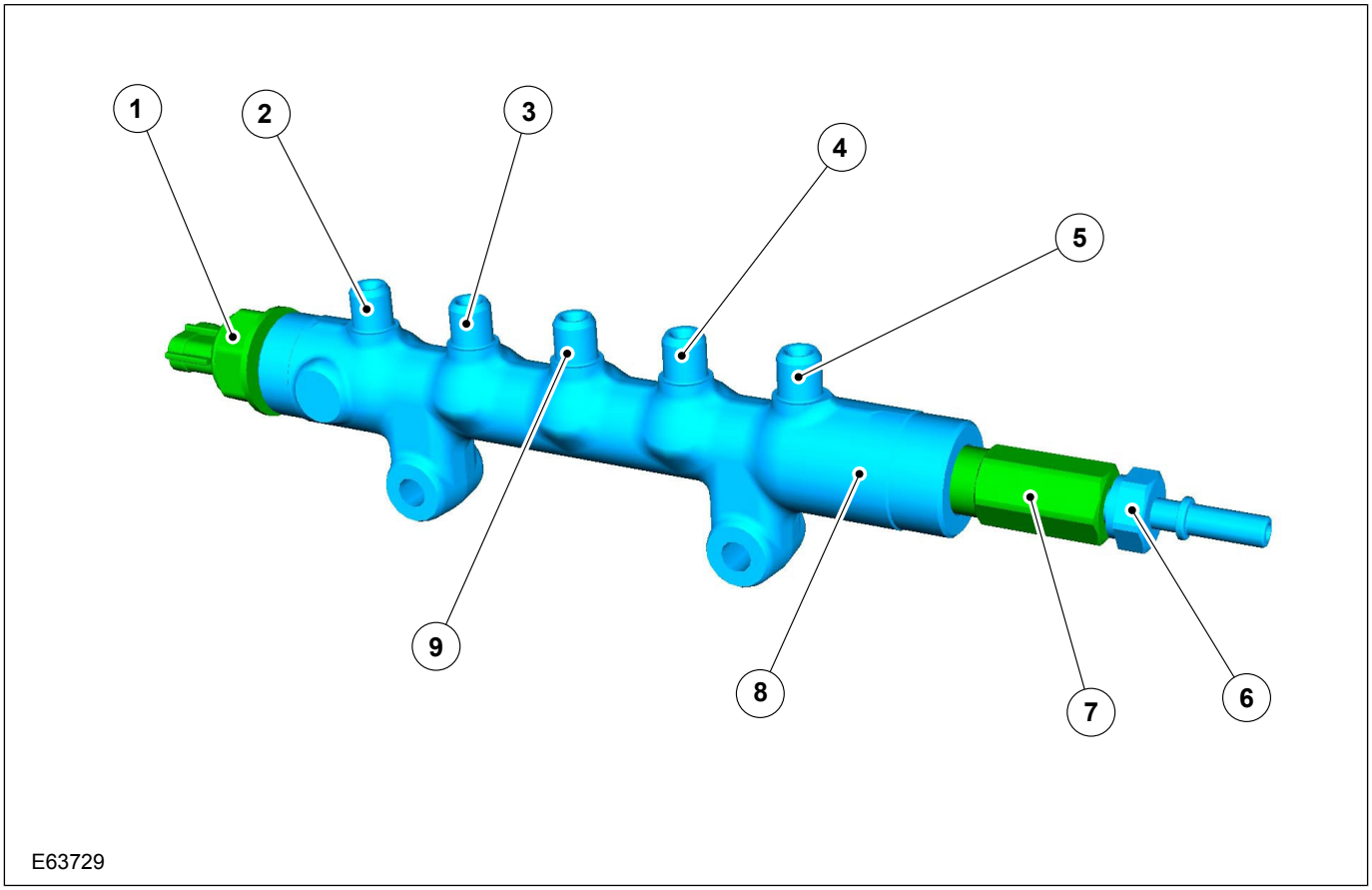
Under normal demand conditions, fuel is delivered to the high-pressure fuel pump chamber unrestricted where it is compressed and delivered to the fuel rail.

A small proportion of fuel is diverted through the fuel pump internal regulator valve. This returned fuel is used to lubricate and cool the fuel pump.

When the engine is off demand (decelerating), the fuel metering valve restricts the fuel pump fuel supply to the high-pressure chamber, which then decreases the high-pressure fuel supply to the fuel rail and fuel injectors.

DIAGNOSIS AND TESTING

Fuel rail



E63729

Item	Description
1	Fuel rail pressure (FRP) sensor
2	Fuel rail to fuel injector number 1 high-pressure fuel supply line union
3	Fuel rail to fuel injector number 2 high-pressure fuel supply line union
4	Fuel rail to fuel injector number 3 high-pressure fuel supply line union
5	Fuel rail to fuel injector number 4 high-pressure fuel supply line union
6	Fuel spigot
7	Fuel pressure relief valve
8	Fuel rail

The fuel rail function is to supply a reservoir of fuel at a constant controlled pressure to all four fuel injectors.

The action of the fuel injectors opening and closing causes changes in pressure to the fuel behind the fuel injector. The fuel rail acts as an accumulator, minimizing this affect.

The volume of fuel held by the fuel rail cannot be too large as this will cause an increase in pressurization time and a corresponding increase in engine start time.

The four fuel injector high-pressure fuel lines attached to the fuel rail are of equal length. This is to eliminate any variation in delivery pressure at the fuel injectors.

Installed into one end of the fuel rail is the FRP sensor. The FRP sensor monitors the current fuel pressure available at the fuel injectors. The FRP sensor is a non-serviceable unit and must be installed as part of a new fuel rail.

If the FRP sensor does not see a minimum preset value during cranking, the PCM will not allow the fuel injectors to inject and the engine will not start.

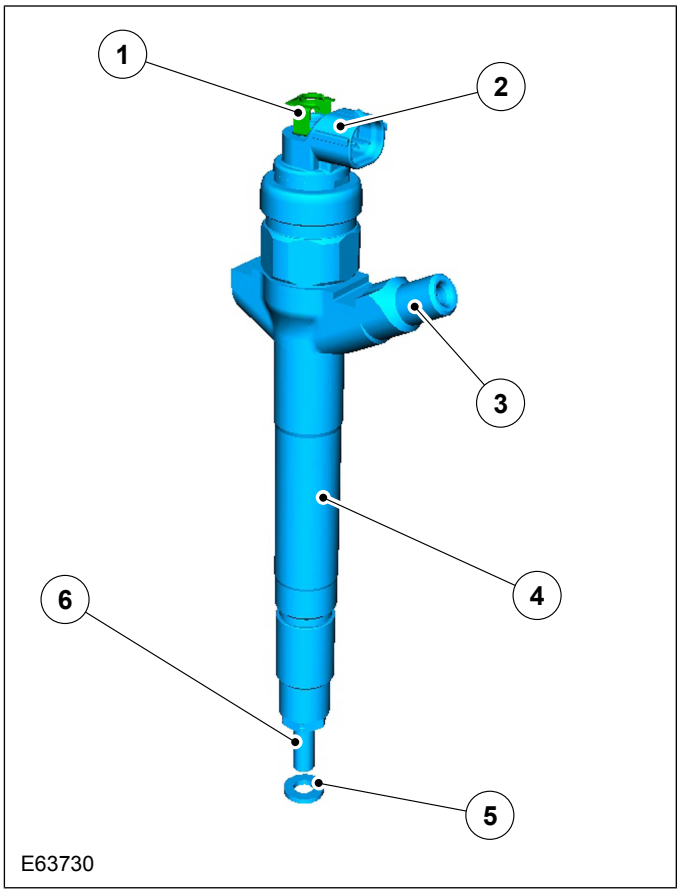
If the FRP sensor signal to the PCM is lost or the value indicated does not match the expected value for the given engine condition, the fuel metering valve will default to the open position.

Installed into the other end of the fuel rail is the fuel pressure relief valve. The fuel pressure relief valve monitors the fuel pressure in the fuel rail. If the fuel pressure becomes abnormally high, the fuel pressure relief valve opens to allow the excess fuel

DIAGNOSIS AND TESTING

to return to the fuel tank and reduce the fuel pressure to the correct value. The fuel pressure relief valve is a serviceable part. When the fuel pressure relief valve has been triggered a diagnostic trouble code (DTC) will be stored in the PCM and the malfunction indicator lamp (MIL) will be illuminated. When the DTC has been triggered, a new fuel pressure relief valve must be installed.

Fuel injector



Item	Description
1	Fuel injector fuel return line retaining clip
2	Fuel injector electrical connector
3	Fuel injector high-pressure fuel supply line union
4	Fuel injector
5	Fuel injector sealing washer
6	Fuel injector high-pressure fuel nozzle

The fuel injector consists of two main sections.

- Electrically operated solenoid control valve.
- Hydraulically operated fuel injection valve.

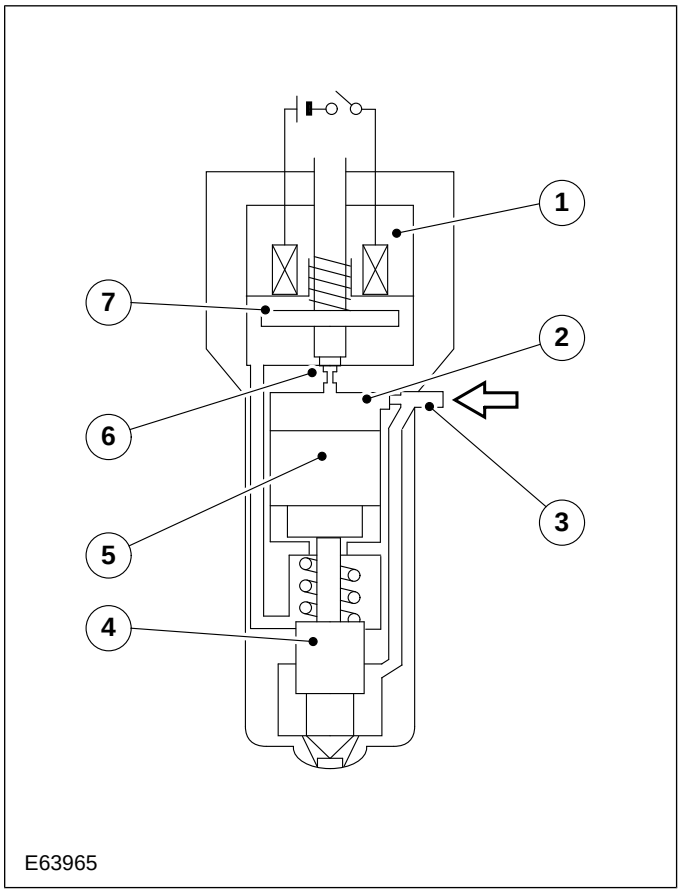
The solenoid has a switching time of approximately 0.4 milliseconds. This short switching time is achieved by keeping the moving components and the distances required to function to a minimum. The design of the fuel injector chambers means that at no time does the solenoid work against any major forces other than that of the two-way valve spring.

The fuel injector nozzle works on a combination of hydraulic and spring control.

All fuel injectors are calibrated to take into account manufacturing tolerances. These calibrations are indicated on the exterior of the fuel injector by a code. The code is used by the PCM to adjust the duration of the fuel injection cycle.

If the codes for the individual fuel injectors are incorrectly matched to the codes stored in the PCM, the engine may exhibit rough idle, increased combustion noise and black smoke emissions.

Fuel injector working state closed



Item	Description
1	Solenoid
2	Control chamber

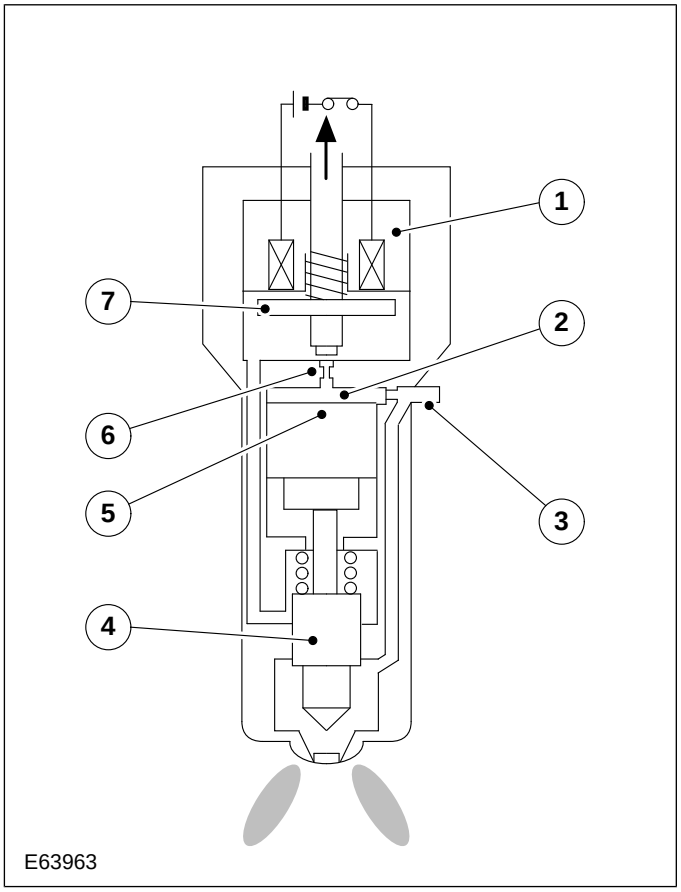
DIAGNOSIS AND TESTING

Item	Description
3	Intake orifice
4	Injector nozzle
5	Command piston
6	Outlet orifice
7	Two-way valve

With the solenoid de-energized, the two-way valve is held in the closed position by the injection control valve spring.

Fuel pressure in the control chamber and the lower chamber is equal to the high-pressure fuel supply pressure. The injector nozzle is held in the closed position by the injector nozzle control spring.

Fuel injector working state opening/injecting



Item	Description
1	Solenoid
2	Control chamber
3	Intake orifice
4	Injector nozzle

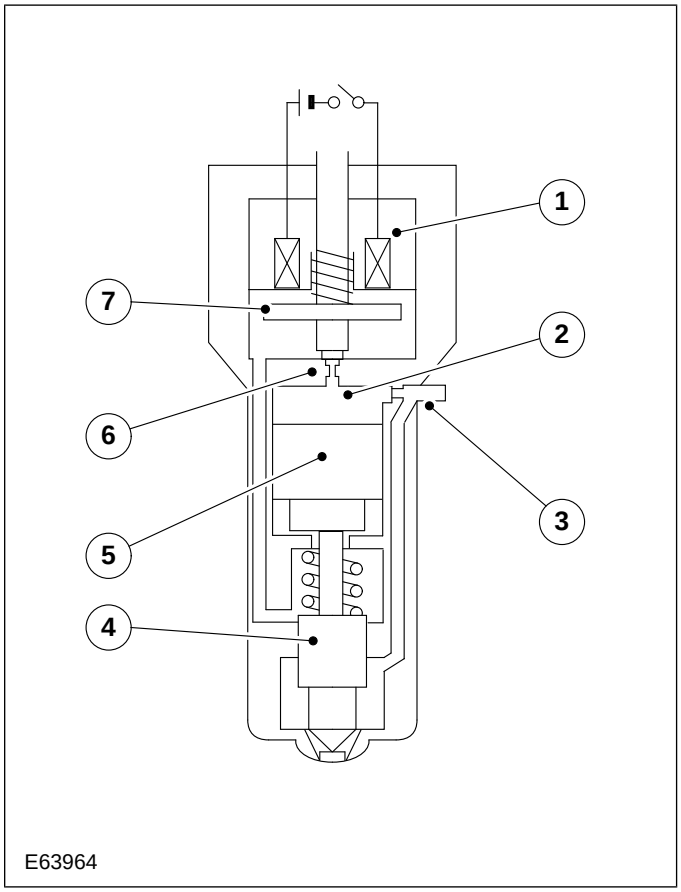
Item	Description
5	Command piston
6	Outlet orifice
7	Two-way valve

The fuel injection process starts with a voltage being applied to the solenoid with a pull-in current of 18 amperes.

The solenoid moves the two-way valve against the pressure of the two-way valve spring.

The two-way valve releases the high-pressure fuel from the control chamber and as the pressure decreases, the command piston is pulled up. This causes the injector nozzle to rise and injection to start.

Fuel injector working state closing



Item	Description
1	Solenoid
2	Control chamber
3	Intake orifice
4	Injector nozzle

DIAGNOSIS AND TESTING

Item	Description
5	Command piston
6	Outlet orifice
7	Two-way valve

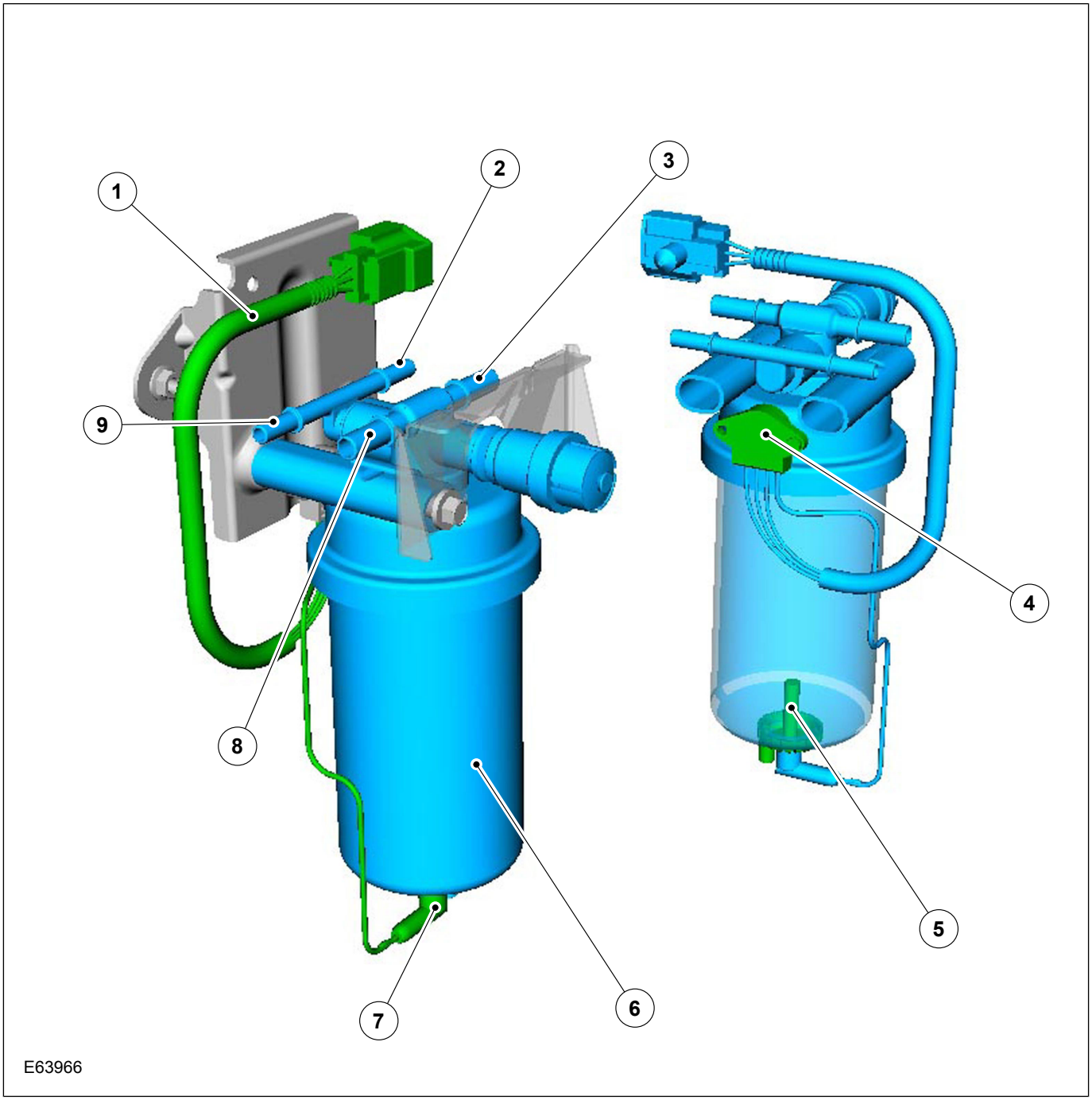
When the solenoid is de-energized, the two-way valve falls and closes the orifice. Fuel then flows into the control chamber through the intake orifice, increasing pressure, which causes the injector nozzle to close and injection to stop.

Fuel injector fuel return

The amount of return fuel developed during the normal functioning of a fuel injector indicates the condition of that fuel injector.

DIAGNOSIS AND TESTING

Fuel filter



Item	Description
1	Fuel filter wiring harness
2	Fuel tank fuel return line union
3	Fuel filter fuel supply line union
4	Water-in-fuel sensor
5	Water-in-fuel sensor probe/fuel filter drain valve
6	Fuel filter element

Item	Description
7	Water-in-fuel sensor probe electrical connector
8	Fuel pump fuel supply line union
9	Fuel pump, fuel rail and fuel injectors fuel return line union

The fuel system is designed to prevent the fuel tank and fuel injection system being run dry. When the fuel tank level reaches a preset limit, after the low fuel indicator has been illuminated, the engine

DIAGNOSIS AND TESTING

will be made to run rough to indicate that the fuel level in the fuel tank is very low. To protect the fuel injection components if this warning is ignored, the PCM will terminate the fuel injection process and the engine will stop.

The fuel filter element in the common rail fuel system is designed to extract far smaller particles from the fuel supply than conventional fuel filters.

To aid with the rapid warm-up of the fuel supply to the fuel pump, the fuel filter is fitted with a temperature conscious fuel return bypass valve.

At temperatures below 50°C, the bypass valve is fully open and the majority of the returned fuel is circulated through the fuel filter and back to the fuel pump.

When the fuel temperature in the fuel filter has reached a temperature above 50°C, the fuel return bypass valve closes and the returned fuel is delivered back to the fuel tank. In certain markets, the return fuel passes through a fuel cooler before returning to the fuel tank.

Inspection and Verification

WARNINGS:

Do not smoke or carry lighted tobacco of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may ignite. Failure to follow these instructions may result in personal injury.

This procedure involves fuel handling. Be prepared for fuel spillage at all times. Failure to follow this instruction may result in personal injury.

CAUTION:Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always fit blanking plugs to any open orifices or lines.

NOTE: As well as carrying out its normal function the glow plug indicator also acts as an engine check lamp which will flash continuously when a hard DTC is detected by the PCM. Soft DTCs are also stored by the PCM but will only be known if the system is checked for DTCs using the WDS.

NOTE: If a DTC is detected, all DTCs must be cleared after the concern is repaired. Failure to clear all DTCs may cause driveability concerns.

NOTE: If the fuel level in the fuel tank drops below approximately four liters, rough running will occur. This is to signal to the driver that the vehicle requires refuelling in order to prevent the fuel system from running dry.

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
Fuel leak(s)	Fuse(s)
Fuel filter	Wiring harness
Air cleaner element	Electrical connector(s)
Vacuum line(s)/vacuum connectors	Relay(s)
Hose(s)/hose connectors	Passive anti-theft system (PATS) LED operation
Tube(s)/tube connectors	Sensor(s)
Contaminated fuel	Glow plug indicator
Fuel supply line(s)	PCM
Fuel return line(s)	
High-pressure fuel supply line(s)	
Fuel injectors	
Fuel rail	
Fuel pump	

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. **NOTE:A PCM calibration update should only be carried out if it is applicable to the symptoms exhibited by the vehicle.**

   If the cause is not visually evident, verify the symptom and refer to the WDS. Check for the availability of an applicable PCM calibration update. Continue with the WDS and retrieve the DTCs.
5. If no DTCs related to the concern are retrieved, proceed to the Symptom Chart to continue diagnostics.

DIAGNOSIS AND TESTING

Symptom Chart

Symptom	Possible Sources	Action
• Engine does not crank and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• Engine does not crank	• Passive anti-theft system (PATS).	• CHECK the PATS LED extinguishes within 3 seconds when the ignition is turned on. REFER to:Anti-Theft - Active (419-01 Anti-Theft - Active, Diagnosis and Testing).
	• Starting system.	• REFER to:Starting System (303-06 Starting System, Diagnosis and Testing).
	• Ignition switch.	• REFER to the Wiring Diagrams.
	• PCM.	• REFER to the WDS.
	• Engine locked.	• REFER to:Engine (303-00 Engine System - General Information, Diagnosis and Testing).
	• Accessories locked.	• REFER to:Accessory Drive (303-05 Accessory Drive, Diagnosis and Testing).
• Engine cranks but does not start and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• Engine cranks but does not start	• Battery	• REFER to:Battery (414-01 Battery, Mounting and Cables, Diagnosis and Testing).
	• Low fuel tank fuel level.	• CHECK the fuel tank fuel level is greater than four liters. If the fuel tank fuel level is less then four litres, FILL with fuel.
	• Inertia fuel shutoff (IFS) switch.	• RESET the IFS switch.
	• Fuel pump.	• REFER to the WDS.
	• Fuel injectors.	• REFER to the WDS.
	• Fuel filter blocked.	• GO to Pinpoint Test A.
	• Fuel lines damaged or blocked.	• GO to Pinpoint Test A.
	• Air ingress into the fuel lines.	• REFER to:Fuel System (310-00 Fuel System - General Information, Diagnosis and Testing).
	• Glow plug relay.	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Glow plugs.	• REFER to the WDS.
	• Crankshaft position (CKP) sensor.	• REFER to the WDS.
	• Camshaft position (CMP) sensor.	• REFER to the WDS.
	• Cylinder head temperature (CHT) sensor.	• REFER to the WDS.
	• FRP sensor.	• REFER to the WDS.
	• Fuel intake metering valve.	• REFER to the WDS.
	• Incorrect valve timing.	• CHECK the valve timing.
	• Low cylinder compression.	• TEST the cylinder compression.
	• PCM.	• REFER to the WDS.
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to: Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to: Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Incorrect pilot learn. • Incorrect pump learn.	• REFER to the WDS.
	• Accessories load.	• REFER to:Accessory Drive (303-05 Accessory Drive, Diagnosis and Testing).
	• Air intake blocked.	• REFER to:Intake Air Distribution and Filtering (303-12 Intake Air Distribution and Filtering, Diagnosis and Testing).
• Poor starting and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• Poor starting	• Low fuel tank fuel level.	• CHECK the fuel tank fuel level is greater than four liters. If the fuel tank fuel level is less then four litres, FILL with fuel.
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Fuel filter blocked.	• GO to Pinpoint Test A.
	• Air cleaner element blocked.	• INSTALL a new air cleaner element.
	• Glow plug relay.	• REFER to the WDS.
	• Glow plugs.	• REFER to the WDS.
	• Fuel system leak.	• CHECK the system for fuel leak(s). REPAIR the system as necessary.
	• Air ingress into the fuel lines.	• REFER to:Fuel System (310-00 Fuel System - General Information, Diagnosis and Testing).
	• Fuel system restriction.	• GO to Pinpoint Test A.
	• Fuel pump.	• GO to Pinpoint Test A.
	• Fuel injector(s).	• REFER to the WDS.
	• Accessories load.	• REFER to:Accessory Drive (303-05 Accessory Drive, Diagnosis and Testing).
	• Incorrect engine oil.	• INSTALL a new engine oil filter and engine oil. CARRY OUT the oil reset procedure. REFER to the Service interval indicator lamp section within the Owner's Guide.
	• Incorrect power steering fluid.	• DRAIN and REFILL the power steering system with the correct fluid. REFER to:Power Steering System Flushing - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (211-00 Steering System - General Information, General Procedures) / Power Steering System Filling (211-00 Steering System - General Information, General Procedures) / Power Steering System Bleeding (211-00 Steering System - General Information, General Procedures).
	• CKP sensor.	• REFER to the WDS.
	• CHT sensor.	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Manifold absolute pressure and temperature (MAPT) sensor.	• REFER to the WDS.
	• FRP sensor.	• REFER to the WDS.
	• Fuel intake metering valve.	• REFER to the WDS.
	• Catalytic converter blocked.	• REMOVE and visually INSPECT the catalytic converter as necessary. REFER to: Catalytic Converter - 2.4L Duratorq-TDCi (Puma) Diesel (309-00 Exhaust System, Removal and Installation).
	• Low cylinder compression.	• TEST the cylinder compression.
• Engine starts but immediately stops and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Engine starts but immediately stops	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• Air cleaner element blocked.	• INSTALL a new air cleaner element.
	• Air ingress into the fuel lines.	• REFER to:Fuel System (310-00 Fuel System - General Information, Diagnosis and Testing).
	• PCM relay.	• CARRY OUT the relay component test. REFER to Wiring Diagrams.
	• Accessories load.	• REFER to:Accessory Drive (303-05 Accessory Drive, Diagnosis and Testing).
	• CKP sensor.	• REFER to the WDS.
	• CMP sensor.	• REFER to the WDS.
	• CHT sensor.	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Fuel intake metering valve.	• REFER to the WDS.
	• PCM.	• REFER to the WDS.
	• Dual mass flywheel.	• Visually INSPECT the dual mass flywheel for damage. INSTALL new parts as necessary.
• Poor idling and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• Poor idling	• Low fuel tank fuel level.	• CHECK the fuel tank fuel level is greater than four liters. If the fuel tank fuel level is less then four litres, FILL with fuel.
	• Air cleaner element blocked.	• INSTALL a new air cleaner element.
	• Accessories load.	• REFER to:Accessory Drive (303-05 Accessory Drive, Diagnosis and Testing).
	• Fuel filter blocked.	• GO to Pinpoint Test A.
	• Fuel injector(s).	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• Air ingress into the fuel lines.	• REFER to:Fuel System (310-00 Fuel System - General Information, Diagnosis and Testing).
	• EGR valve sticking open.	• REFER to:Engine Emission Control (303-08 Engine Emission Control, Diagnosis and Testing).
	• MAPT sensor.	• REFER to the WDS.
	• CKP sensor.	• REFER to the WDS.
	• FRP sensor.	• REFER to the WDS.
	• Fuel intake metering valve.	• REFER to the WDS.
	• Fuel pump.	• GO to Pinpoint Test A.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Dual mass flywheel.	• Visually INSPECT the dual mass flywheel for damage. INSTALL new parts as necessary.
• Engine stumbling and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• Engine stumbling	• Low fuel level.	• CHECK the fuel tank level is greater than four liters. If the fuel tank level is less than four litres, FILL with fuel.
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• Accelerator pedal position (APP) sensor.	• REFER to the WDS.
	• Fuel injector(s).	• REFER to the WDS.
	• Fuel pump.	• GO to Pinpoint Test A.
	• FRP sensor.	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• CKP sensor.	• REFER to the WDS.
	• CMP sensor.	• REFER to the WDS.
	• Dual mass flywheel.	• Visually INSPECT the dual mass flywheel for damage. INSTALL new parts as necessary.
• Engine lacks power and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• Engine lacks power	• Low fuel level.	• CHECK the fuel tank level is greater than four liters. If the fuel tank level is less than four liters, FILL with fuel.
	• Fuel system leak(s).	• Carry out a Fuel System Leak Test using the WDS menu options: ToolBox/Powertrain/Service Functions. REFER to the WDS.
	• Brakes binding.	• CHECK the braking system. REFER to:Brake System (206-00 Brake System - General Information, Diagnosis and Testing).
	• Vehicle overloaded, or excessive wind resistance (roof racks, towing etc).	• ADVISE the customer about the effects of overloading the vehicle and wind resistance on the performance.
	• Accessories load.	• REFER to:Accessory Drive (303-05 Accessory Drive, Diagnosis and Testing).
	• Air cleaner element blocked.	• INSTALL a new air cleaner element as necessary.
	• Fuel filter blocked.	• GO to Pinpoint Test A.
	• Kinked or restricted fuel lines.	• GO to Pinpoint Test A.
	• Fuel pump.	• GO to Pinpoint Test A.
	• Fuel injector(s).	• REFER to the WDS.
	• Air ingress into the fuel lines.	• REFER to:Fuel System (310-00 Fuel System - General Information, Diagnosis and Testing).
	• Turbocharger. • Turbocharger vacuum control. • Turbocharger vacuum diaphragm unit. • Vane adjustment solenoid valve.	• INSPECT the vacuum line(s) for visible signs of damage or blockage. CLEAN, REPAIR or INSTALL new parts as necessary.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• EGR valve sticking open.	• REFER to:Engine Emission Control (303-08 Engine Emission Control, Diagnosis and Testing).
	• Charge air cooler blocked or cracked. • Charge air cooler pipes split or cracked. • Charge air cooler retaining clips missing or loose.	• INSPECT for visible signs of damage or blockage. CLEAN, REPAIR or INSTALL new parts as necessary.
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• Vehicle speed sensor (VSS).	• REFER to the WDS.
	• CHT sensor.	• REFER to the WDS.
	• MAPT sensor.	• REFER to the WDS.
	• MAF sensor.	• REFER to the WDS.
	• APP sensor.	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• CKP sensor.	• REFER to the WDS.
	• Fuel pressure relief valve.	• REFER to the WDS.
	• FRP sensor.	• REFER to the WDS.
	• Fuel intake metering valve.	• REFER to the WDS.
	• Incorrect valve timing.	• CHECK the valve timing.
	• Low cylinder compression.	• CHECK the cylinder compression
	• Catalytic converter blocked.	• REMOVE and visually INSPECT the catalytic converter for damage. INSTALL a new catalytic converter as necessary. REFER to:Catalytic Converter - 2.4L Duratorq-TDCi (Puma) Diesel (309-00 Exhaust System, Removal and Installation).
	• Wiring harness/connector.	• REFER to the WDS.
	• PCM.	• REFER to:Electronic Engine Controls (303-14 Electronic Engine Controls, Diagnosis and Testing).
• Black smoke at idle and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Black smoke at idle	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• Air cleaner element blocked.	• INSTALL a new air cleaner element as necessary.
	• Glow plug relay.	• REFER to the WDS.
	• Fuel injector(s).	• REFER to the WDS.
	• Turbocharger vacuum control. • Vane adjustment solenoid valve.	• INSPECT for visible signs of damage or blockage. CLEAN, REPAIR or INSTALL new parts as necessary. REFER to:Turbocharger (303-04 Fuel Charging and Controls - Turbocharger, Diagnosis and Testing).
	• Incorrect pilot learn. • Incorrect pump learn.	• REFER to the WDS.
	• Incorrect engine timing.	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Fuel pressure relief valve.	• REFER to the WDS.
	• CHT sensor.	• REFER to the WDS.
	• CKP sensor.	• REFER to the WDS.
	• MAPT sensor.	• REFER to the WDS.
	• FRP sensor.	• REFER to the WDS.
	• Incorrect valve timing.	• CHECK the valve timing.
	• Catalytic converter blocked.	• REMOVE and visually INSPECT the catalytic converter for damage. INSTALL a new catalytic converter as necessary. REFER to: Catalytic Converter - 2.4L Duratorq-TDCi (Puma) Diesel (309-00 Exhaust System, Removal and Installation).
	• Wiring harness/connector.	• REFER to the WDS.
	• PCM.	• REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls, Diagnosis and Testing).
• Excessive black smoke during acceleration and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• Excessive black smoke during acceleration	• Air cleaner element blocked.	• INSTALL a new air cleaner element as necessary.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• EGR valve sticking open.	• REFER to:Engine Emission Control (303-08 Engine Emission Control, Diagnosis and Testing).
	• Incorrect pilot learn. • Incorrect pump learn.	• REFER to the WDS.
	• Fuel injector(s).	• REFER to the WDS.
	• APP sensor.	• REFER to the WDS.
	• CKP sensor.	• REFER to the WDS.
	• Fuel pressure relief valve.	• REFER to the WDS.
	• FRP sensor.	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Catalytic converter blocked.	• REMOVE and visually INSPECT the catalytic converter for damage. INSTALL a new catalytic converter as necessary. REFER to: Catalytic Converter - 2.4L Duratorq-TDCi (Puma) Diesel (309-00 Exhaust System, Removal and Installation).
	• Wiring harness/connector.	• REFER to the WDS.
	• PCM.	• REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls, Diagnosis and Testing).
• Black smoke at cruising speeds and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Black smoke at cruising speeds	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• Air cleaner element blocked.	• INSTALL a new air cleaner element.
	• EGR valve sticking open.	• REFER to:Engine Emission Control (303-08 Engine Emission Control, Diagnosis and Testing).
	• Incorrect pilot learn. • Incorrect pump learn.	• REFER to the WDS.
	• Fuel pressure relief valve.	• REFER to the WDS.
	• Turbocharger vacuum diaphragm unit. • Vane adjustment solenoid valve.	• REFER to:Turbocharger (303-04 Fuel Charging and Controls - Turbocharger, Diagnosis and Testing).
	• Incorrect engine timing.	• REFER to the WDS.
	• CHT sensor.	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• MAPT sensor.	• REFER to the WDS.
	• Fuel injector(s).	• REFER to the WDS.
	• FRP sensor.	• REFER to the WDS.
	• Catalytic converter blocked.	• REMOVE and visually INSPECT the catalytic converter for damage. INSTALL a new catalytic converter as necessary. REFER to: Catalytic Converter - 2.4L Duratorq-TDCi (Puma) Diesel (309-00 Exhaust System, Removal and Installation).
	• Wiring harness/connector.	• REFER to the WDS.
	• PCM.	• REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls, Diagnosis and Testing).
• Blue smoke and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• Blue smoke	• Engine burning oil.	• CARRY OUT a controlled oil consumption test over 1000 km (600 miles). CONFIRM that the oil consumption is less than 0.1 litre per 1000 km (600 miles).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• Positive crankcase ventilation (PCV) system.	• INSPECT for visible signs of damage or blockage. CLEAN, REPAIR or INSTALL new parts as necessary.
	• Turbocharger oil return tube blocked or damaged.	• REFER to:Turbocharger (303-04 Fuel Charging and Controls - Turbocharger, Diagnosis and Testing).
	• Worn or damaged valve guide(s), piston ring(s), cylinder bore(s), cylinder head or gasket.	• REMOVE the cylinder head. INSPECT the cylinder head, pistons and cylinder bores for signs of wear or damage. REFER to:Cylinder Head (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• White smoke and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• White smoke	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• Incorrect pilot learn. • Incorrect pump learn.	• REFER to the WDS.
	• Fuel pressure relief valve.	• REFER to the WDS.
	• Incorrect engine timing.	• REFER to the WDS.
	• Fuel injector(s).	• REFER to the WDS.
	• EGR valve sticking open.	• REFER to:Engine Emission Control (303-08 Engine Emission Control, Diagnosis and Testing).
	• Incorrect valve timing.	• CHECK the valve timing.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Coolant in the combustion chamber.	• CARRY OUT a cooling system pressure test. REFER to:Engine Cooling - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Diagnosis and Testing). REMOVE the cylinder head. INSPECT the cylinder head, cylinder head gasket and cylinder bores for wear or damage. REFER to:Cylinder Head (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).
	• Wiring harness/connector.	• REFER to the WDS.
	• PCM.	• REFER to:Electronic Engine Controls (303-14 Electronic Engine Controls, Diagnosis and Testing).
• Engine misfire and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• Engine misfire	• Low fuel tank level.	• CHECK the fuel tank level is greater than four liters. If the fuel tank level is less than four litres, FILL with fuel.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• Incorrect pilot learn. • Incorrect pump learn.	• REFER to the WDS.
	• Fuel pressure relief valve.	• REFER to the WDS.
	• Incorrect engine timing.	• REFER to the WDS.
	• Air ingress into the fuel lines.	• REFER to:Fuel System (310-00 Fuel System - General Information, Diagnosis and Testing).
	• Fuel pump.	• GO to Pinpoint Test A.
	• Fuel injector(s).	• REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• EGR valve sticking open.	• REFER to:Engine Emission Control (303-08 Engine Emission Control, Diagnosis and Testing).
	• Engine operating temperature too high.	• REFER to:Engine Cooling - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (303-03 Engine Cooling, Diagnosis and Testing).
	• CHT sensor.	• REFER to the WDS.
	• CKP sensor.	• REFER to the WDS.
	• CMP sensor.	• REFER to the WDS.
	• MAPT sensor.	• REFER to the WDS.
	• FRP sensor.	• REFER to the WDS.
	• Low cylinder compression.	• CHECK the cylinder compression.
	• Worn or damaged valve(s), tappet(s), camshaft(s) or cylinder head gasket.	• REMOVE the cylinder head. INSPECT the cylinder head, valves, tappets and camshafts for signs of wear or damage. REFER to:Cylinder Head (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).
	• Wiring harness/connector.	• REFER to the WDS.
	• PCM.	• REFER to:Electronic Engine Controls (303-14 Electronic Engine Controls, Diagnosis and Testing).
• Engine knock at idle and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• Engine knock at idle	• Low engine oil level.	• CHECK the engine oil level. REFILL as necessary.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• Incorrect pilot learn. • Incorrect pump learn.	• REFER to the WDS.
	• Incorrect engine timing.	• REFER to the WDS.
	• Fuel injector(s).	• REFER to the WDS.
	• CKP sensor.	• REFER to the WDS.
	• Incorrect valve timing.	• CHECK the valve timing.
	• Excessive carbon build up.	• REMOVE the cylinder head. INSPECT the cylinder head and pistons for signs carbon build up. REFER to:Cylinder Head (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Worn or damaged oil pump. • Worn or damaged timing chain or sprocket. • Major mechanical engine failure.	• INSPECT the engine components.
	• Dual mass flywheel.	• Visually INSPECT the dual mass flywheel for damage. INSTALL new parts as necessary.
	• Wiring harness/connector.	• REFER to the WDS.
	• PCM.	• REFER to:Electronic Engine Controls (303-14 Electronic Engine Controls, Diagnosis and Testing).
• Engine knock during acceleration and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
• Engine knock during acceleration	• Incorrect pilot learn. • Incorrect pump learn.	• REFER to the WDS.
	• Incorrect engine timing.	• REFER to the WDS.
	• Fuel injector(s).	• REFER to the WDS.
	• Fuel intake metering valve.	• REFER to the WDS.
	• Fuel pump.	• GO to Pinpoint Test A.
	• Major mechanical engine failure.	• REFER to:Engine (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, Diagnosis and Testing).
	• Wiring harness/connector.	• REFER to the WDS.
	• PCM.	• REFER to:Electronic Engine Controls (303-14 Electronic Engine Controls, Diagnosis and Testing).
• Excessive fuel consumption and glow plug indicator is flashing	• DTC detected.	• REFER to the WDS.
NOTE: Before proceeding with any of the actions in relation to the possible sources for excessive fuel consumption, a fuel consumption test must be carried out using the WDS. • Excessive fuel consumption	• Brakes binding.	• CHECK the braking system. REFER to:Brake System (206-00 Brake System - General Information, Diagnosis and Testing).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Vehicle overloaded, or excessive wind resistance (roof racks, towing etc).	• ADVISE the customer about the effects of overloading the vehicle and wind resistance on the fuel consumption.
	• Incorrect or contaminated fuel.	• CHECK for signs of contamination such as strange odors from the fuel tank. • CHECK for signs of water or petrol in the diesel. • If contaminated fuel is found, DRAIN the complete fuel system. FLUSH the fuel system through with clean diesel. INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). INSTALL a new fuel pump, fuel injectors, fuel rail, and high-pressure fuel supply lines. REFER to:Fuel Pump (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Injectors (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation) / Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).
	• Air cleaner element blocked.	• INSTALL a new air cleaner element.
	• Fuel filter blocked.	• GO to Pinpoint Test A.
	• Incorrect pilot learn. • Incorrect pump learn.	• REFER to the WDS.
	• Incorrect engine timing.	• REFER to the WDS.
	• Fuel system leak(s).	• CHECK the system for fuel leak(s). REPAIR or INSTALL new parts as necessary.
	• Incorrect engine oil.	• INSTALL a new oil filter and engine oil.

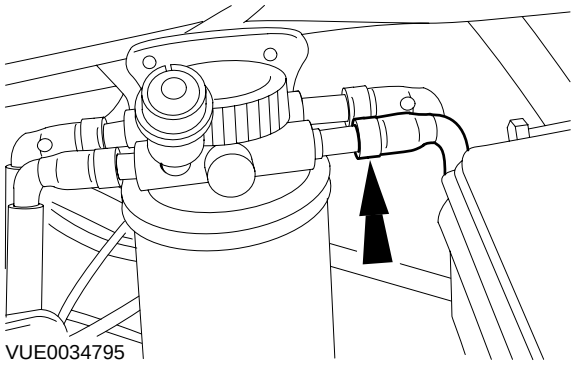
DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Generator.	• REFER to:Generator (414-02 Generator and Regulator, Diagnosis and Testing).
	• EGR valve sticking open.	• REFER to:Engine Emission Control (303-08 Engine Emission Control, Diagnosis and Testing).
	• Turbocharger vacuum diaphragm unit.	• REFER to:Turbocharger (303-04 Fuel Charging and Controls - Turbocharger, Diagnosis and Testing).
	• Air ingress into the fuel lines.	• REFER to:Fuel System (310-00 Fuel System - General Information, Diagnosis and Testing).
	• Fuel pressure relief valve.	• REFER to the WDS.
	• CHT sensor.	• REFER to the WDS.
	• MAPT sensor.	• REFER to the WDS.
	• Fuel injector(s).	• REFER to the WDS.
	• Turbocharger.	• REFER to:Turbocharger (303-04 Fuel Charging and Controls - Turbocharger, Diagnosis and Testing).
	• Incorrect valve timing.	• CHECK the valve timing.
	• Slipping clutch.	• REFER to:Manual Transmission and Clutch - Vehicles With: MT-75 (308-00 Manual Transmission/Transaxle and Clutch - General Information, Diagnosis and Testing) / Manual Transaxle and Clutch - Vehicles With: VXT-75 (308-00 Manual Transmission/Transaxle and Clutch - General Information, Diagnosis and Testing) / Manual Transmission and Clutch - Vehicles With: MT82 (308-00 Manual Transmission/Transaxle and Clutch - General Information, Diagnosis and Testing).
	• Low cylinder compression.	• CHECK the cylinder compression.
	• Dual mass flywheel.	• Visually INSPECT the dual mass flywheel for damage. INSTALL new parts as necessary.

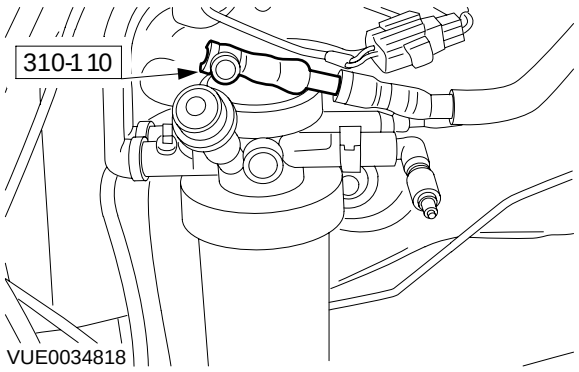
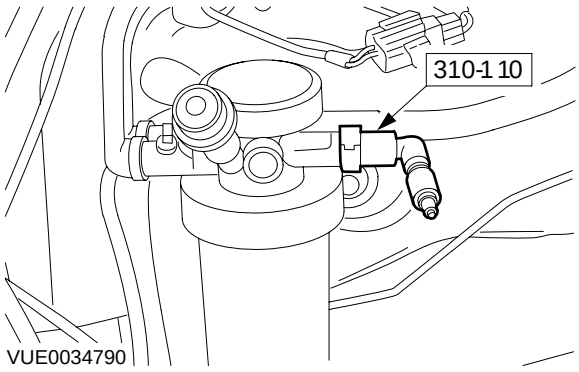
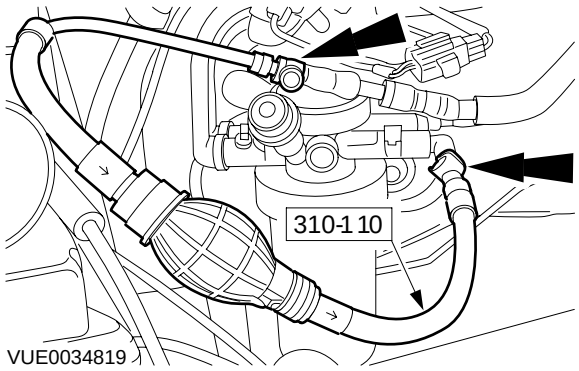
DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Wiring harness/connector.	• REFER to the WDS.
	• PCM.	• REFER to:Electronic Engine Controls (303-14 Electronic Engine Controls, Diagnosis and Testing).
• Engine cuts out during hard acceleration	• CMP sensor.	• REFER to the WDS.
	• CKP sensor.	• REFER to the WDS.
	• Incorrect pilot learn. • Incorrect pump learn.	• REFER to the WDS.
	• Fuel pressure relief valve.	• REFER to the WDS.
	• FRP sensor.	• REFER to the WDS.
	• Fuel intake metering valve.	• REFER to the WDS.
	• Fuel pump.	• GO to Pinpoint Test A.

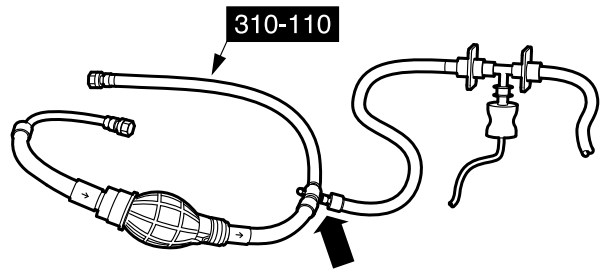
PINPOINT TEST A : FUEL PUMP FUEL SUPPLY TEST

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK THE FUEL PUMP FUEL SUPPLY PRESSURE	
	1 Clean the area around the fuel filter quick release couplings. REFER to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).
 VUE0034795	2 Disconnect the fuel tank to fuel filter fuel supply line quick release coupling. REFER to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).

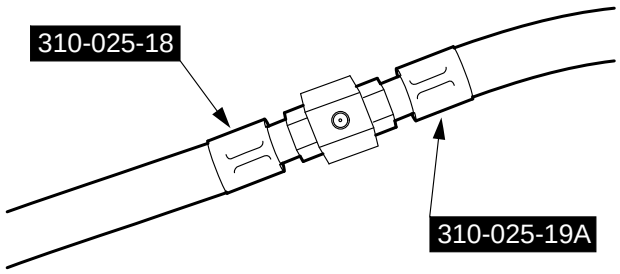
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Install the special tool adapter to the fuel tank to fuel filter fuel supply line.
	4 Install the special tool adapter to the fuel filter.
	**NOTE:**Make sure that the hand primer arrow indicating the fuel flow is pointing towards the fuel filter. 5 Install the special tool between the special tool adapters.

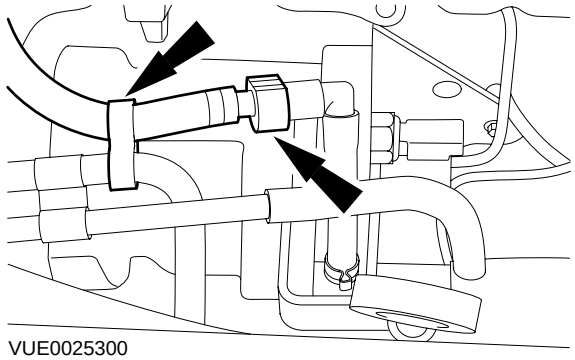
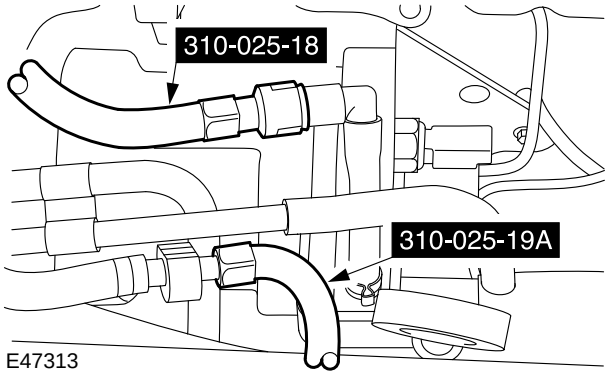
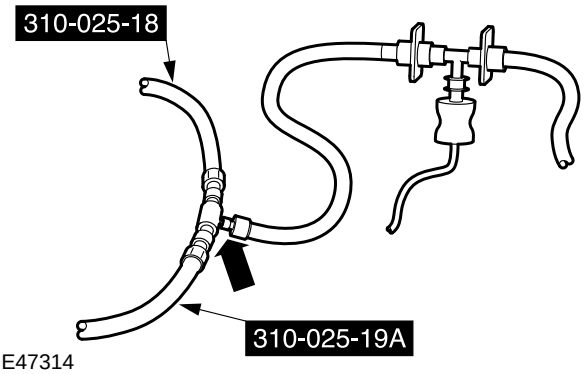
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E47294	6 Connect the WDS pressure transducer to the special tool.
	7 Using the WDS, select the digital multi meter (DMM) function from the toolbox menu. Select the pressure vacuum transducer (PVT) function and configure the DMM to display pressure/vacuum.
	8 Remove the lint-free material protecting the generator if installed.
	9 Start the engine.
	10 Allow the engine to idle for at least one minute.
	11 Make a note of the value displayed by the WDS. • Is the value displayed between -50 mB and -250 mB? → **Yes** GO to A3. → **No** If the displayed value is between 0 mB and -50 mB, GO to A2. If the displayed value is -250 mB or a greater negative value, GO to A4.

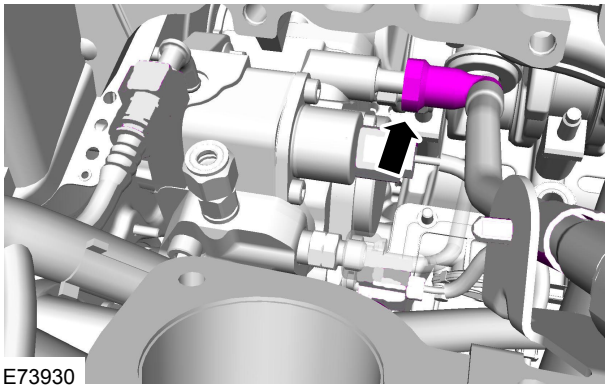
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A2: CHECK THE FUEL SYSTEM FOR AIR INGRESS	
	NOTE:A small amount of air bubbles in the fuel supply line is acceptable. 1 Observe the flow of fuel through the clear plastic pipe of the hand pressure pump. • Is the hand pressure pump clear plastic pipe free from an excessive volume of air bubbles? → **Yes** Using the WDS, guided diagnostic, run the fuel system pressure test, CHECK the fuel pump high-pressure fuel supply pressure. → **No** CHECK for air ingress into the fuel lines. REFER to:Fuel System (310-00 Fuel System - General Information, Diagnosis and Testing).
A3: CHECK THE FUEL PUMP FUEL RETURN PRESSURE	
NOTE: Before this test can be carried out, the latest calibration must be programed into the PCM.	
	1 Clean the area around the fuel injector to fuel pump fuel return line quick release coupling. REFER to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).
 E46840	2 Connect special tools 310-025-18 and 310-025-19A to the WDS pressure transducer adaptor GV2323.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VUE0025300	3 Disconnect the fuel injector to fuel pump fuel return line quick release coupling. REFER to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).
 E47313	4 Connect the special tools between the fuel injector to fuel pump fuel return line and the fuel pump.
	5 Start the engine.
	6 Using the WDS data logger function, monitor the fuel system temperature until a temperature of over 50°C is obtained.
	7 Stop the engine.
	8 Disconnect the WDS pressure transducer from the special tool 310-110.
 E47314	9 Connect the WDS pressure transducer to the WDS pressure transducer adaptor GV2323.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	10 Using the WDS, select the digital multimeter (DMM) function from the toolbox menu. Select the pressure vacuum transducer (PVT) function and configure the DMM to display pressure/vacuum.
	11 Start the engine.
	12 Make a note of the value displayed by the WDS with the engine at idle. • Is the value displayed less than 400mB at idle. → **Yes** Using the WDS fuel system fuel pressure test. CHECK the fuel pump high-pressure fuel supply pressure. If no fault is indicated with the fuel pump high-pressure fuel supply pressure, RETURN to the Symptom Chart. → **No** CHECK the fuel return system for damage or restriction. REPAIR or INSTALL new components as required. TEST the system for normal operation.
A4: CHECK THE FUEL PUMP FUEL SUPPLY SYSTEM FOR RESTRICTION	
	1 Clean the area around the fuel pump fuel supply line quick release coupling. REFER to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).
 E73930	2 Disconnect the fuel pump fuel supply line. REFER to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures). – Install a blanking plug to the open end of the fuel pump union.
	3 Place the open end of the fuel pump fuel supply line into a clean container.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Operate the hand pressure pump at least three times in rapid succession and observe the value displayed by the WDS. • Does the fuel pressure indicated by the WDS when operating the hand pressure pump instantly fall to zero when the hand pressure pump is released? → **Yes** CHECK the fuel level sensor and fuel tank fuel supply line for restriction. REPAIR or INSTALL new components as required. → **No** INSTALL a new fuel filter element. REFER to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation). Test the system for normal operation.

GENERAL PROCEDURES

Fuel Injection Component Cleaning

General Equipment

Pneumatic vacuum gun

WARNINGS:

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may ignite. Failure to follow these instructions may result in personal injury.

Do not carry out any repairs to the fuel injection system with the engine running. The fuel pressure within the system can be as high as 1600 bar. Failure to follow this instruction may result in personal injury.

Eye protection must be worn at all times when working on or near any fuel related components. Failure to follow this instruction may result in personal injury.

CAUTIONS:

Make sure that the workshop area in which the vehicle is being worked on is as clean and dust-free as possible. Areas in which work on clutches, brakes or where welding or machining are carried out are not suitable in view of the risk of contamination to the fuel system.

Make sure that clean non-plated tools are used. Clean tools using a new brush that will not lose its bristles and fresh suitable evaporative cleaning agent, prior to starting work on the vehicle.

Use a steel topped workbench and cover it with clean, lint-free non-flocking material.

Make sure that all parts removed from the vehicle are placed on the lint-free non-flocking material.

Make sure that any protective clothing worn is clean and made from lint-free non-flocking material.

Make sure that any protective gloves worn are new and are of the non-powdered latex type.

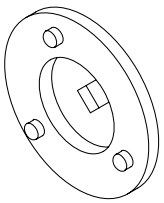
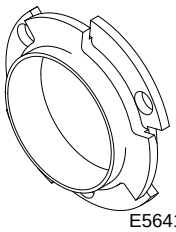
Before using the suitable evaporative cleaning agent, protect all electrical components and connectors with lint-free non-flocking material.

1. **Using a new brush that will not lose its bristles, brush a suitable evaporative cleaning agent onto the components being removed and onto the surrounding area.**
2. **Using the pneumatic vacuum gun, remove all traces of evaporative cleaning agent and foreign material.**
3. **Dispose of any unused evaporative cleaning agent and the brush after completing the repair.**

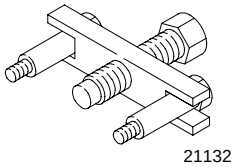
REMOVAL AND INSTALLATION

Fuel Pump

Special Tool(s)

 303679	Remover/Installer, Engine Front Cover Inspection Plate 303-679
 E56412	Locking Tool, Fuel Injection Pump Sprocket 303-1151

Special Tool(s)

 21132	Remover, Crankshaft Timing Pulley 303-249

General Equipment

Worldwide Diagnostic System (WDS)

Removal

WARNINGS:

Refer to:Health and Safety Precautions (100-00 General Information, Description and Operation).

Make sure that the engine is switched off.

Make sure that the fuel pressure has dropped to zero and that the fuel temperature is at ambient temperature.

Wait for a minimum of 1 minute after the engine has stopped before commencing any repair to the fuel injection system.

1. Within the datalogger function of the WDS, check that the fuel pressure has dropped to zero and that the fuel temperature has either reached ambient temperature or is below 30ºC whichever is the greater.

   General Equipment: Worldwide Diagnostic System (WDS)

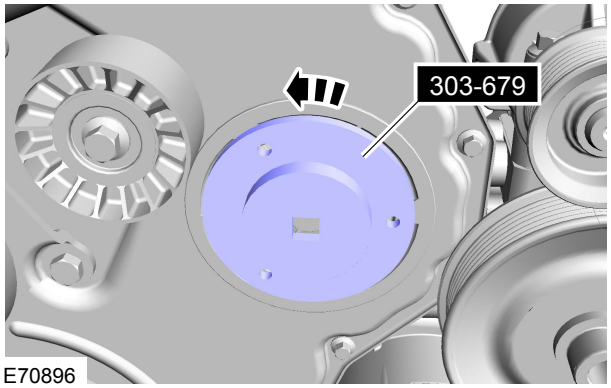
2. Disconnect the battery ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

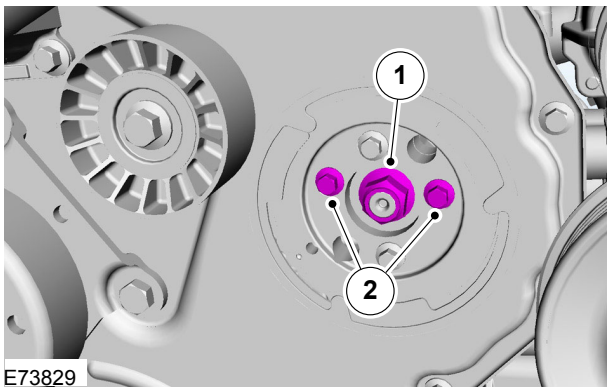
3. Remove the accessory drive belt.

   Refer to:Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).

4. Special Tool(s): 303-679



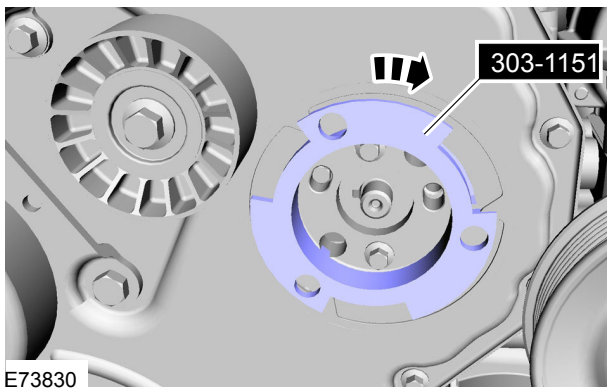
5.



REMOVAL AND INSTALLATION

6. Using the special tool, support the fuel pump sprocket.

   Special Tool(s): 303-1151



7. Remove the intake manifold.

   Refer to:Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

8. **CAUTIONS:**

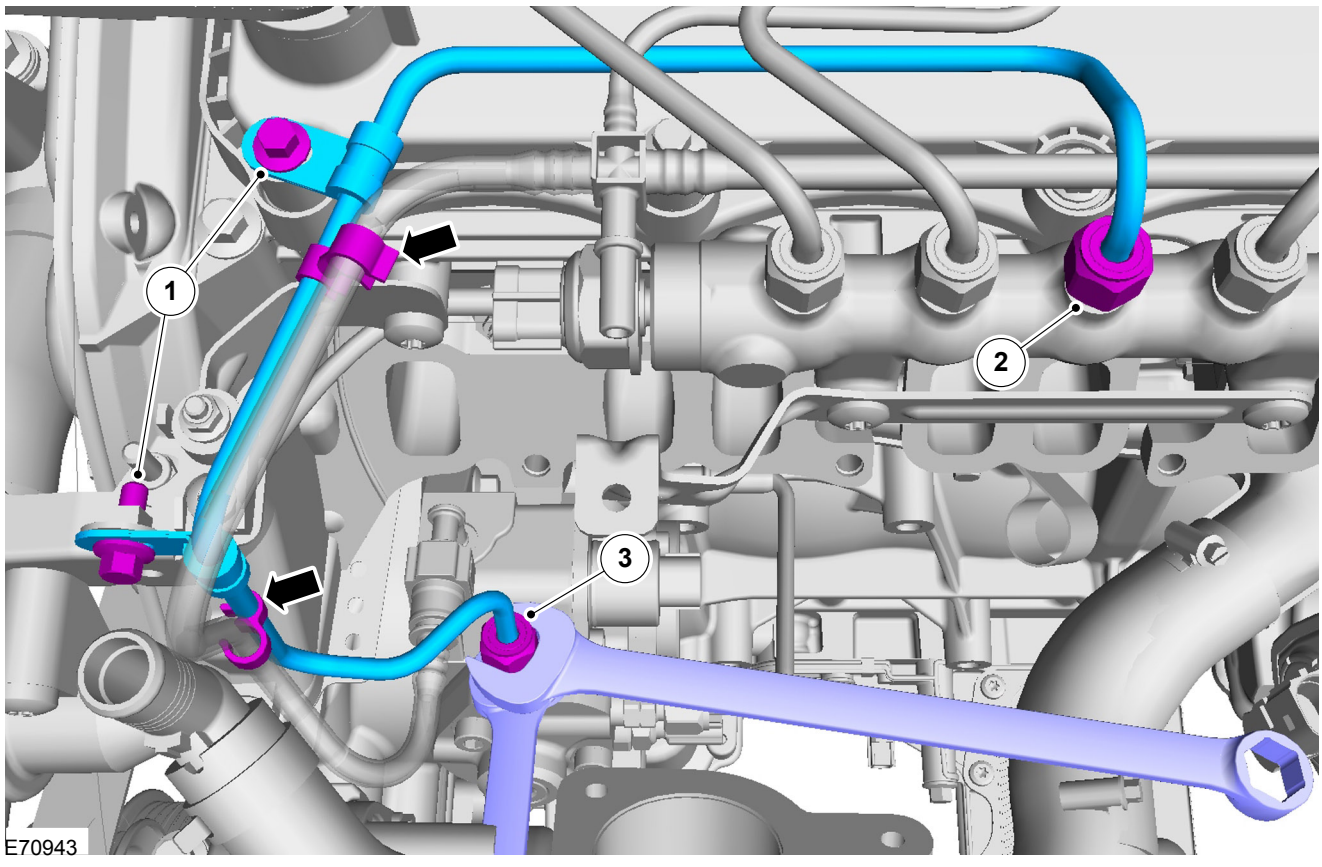
   Make sure that the fuel line remains in contact at both ends until both unions nuts have been unscrewed and the area around the joints thoroughly cleaned.

   Make sure that all openings are sealed. Use new blanking caps.

   1. Torque: 10 Nm
   2. Vacuum foreign material from the high-pressure fuel supply line, the fuel pump and the fuel rail.

      Refer to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).

      Torque: 35 Nm

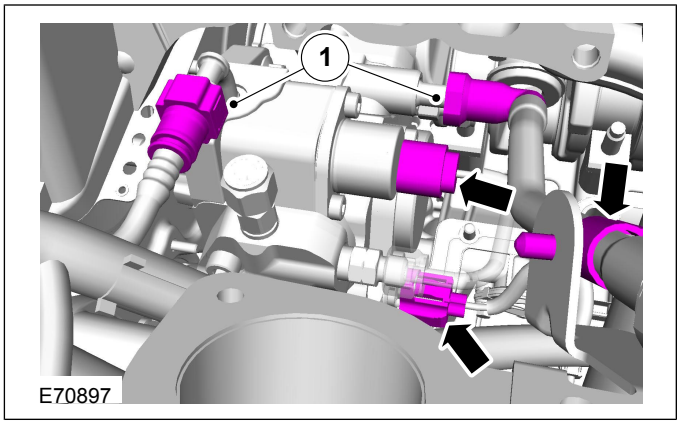


9. Discard the high-pressure fuel supply line.

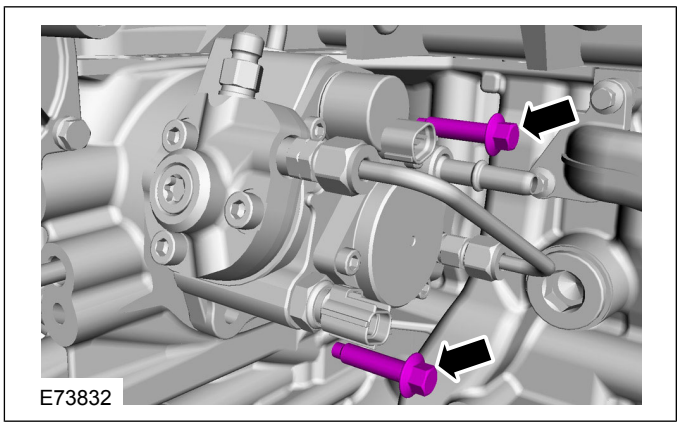
REMOVAL AND INSTALLATION

10. **CAUTION:Make sure that all openings are sealed. Use new blanking caps.**
    1. Vacuum foreign material from the high-pressure fuel supply line and fuel return line.

       Refer to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).
       Refer to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).

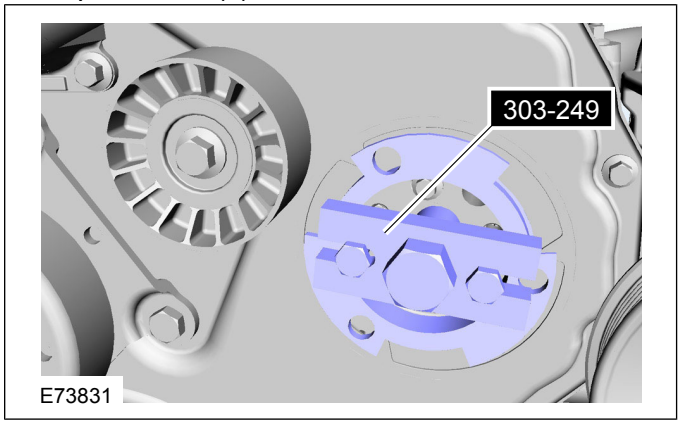


11.

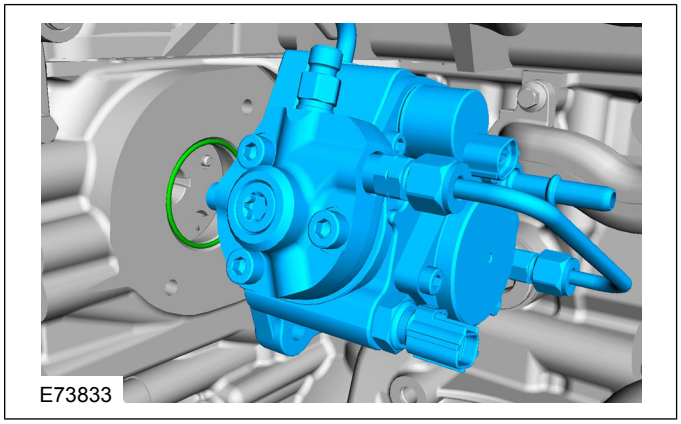


12. While supporting the fuel pump, operate the special tool.

    Special Tool(s): 303-249



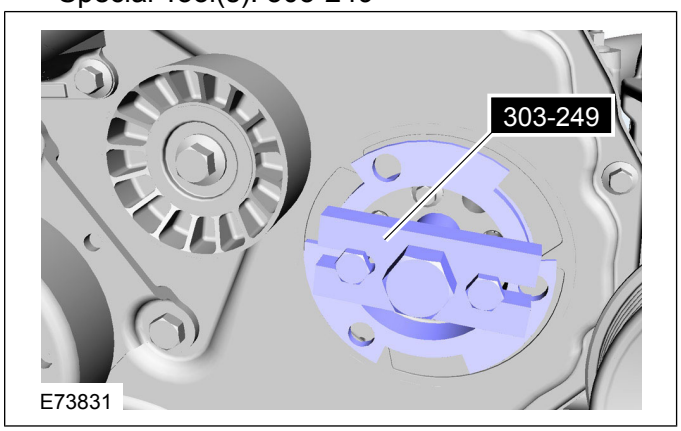
13.



Installation

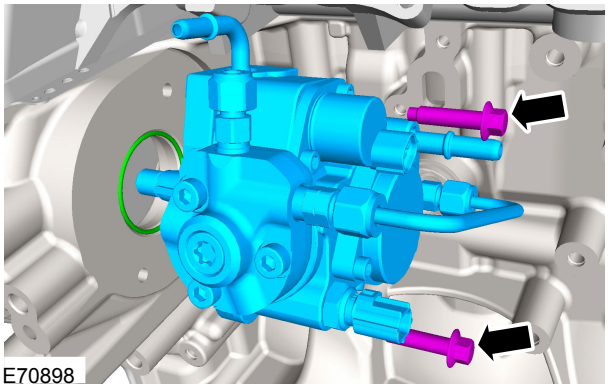
1. Remove the special tool.

   Special Tool(s): 303-249

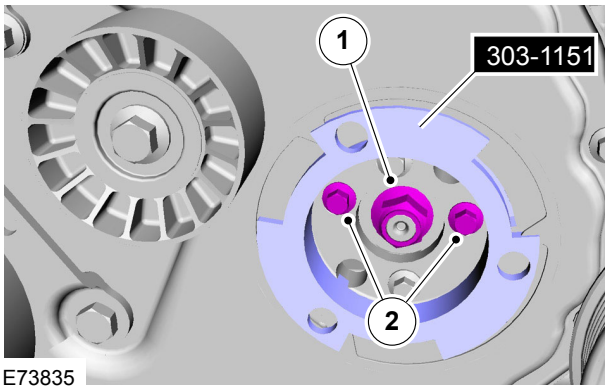


REMOVAL AND INSTALLATION

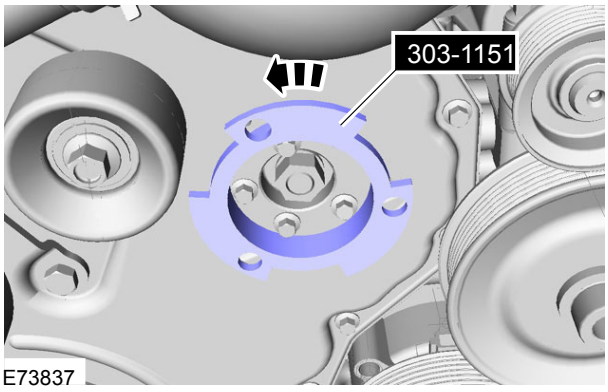
2. Torque: 23 Nm



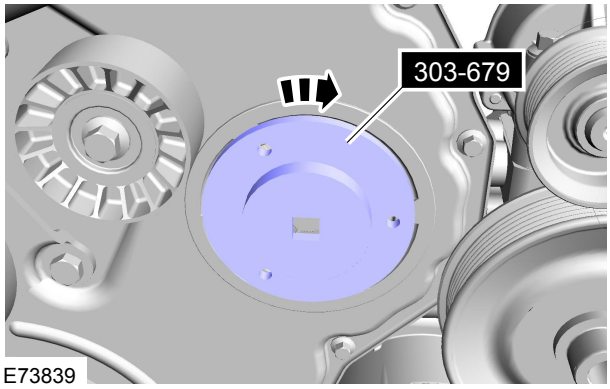
3. 1. Torque: 64 Nm
2. Torque: 33 Nm



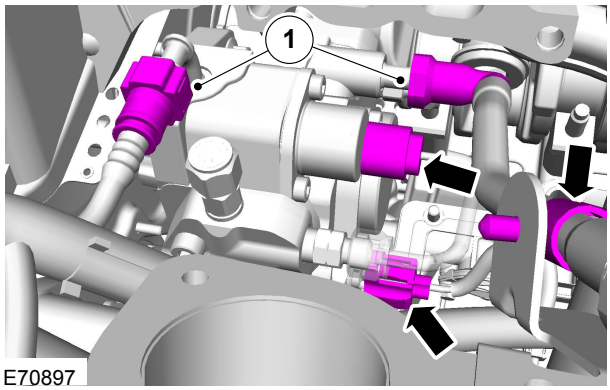
4. Special Tool(s): 303-1151



5. Special Tool(s): 303-679

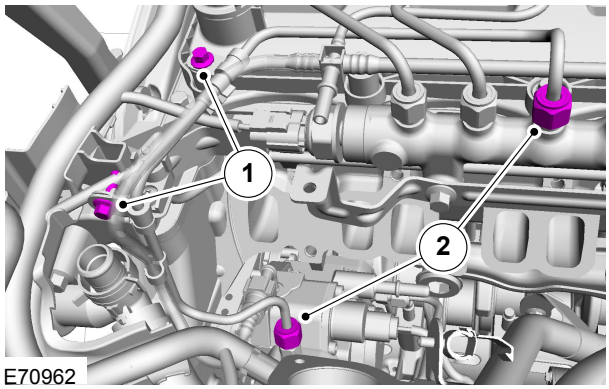


6.



7. Install a new fuel rail high-pressure fuel supply line.

8. Tighten the fuel rail high-pressure fuel supply line unions in two stages, in the sequence indicated.
Torque:
- Fuel rail high-pressure fuel supply line bracket bolts 10 Nm
- Fuel rail high-pressure fuel supply line unions
  - Stage1: 5 Nm
  - Stage2: 35 Nm



REMOVAL AND INSTALLATION

9. Install the intake manifold.

   Refer to:Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

10. Install the accessory drive belt.

    Refer to:Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).

11. Connect the battery ground cable.

    Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

12. Install a new fuel filter element.

    Refer to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation).

13. Carry out a Fuel System Leak Test using the following WDS menu options: ToolBox/Powertrain/Service Functions

    General Equipment: Worldwide Diagnostic System (WDS)

14. Carry out a Pump Learn procedure using the following WDS menu options: ToolBox/Powertrain/Service Functions

    General Equipment: Worldwide Diagnostic System (WDS)

15. Carry out the Pilot Correction Learn procedure using the following WDS menu options: ToolBox/Powertrain/Service Functions

    General Equipment: Worldwide Diagnostic System (WDS)

REMOVAL AND INSTALLATION

Fuel Rail

General Equipment

Worldwide Diagnostic System (WDS)

Removal

WARNINGS:

Make sure that the engine is switched off.

Make sure that the fuel pressure has dropped to zero and that the fuel temperature is at ambient temperature.

Wait at least 1 minute after the engine has stopped before commencing any repair to the fuel injection system.

CAUTION:Always carry out the cleaning process before carrying out any repairs to the fuel injection system components.

NOTE: Removal steps in this procedure may contain installation details.

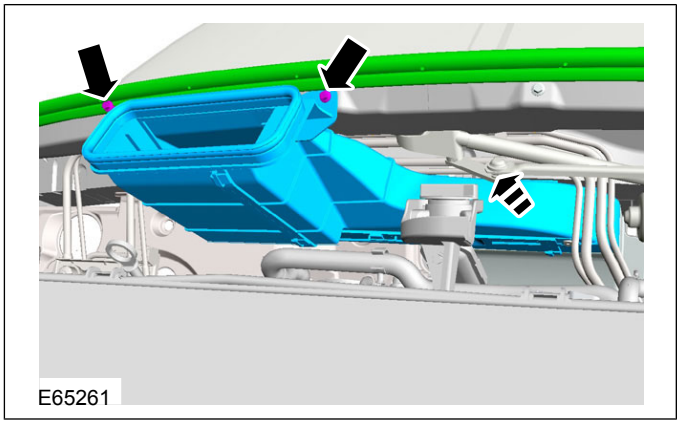
1. Within the datalogger function of WDS, check that the fuel pressure has dropped to zero and that the fuel temperature has either reached ambient temperature or is below 30ºC whichever is the greater.

   General Equipment: Worldwide Diagnostic System (WDS)

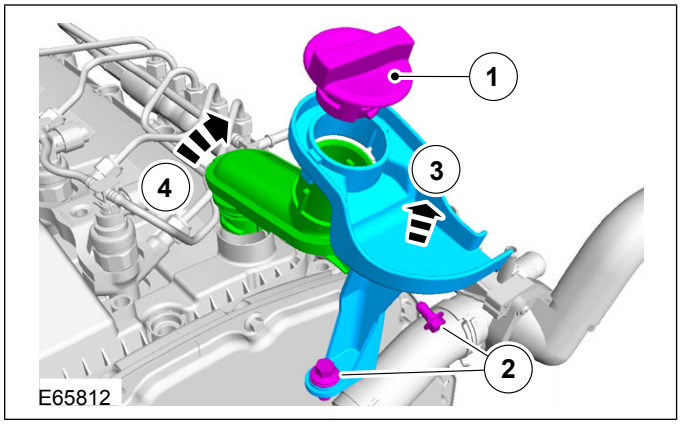
2. Disconnect the battery ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

3.



4.



5. Remove the intake manifold.

   Refer to:Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

6. **CAUTIONS:**

   Make sure that the fuel line remains in contact at both ends until both unions nuts have been unscrewed and the area around the joints thoroughly cleaned.

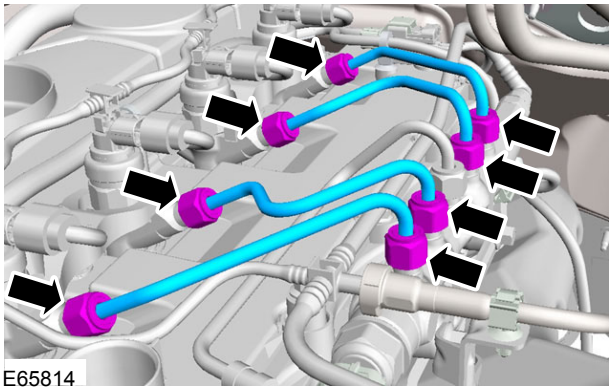
   Make sure that all openings are sealed. Use new blanking caps.

   Vacuum foreign material from the high-pressure fuel supply line, the fuel injector and the fuel rail.

   Refer to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, General Procedures).

REMOVAL AND INSTALLATION

7. Discard the high-pressure fuel supply lines.


E65814

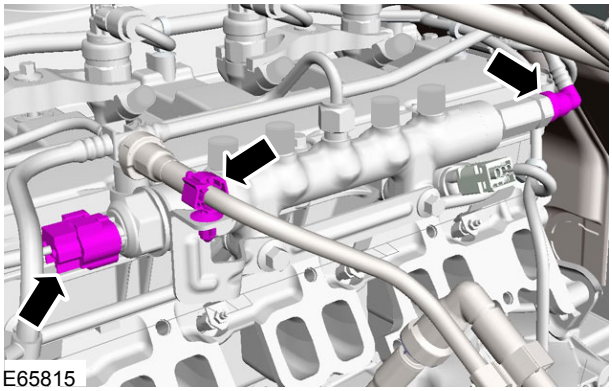
8. Vacuum foreign material from the fuel rail fuel return line quick release coupling.

   Refer to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, General Procedures).

9. ⚠ **CAUTION:Make sure that all openings are sealed. Use new blanking caps.**

   Disconnect the following items:
   - Fuel rail pressure (FRP) sensor electrical connector.
   - Fuel rail fuel return line quick release coupling.

     Refer to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).


E65815

10. **CAUTIONS:**

    ⚠ **Make sure that the high-pressure fuel supply line remains in contact with both the fuel pump and the fuel rail until both unions have been detached and cleaned.**

    ⚠ **Make sure that all openings are sealed. Use new blanking caps.**

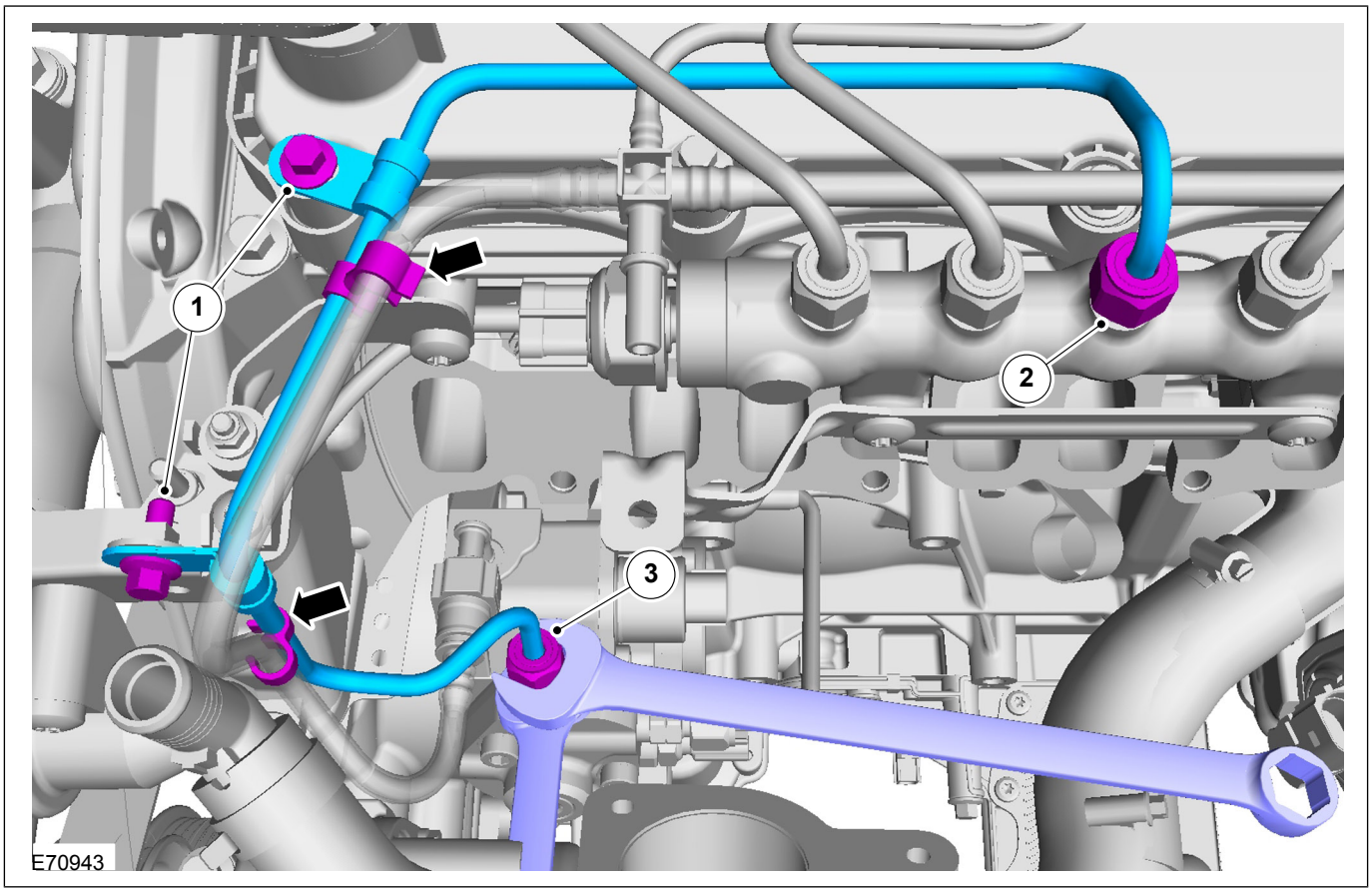
    Vacuum foreign material from the high-pressure fuel supply line, the fuel pump and the fuel rail.

    Refer to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, General Procedures).

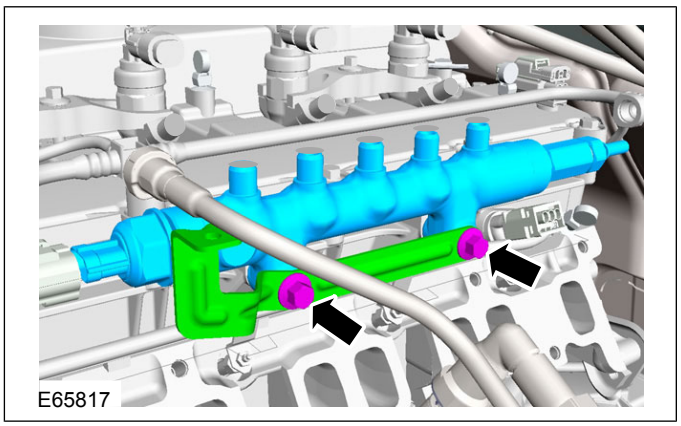
11. Use an open-ended wrench to hold the fuel pump union while disconnecting the high-pressure fuel supply line from the fuel pump.

12. Discard the high-pressure fuel supply line.

REMOVAL AND INSTALLATION



13.

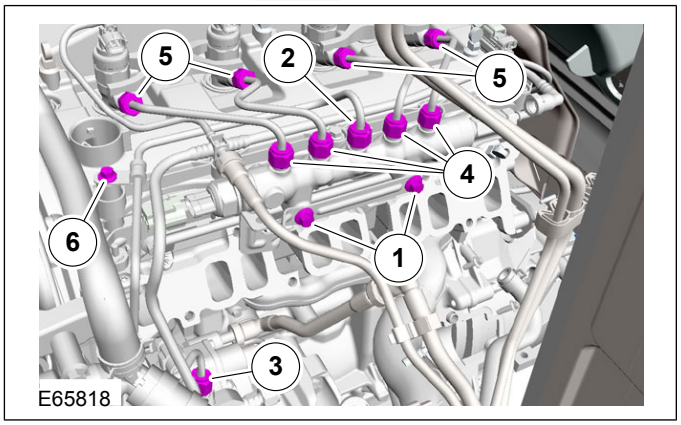


Installation

1. To install, reverse the removal procedure.
2. Install new fuel injector and fuel rail high-pressure fuel supply lines.

REMOVAL AND INSTALLATION

3. Tighten the bolts and unions in two stages in the sequence indicated.
   Torque:
   - Fuel rail bolts
     - Stage1: 6 Nm
     - Stage2: 23 Nm
   - Fuel rail high-pressure fuel supply line unions
     - Stage1: 5 Nm
     - Stage2: 35 Nm
   - Fuel injector high-pressure fuel supply line unions
     - Stage1: 5 Nm
     - Stage2: 35 Nm
   - Fuel rail high-pressure fuel supply line bracket bolt 10 Nm



4. Carry out a Fuel System Leak Test using the following WDS menu options:
   ToolBox/Powertrain/Service Functions

   General Equipment: Worldwide Diagnostic System (WDS)

REMOVAL AND INSTALLATION

Fuel Pressure Relief Valve

General Equipment

Worldwide Diagnostic System (WDS)

Removal

WARNINGS:

Refer to:Diesel Fuel System Health and Safety Precautions (100-00 General Information, Description and Operation).

Make sure that the engine is switched off.

Make sure that the fuel pressure has dropped to zero and that the fuel temperature is at ambient temperature.

Wait at least 1 minute after the engine has stopped before commencing any repair to the fuel injection system.

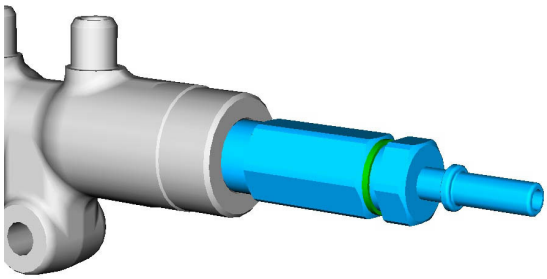
NOTE: Removal steps in this procedure may contain installation details.

1. Remove the fuel rail.

   Refer to:Fuel Rail (303-04 Fuel Charging and Controls - 2.4L Duratorq-TDCi (Puma) Diesel, Removal and Installation).

2. Vacuum foreign material from the fuel rail.

   Refer to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).



E67120

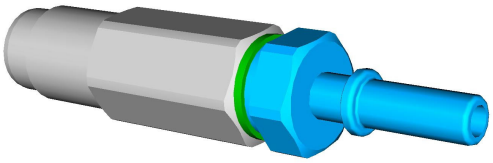
3. **CAUTION:Take extra care not to damage the mating faces.**

   Using tweezers, remove and discard the gasket.



E66949

4. Discard the fuel spigot.
   Torque: 20 Nm



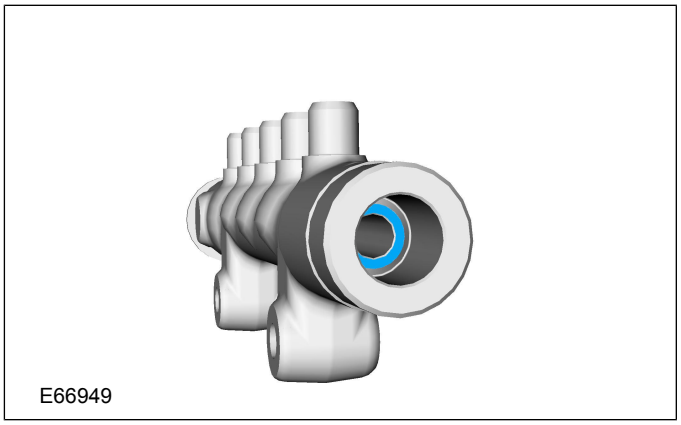
E66950

Installation

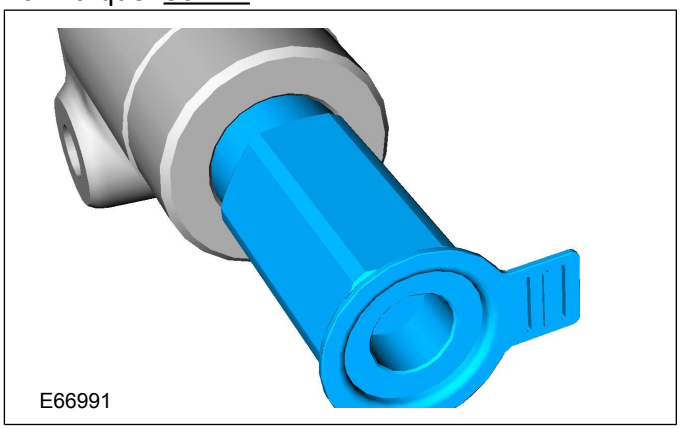
1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

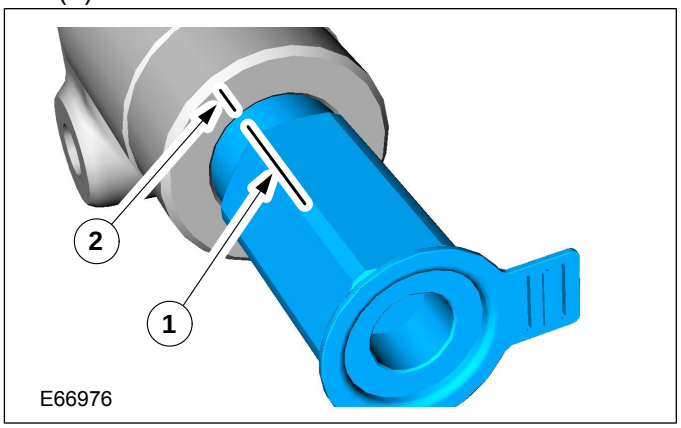
2. ⚠ **CAUTION:Take extra care not to damage the mating faces.**



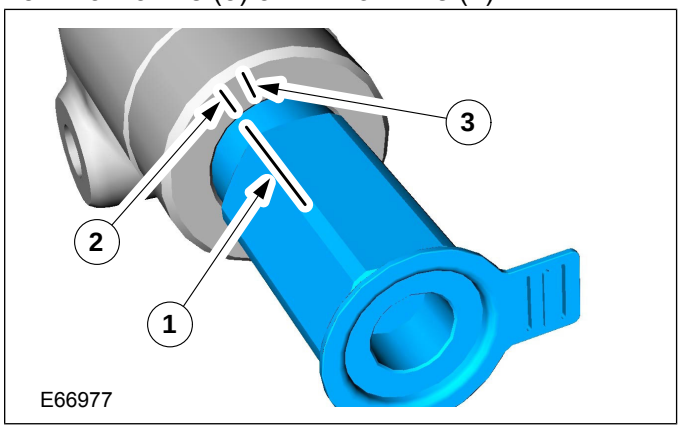
3. Torque: 30 Nm



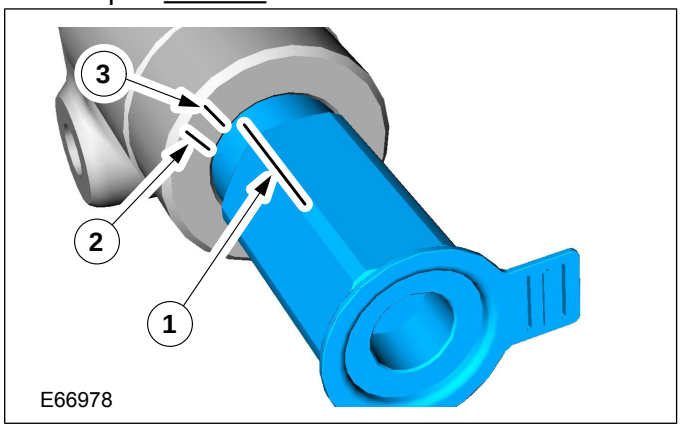
4. Draw a line on the corner of the fuel pressure relief valve (1) and on the side of the fuel rail (2).



5. Draw a line (3) 3 mm from line (2).



6. Tighten the fuel pressure relief valve and make sure that line (1) passes line (3).
Torque: 172 Nm



7. If line (1) does not pass line (3) remove the fuel pressure relief valve and inspect for contamination and thread damage to the fuel rail. Reassemble from step 2.

8. Carry out a Fuel System Leak Test using the following WDS menu options:
ToolBox/Powertrain/Service Functions

   General Equipment: Worldwide Diagnostic System (WDS)

REMOVAL AND INSTALLATION

Fuel Injectors

General Equipment

Worldwide Diagnostic System (WDS)

General Equipment

Long nose pliers

Removal

WARNINGS:

Refer to:Diesel Fuel System Health and Safety Precautions (100-00 General Information, Description and Operation).

Make sure that the engine is switched off.

Make sure that the fuel pressure has dropped to zero and that the fuel temperature is at ambient temperature.

Wait for a minimum of 1 minute after the engine has stopped before commencing any repair to the fuel injection system.

CAUTIONS:

Fuel injectors must not be dismantled or the nozzles cleaned, not even with ultrasonic equipment. Install new fuel injectors if necessary.

Fuel injectors sharing a common fuel injector clamp must be removed in pairs.

NOTE: Removal steps in this procedure may contain installation details.

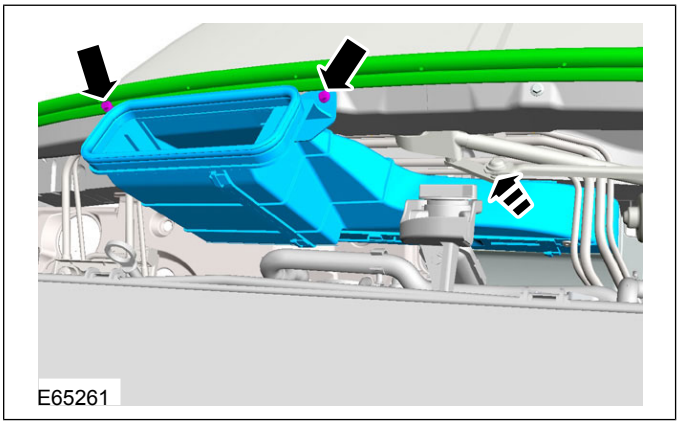
1. Within the datalogger function of WDS, check that the fuel pressure has dropped to zero and that the fuel temperature has either reached ambient temperature or is below 30ºC whichever is the greater.

   General Equipment: Worldwide Diagnostic System (WDS)

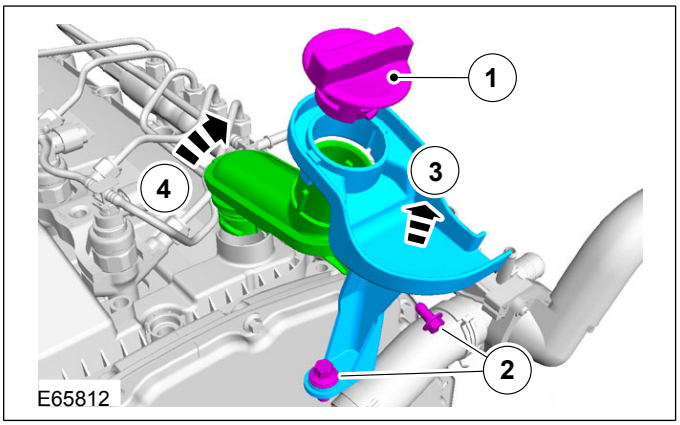
2. Disconnect the battery ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

3.



4.

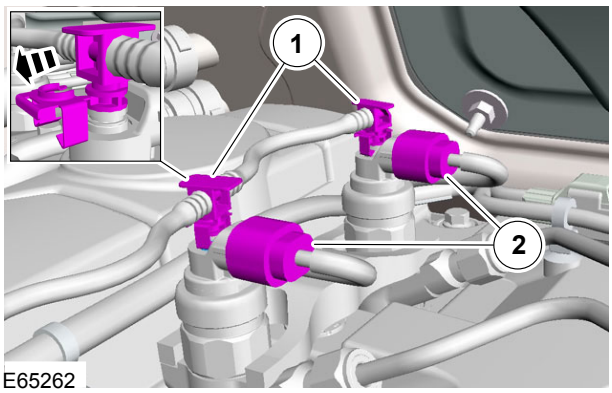


5. **CAUTION:Make sure that all openings are sealed. Use new blanking caps.**

REMOVAL AND INSTALLATION

Vacuum foreign material from the fuel injector and fuel return lines.

Refer to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).



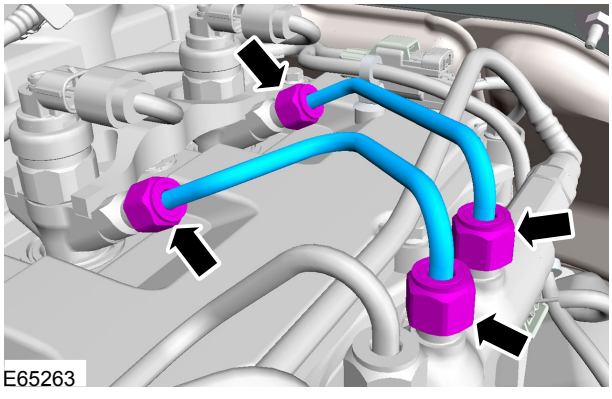
6. **CAUTIONS:**

   Make sure that the fuel line remains in contact at both ends until both unions nuts have been unscrewed and the area around the joints thoroughly cleaned.

   Make sure that all openings are sealed. Use new blanking caps.

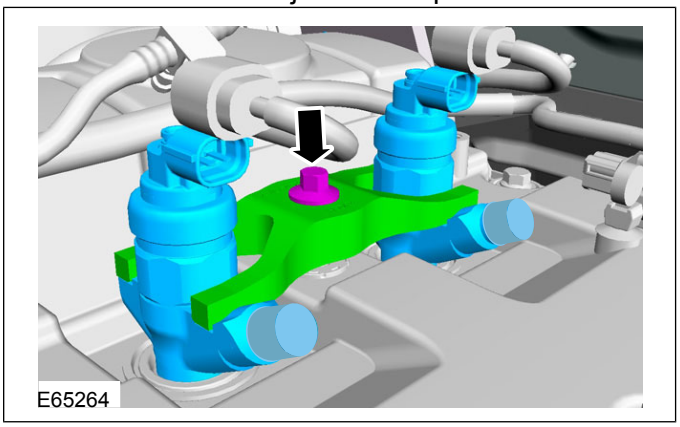
   Vacuum foreign material from the high-pressure fuel supply line, the fuel injector and the fuel rail.

   Refer to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).



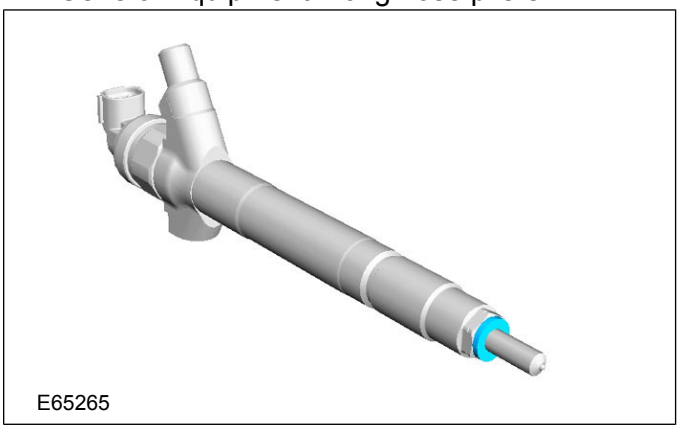
7. Discard the high-pressure fuel supply lines.

8. Discard the fuel injector clamp bolt.



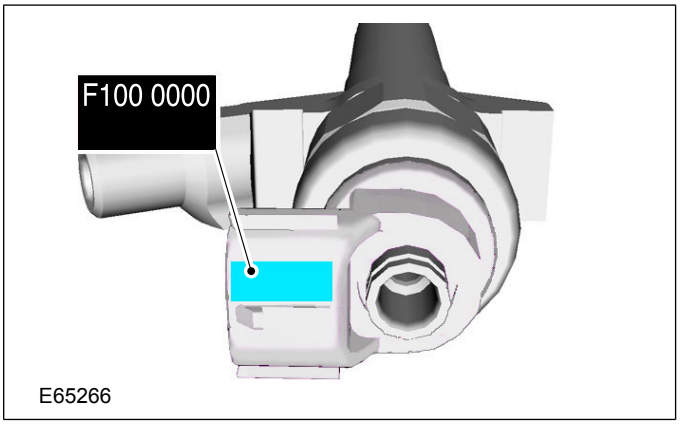
9. Discard the fuel injector copper seals from both removed fuel injectors making sure that the fuel injector nozzle is not damaged.

   General Equipment: Long nose pliers



Installation

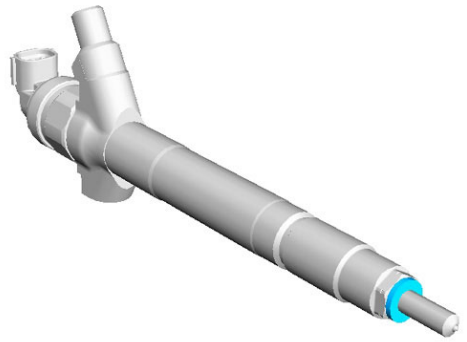
1. To install, reverse the removal procedure.
2. Record the new fuel injector correction factor code.



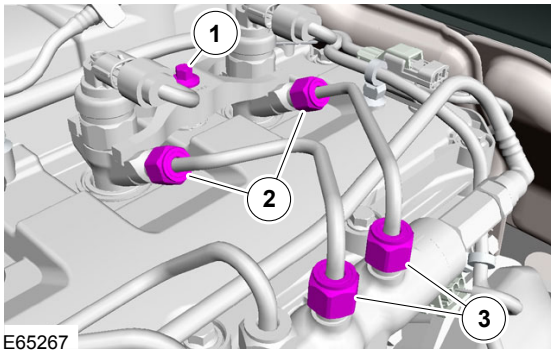
3. Install new fuel injector copper seals to both removed fuel injectors.

REMOVAL AND INSTALLATION

4. Using a socket (or similar), press the new fuel injector copper seals onto the fuel injectors making sure that the copper seals are pushed fully home to prevent uneven clamping.


E65265

5. Install a new fuel injector clamp bolt.
6. Install new fuel injector high-pressure fuel supply lines.
7. Tighten the bolts and unions in stages in the sequence indicated.
   Torque:
   - Fuel injector clamp bolt
     - Stage1: 6 Nm
     - Stage2: 180°
   - Fuel injector high-pressure fuel supply line unions
     - Stage1: 5 Nm
     - Stage2: 35 Nm



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8. Input the new Injector Correction Factors using the following WDS menu options:
   ToolBox/Powertrain/Service Functions

   General Equipment: Worldwide Diagnostic System (WDS)
9. Carry out a Fuel System Leak Test using the following WDS menu options:
   ToolBox/Powertrain/Service Functions

   General Equipment: Worldwide Diagnostic System (WDS)
10. Carry out the Pilot Correction Learn procedure using the following WDS menu options:
    ToolBox/Powertrain/Service Functions

    General Equipment: Worldwide Diagnostic System (WDS)

SECTION 303-05 Accessory Drive

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Accessory Drive 303-05-2
Vehicles with 2.3L Duratec-HE (MI4) engine 303-05-2
Vehicles with 2.2L Duratorq-TDCi (Puma) diesel engine 303-05-4
Vehicles with 2.4L Duratorq-TDCi (Puma) diesel engine 303-05-6

DIAGNOSIS AND TESTING

Accessory Drive 303-05-8
Inspection and Verification 303-05-8
Accessory Drive Belt Concerns 303-05-8
Symptom Chart 303-05-13
Component Tests 303-05-18

REMOVAL AND INSTALLATION

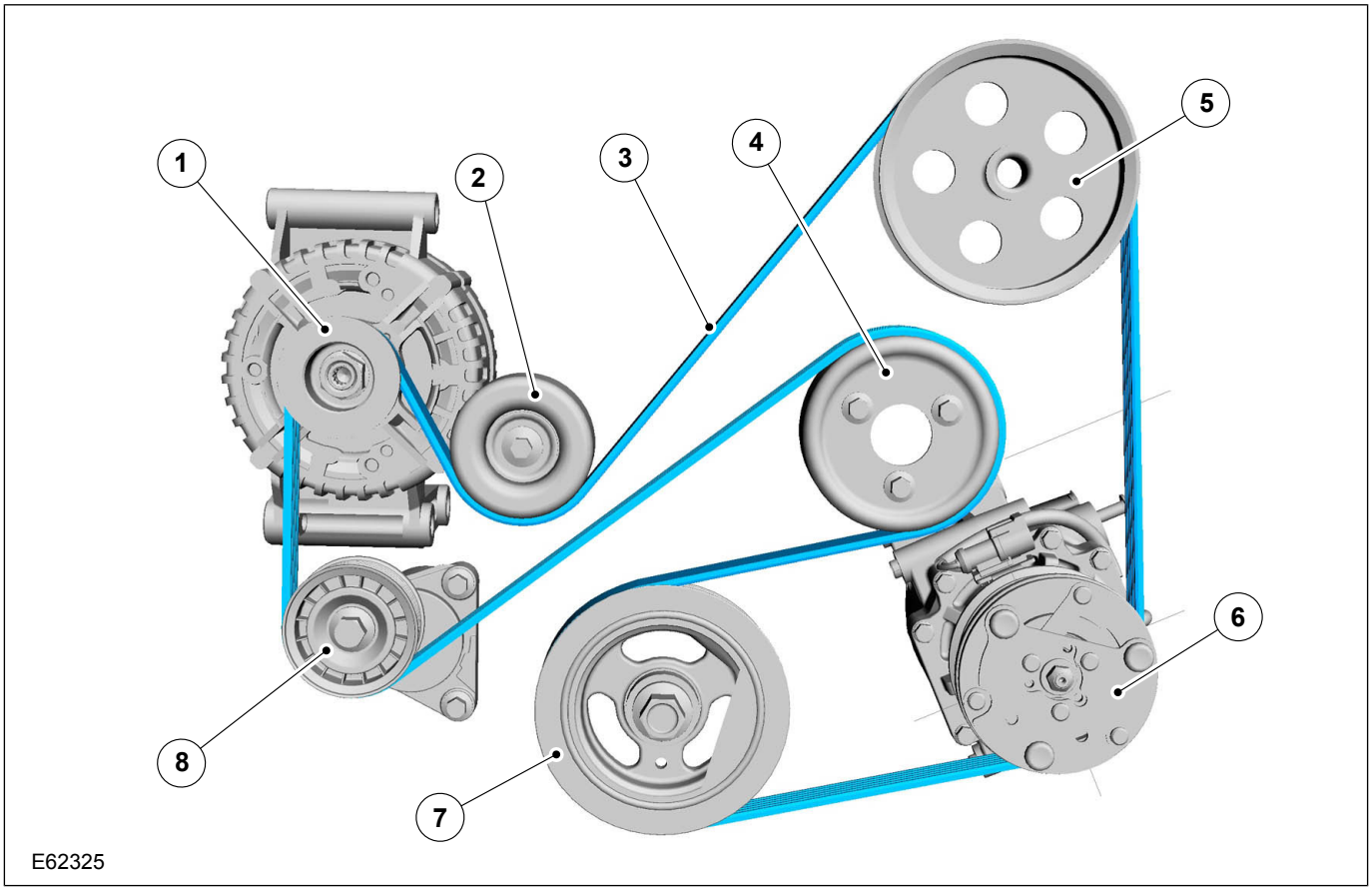
Accessory Drive Belt — Vehicles Without: Accessory Drive Belt Tensioner ... (21 567 0) 303-05-20
Accessory Drive Belt — 2.4L Duratorq-TDCi (Puma) Diesel ..... (21 567 0) 303-05-22
Accessory Drive Belt Tensioner — 2.4L Duratorq-TDCi (Puma) Diesel 303-05-24
Accessory Drive Belt — 2.3L Duratec-HE (MI4) ..... (21 567 0) 303-05-25

DESCRIPTION AND OPERATION

Accessory Drive

Vehicles with 2.3L Duratec-HE (MI4) engine

Vehicles with air conditioning

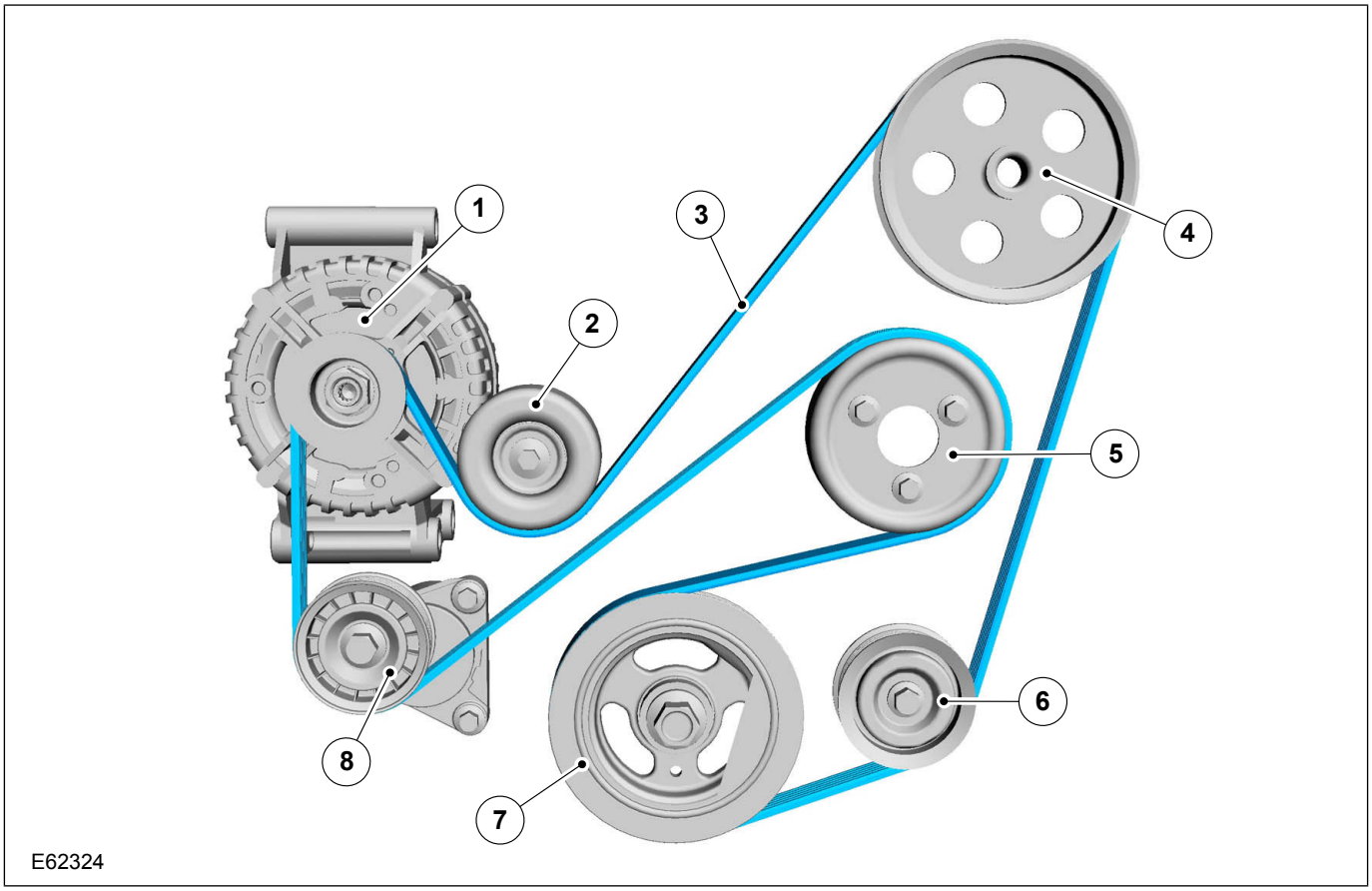


Item	Description
1	Generator
2	Accessory drive belt idler pulley
3	Accessory drive belt
4	Coolant pump pulley

Item	Description
5	Power steering pump pulley
6	Air conditioning (A/C) compressor
7	Crankshaft pulley
8	Accessory drive belt tensioner pulley

DESCRIPTION AND OPERATION

Vehicles without air conditioning



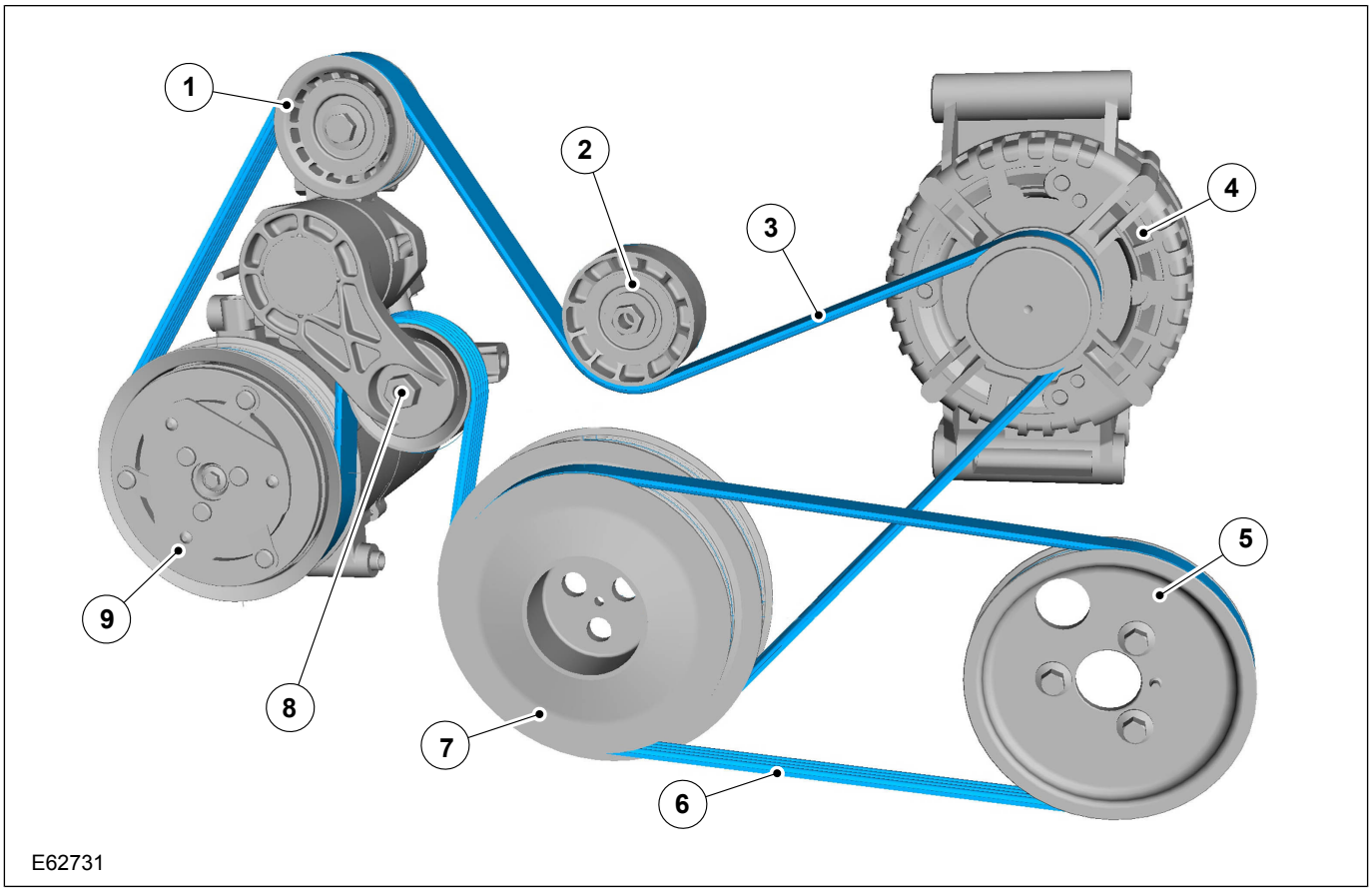
Item	Description
1	Generator
2	Accessory drive belt idler pulley
3	Accessory drive belt
4	Power steering pump pulley

Item	Description
5	Coolant pump pulley
6	Accessory drive belt idler pulley
7	Crankshaft pulley
8	Accessory drive belt tensioner pulley

DESCRIPTION AND OPERATION

Vehicles with 2.2L Duratorq-TDCi (Puma) diesel engine

Vehicles with air conditioning

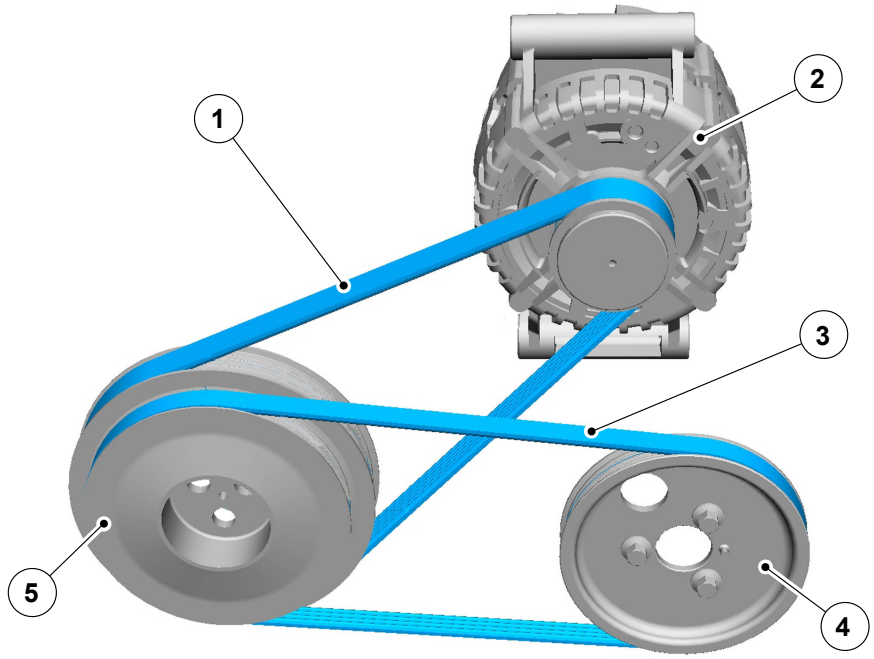


Item	Description
1	Accessory drive belt idler pulley
2	Accessory drive belt idler pulley
3	Accessory drive belt
4	Generator

Item	Description
5	Power steering pump pulley
6	Power steering pump belt
7	Crankshaft pulley
8	Accessory drive belt tensioner pulley
9	Air conditioning (A/C) compressor

DESCRIPTION AND OPERATION

Vehicles without air conditioning



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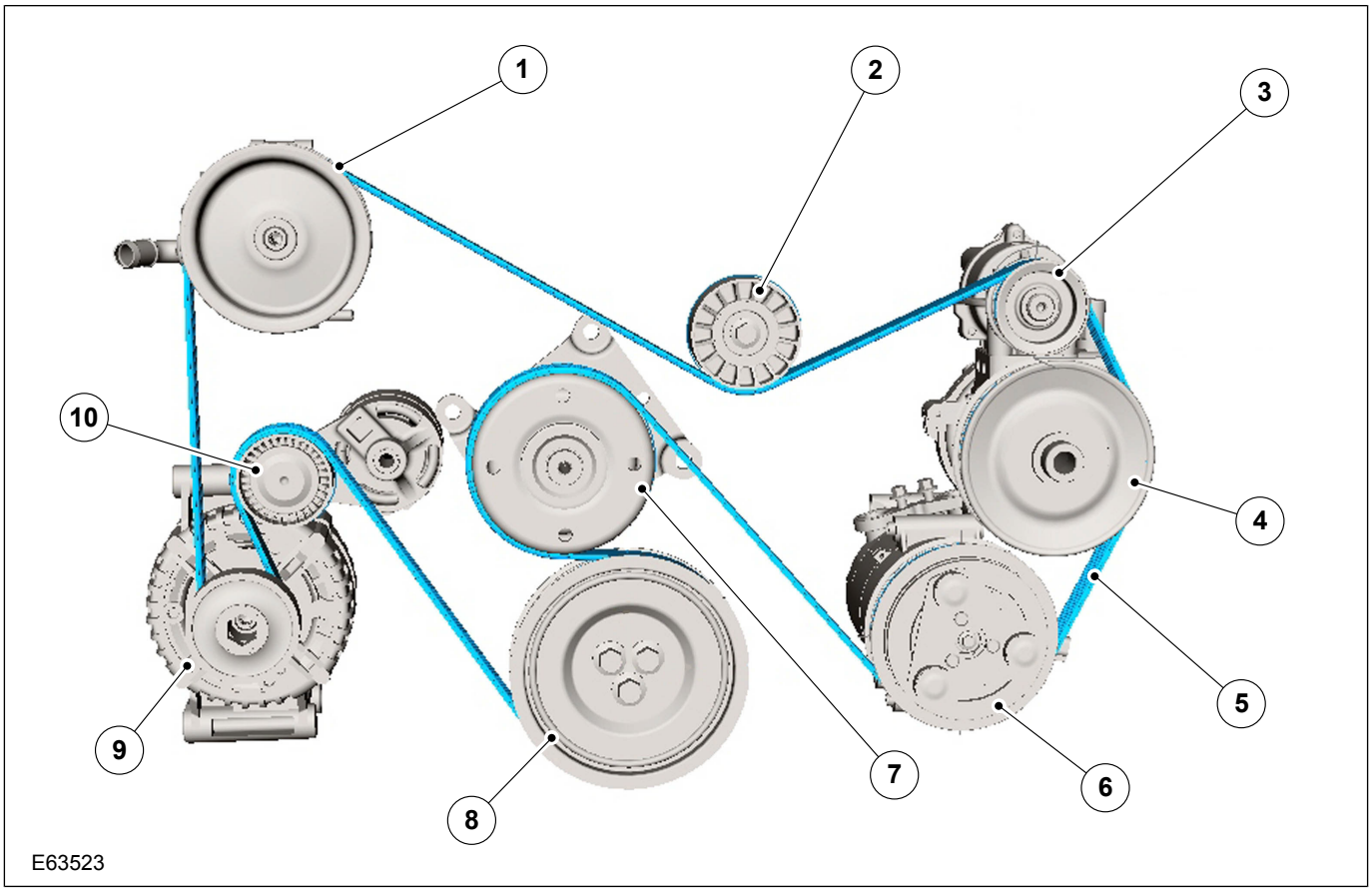
Item	Description
1	Accessory drive belt
2	Generator

Item	Description
3	Power steering pump belt
4	Power steering pump pulley
5	Crankshaft pulley

DESCRIPTION AND OPERATION

Vehicles with 2.4L Duratorq-TDCi (Puma) diesel engine

Vehicles with air conditioning

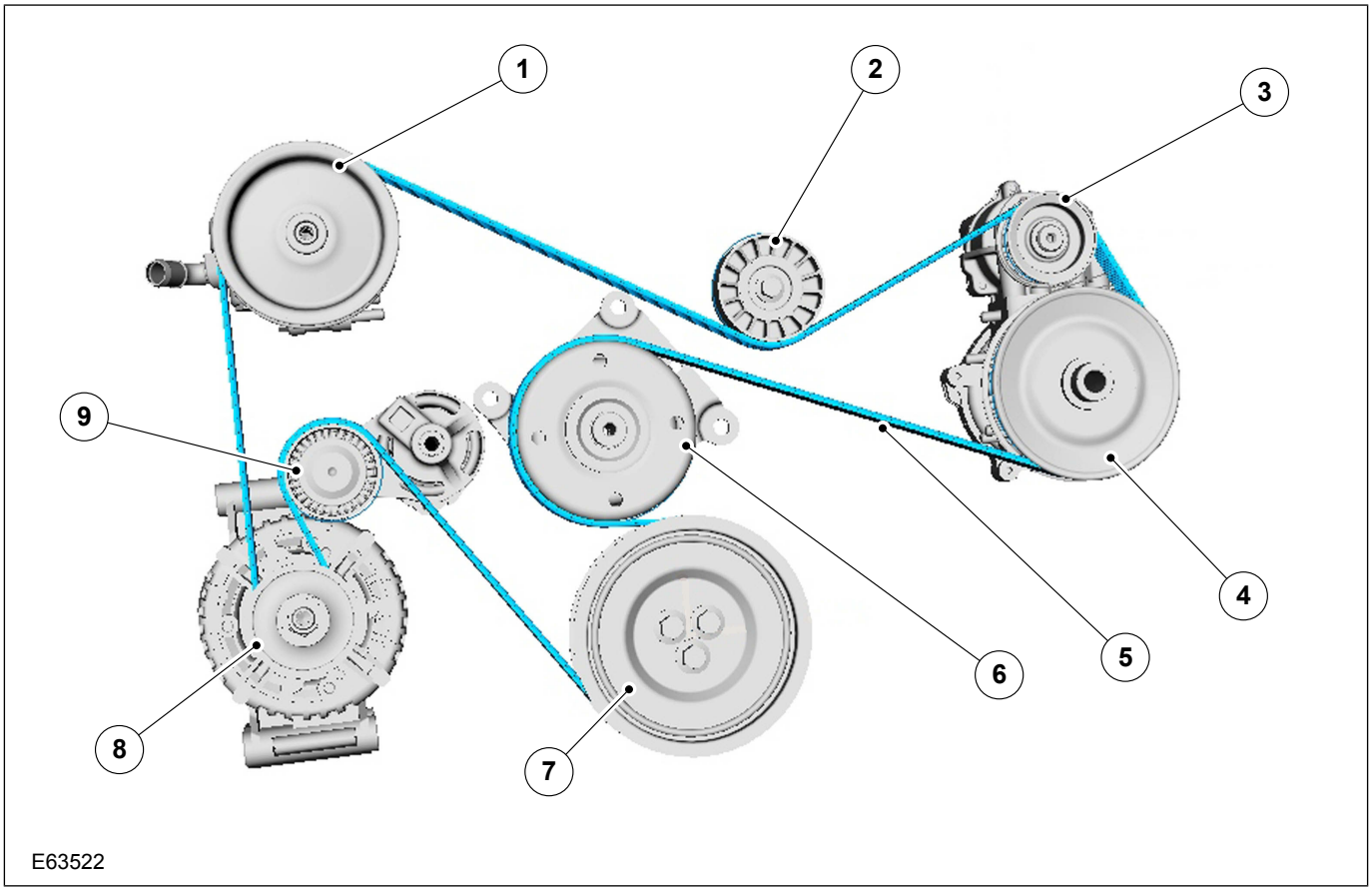


Item	Description
1	Power steering pump pulley
2	Accessory drive belt idler pulley
3	Brake vacuum pump pulley
4	Coolant pump pulley
5	Accessory drive belt

Item	Description
6	Air conditioning (A/C) compressor
7	Cooling fan pulley
8	Crankshaft pulley
9	Generator
10	Accessory drive belt tensioner pulley

DESCRIPTION AND OPERATION

Vehicles without air conditioning



Item	Description
1	Power steering pump pulley
2	Accessory drive belt idler pulley
3	Brake vacuum pump pulley
4	Coolant pump pulley
5	Accessory drive belt
6	Cooling fan pulley
7	Crankshaft pulley
8	Generator
9	Accessory drive belt tensioner pulley

DIAGNOSIS AND TESTING

Accessory Drive

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical damage.

Visual Inspection Chart

Mechanical
– Damaged or contaminated accessory drive belt
– Damaged or contaminated pulley(s)
– Incorrect accessory drive belt
– Incorrect installation of the accessory drive belt
– Accessory drive belt tensioner
– Accessory drive belt idler pulley
– Generator
– Generator decoupler
– Power steering pump
– Power steering pump leakage
– Air conditioning (A/C) compressor
– Pulley(s)
– Loose hardware

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.

Accessory Drive Belt Concerns

CAUTION:Do not lubricate the accessory drive belt, accessory drive belt tensioner or idler pulley(s) as potential damage to the accessory drive belt material construction, accessory drive belt tensioner damping mechanism, accessory drive belt tensioner pulley bearing and idler pulley(s) bearing may occur.

Cracking

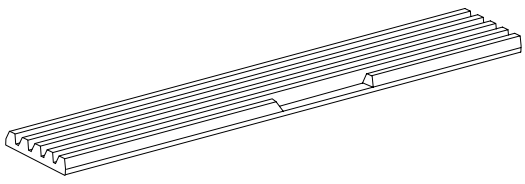
Accessory drive belts are made from rubber which hardens with time and can develop cracks. As the accessory drive belt runs on the back of some of the pulleys, the cracks are opened up. Small cracks are not considered to be a failure of the accessory drive belt. Only if the crack is deep enough to reach the bottom of the groove to expose the cord or any chunks are found to be missing from the accessory drive belt, is the accessory drive belt condition considered to be unacceptable.

1. Check the accessory drive belt for cracks. If the damage exceeds the acceptable limit, install a new accessory drive belt.

- REFER to:Accessory Drive Belt - Vehicles Without: Accessory Drive Belt Tensioner (303-05 Accessory Drive, Removal and Installation).
- REFER to:Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation).
- REFER to:Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Air Conditioning (303-05 Accessory Drive, Removal and Installation).
- REFER to:Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).
- REFER to:Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

Chunking

Chunking describes the condition where long lengths of rubber become detached from the ribs of the accessory drive belt. This is considered to be a failure of the accessory drive belt.



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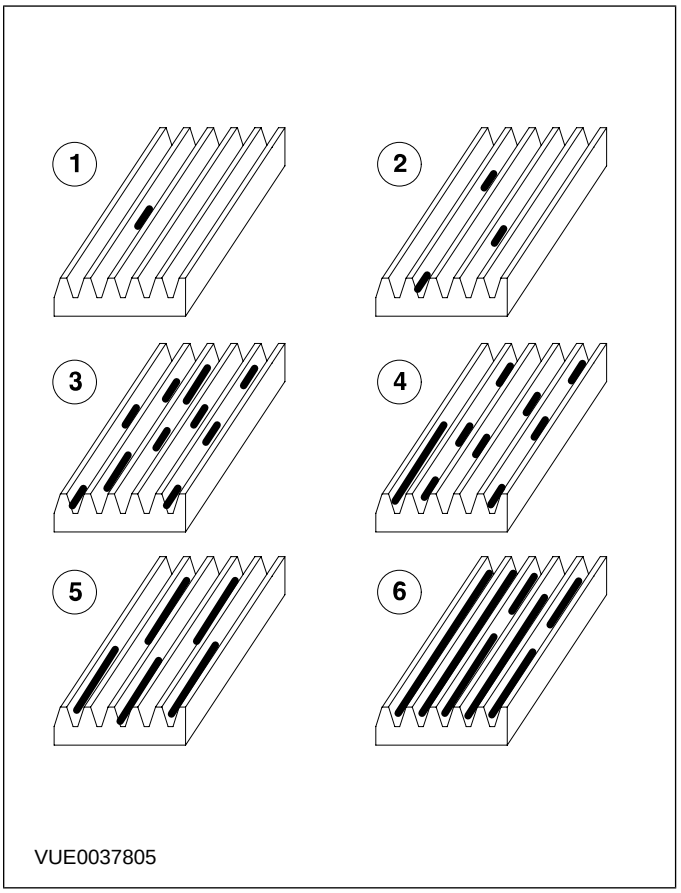
2. Check the accessory drive belt for damage. If any chunks are found to be missing, install a new accessory drive belt.

DIAGNOSIS AND TESTING

- REFER to:Accessory Drive Belt - Vehicles Without: Accessory Drive Belt Tensioner (303-05 Accessory Drive, Removal and Installation).
- REFER to:Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation).
- REFER to:Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Air Conditioning (303-05 Accessory Drive, Removal and Installation).
- REFER to:Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).
- REFER to:Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

Pilling

Pilling is dust that forms in between the ribs of the accessory drive belt from rubber that is worn off the accessory drive belt when it is new. There may also be loose particles left on the accessory drive belt during the manufacturing process. These are worn off and form into small balls of rubber that then get trapped in the grooves of the accessory drive belt. This condition will usually clear itself within 4800 km - 8000 km (3000 miles - 5000 miles) of normal driving.



3. Check the accessory drive belt for pilling. The condition of the accessory drive belt should be compared against the illustration.
   1. Small scattered pills. Not considered a concern. No action required.
   2. Small scattered pills. Not considered a concern. No action required.
   3. Longer pills up to 50% of the rib height. Possible noise concern. INSTALL a new accessory drive belt if noise is apparent.

      REFER to:Accessory Drive Belt - Vehicles Without: Accessory Drive Belt Tensioner (303-05 Accessory Drive, Removal and Installation)
      / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
      / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
      / Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation)
      / Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

DIAGNOSIS AND TESTING

4. Longer pills up to 50% of the rib height. Possible noise concern. INSTALL a new accessory drive belt if noise is apparent.

   REFER to:Accessory Drive Belt - Vehicles Without: Accessory Drive Belt Tensioner (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).
5. Heavy deposits in the grooves. Possible noise and stability concern. INSTALL a new accessory drive belt.

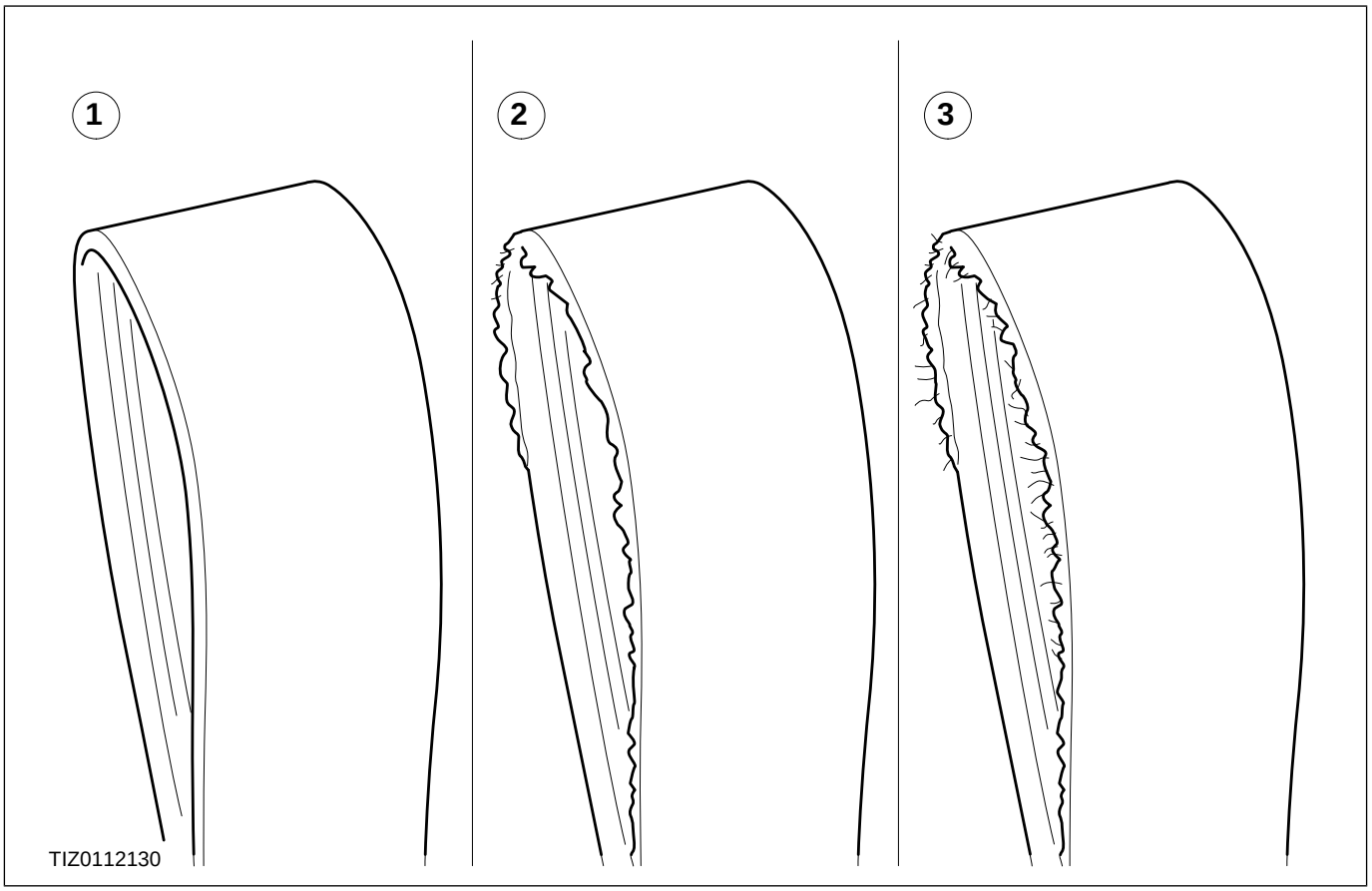
   REFER to:Accessory Drive Belt - Vehicles Without: Accessory Drive Belt Tensioner (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).
6. Heavy deposits in the grooves. Possible noise and stability concern. INSTALL a new accessory drive belt.

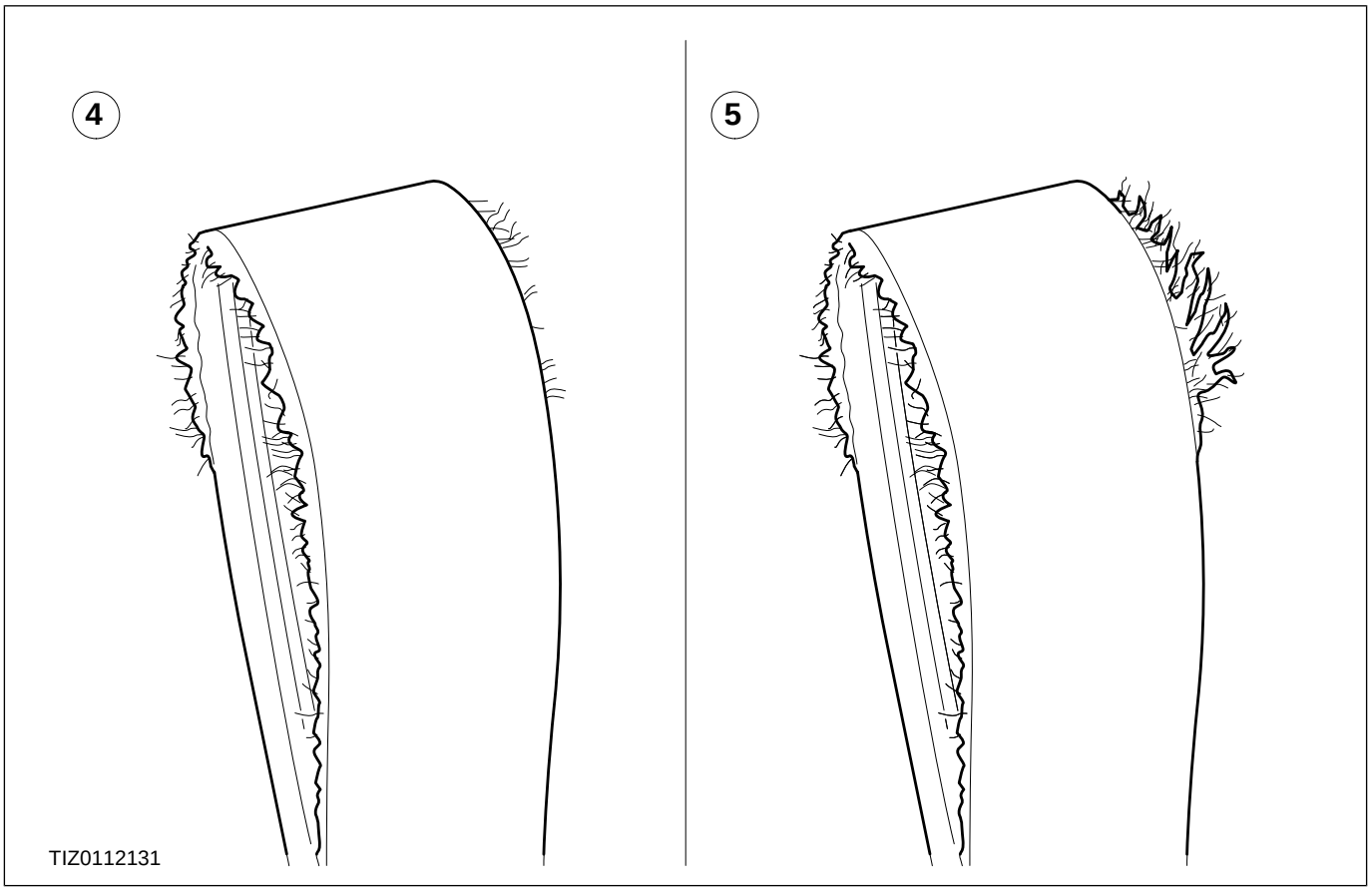
   REFER to:Accessory Drive Belt - Vehicles Without: Accessory Drive Belt Tensioner (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

Fraying - Vehicles without accessory drive belt tensioner built up to 02/2003

Due to the manufacturing process, the accessory drive belt edge may appear frayed, but this frayed appearance does not necessarily affect the durability or performance of the accessory drive belt. If a concern is raised during a service or repair over the level of fraying, the condition of the accessory drive belt should be compared against the illustrations.

DIAGNOSIS AND TESTING





4. Check the accessory drive belt for fraying.

1. No fraying (new accessory drive belt). Not considered a concern. No action required.

DIAGNOSIS AND TESTING

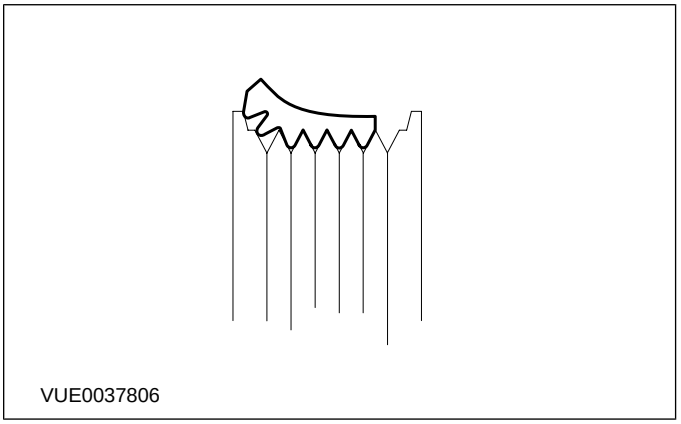
2. Fraying just starting. Not considered a concern. No action required.
3. Slight fraying. Not considered a concern. No action required.
4. High amount of fraying without cord cuts. INSTALL a new accessory drive accessory drive belt.

   REFER to:Accessory Drive Belt - Vehicles Without: Accessory Drive Belt Tensioner (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).
5. High amount of fraying with cord cuts. INSTALL a new accessory drive belt.

   REFER to:Accessory Drive Belt - Vehicles Without: Accessory Drive Belt Tensioner (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

Incorrect installation

Accessory drive belt noise can be generated by the accessory drive belt being incorrectly fitted on the pulley as shown in the following illustration. Make sure that all the V grooves on the accessory drive belt contact correctly with the pulley.


VUE0037806

5. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

DIAGNOSIS AND TESTING

Symptom Chart

Symptom	Possible Sources	Action
• Accessory drive belt noise	• Accessory drive system - Vehicles with accessory drive belt tensioner	• CHECK the system with the engine running and the accessory drive belt removed (only run the engine for a very short period). If a noise is apparent, the cause is not the accessory drive system. If a noise is not apparent, the cause is the accessory drive system. CHECK where the noise is coming from. Use a stethoscope or other listening device to determine the source of the noise. INSTALL new components as necessary. TEST the system for normal operation.
	• Accessory drive system - Vehicles without accessory drive belt tensioner	• Use a stethoscope or other listening device to determine the source of the noise. INSTALL new components as necessary. TEST the system for normal operation.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Accessory drive belt incorrectly installed.	• CHECK the accessory drive belt is correctly installed in the pulley grooves. INSTALL a new accessory drive belt as necessary. REFER to:Accessory Drive Belt - Vehicles Without: Accessory Drive Belt Tensioner (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Air Conditioning (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation). TEST the system for normal operation.
	• Pulley(s).	• CHECK the pulley(s) for damage, freedom of rotation, stone entrapment and alignment. INSTALL new components as necessary. TEST the system for normal operation.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Lubricant or other contamination.	• CHECK the accessory drive belt for contamination or damage. RECTIFY the source of the leak and INSTALL a new accessory drive belt. REFER to:Accessory Drive Belt - Vehicles Without: Accessory Drive Belt Tensioner (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Air Conditioning (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation). TEST the system for normal operation.
	• Generator decoupler seized.	• CHECK the generator decoupler for correct operation or damage. REFER to the Generator Decoupler Component Test in this procedure.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
NOTE: Squeal is defined as a continuous shriek, most noticeable when the engine is being accelerated or with electrical load. • Accessory drive belt squeal	• Accessory drive belt tensioner worn, damaged or contaminated with oil.	• CHECK the accessory drive belt tensioner for correct operation, damage or contamination. REFER to the Accessory Drive Belt Tensioner Component Test in this procedure. INSTALL a new accessory drive belt tensioner as necessary. REFER to:Accessory Drive Belt Tensioner - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation). TEST the system for normal operation.
	• Generator decoupler seized.	• CHECK the generator decoupler for correct operation or damage. REFER to the Generator Decoupler Component Test in this procedure.
NOTE: Whine is defined as a continuous noise at the same frequency, generally associated with plastic pulleys. • Accessory drive belt whine	• Poor surface finish on accessory drive belt idler pulley flat surface(s).	• REMOVE the accessory drive belt. REFER to:Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation). INSPECT the idler pulley(s) for surface finish. INSTALL a new idler pulley(s) as necessary. TEST the system for normal operation.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Accessory drive belt idler pulley bearing failure.	• REMOVE the accessory drive belt. REFER to:Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation) / Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation). INSPECT the idler pulley(s) for smooth rotation. INSTALL a new idler pulley(s) as necessary. TEST the system for normal operation.
NOTE: Chirp is defined as a twittering noise, often intermittent • Accessory drive belt chirp	• Pulley misalignment (usually evident at idle).	• CHECK that the accessory drive belt is running centrally on the flat pulleys. TEST the system for normal operation. • CHECK the pulleys for excessive end float and bent flanges. • With the engine running at idle, use a stethoscope to identify the source of the noise. INSTALL new components as necessary. TEST the system for normal operation.
	• Generator decoupler seized.	• CHECK the generator decoupler for correct operation or damage. REFER to the Generator Decoupler Component Test in this procedure.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
NOTE: Rattle is defined as a metallic knocking noise • Accessory drive belt rattle	• Accessory drive belt tensioner hitting the end stops.	• CHECK the accessory drive belt tensioner for correct operation or damage. REFER to the Accessory Drive Belt Tensioner Component Test in this procedure. INSTALL a new accessory drive belt tensioner as necessary. REFER to:Accessory Drive Belt Tensioner - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation). TEST the system for normal operation.
	• Loose components or hardware.	• CHECK the components or hardware for correct installation and tighten as necessary. TEST the system for normal operation.
• Accessory drive belt fraying	• Accessory drive belt. • Pulley(s).	• CHECK the extent of the fraying by referring to the illustrations shown in the Visual Inspection section. Only INSTALL a new accessory drive belt if the fraying is within the criteria quoted in the Visual Inspection section. TEST the system for normal operation. • CHECK the pulley(s) for damage, freedom of rotation and alignment. INSTALL new components as necessary. TEST the system for normal operation.

Component Tests

Accessory Drive Belt Tensioner - Static Check

The accessory drive belt tensioner may be checked statically as follows:

1. Inspect the area surrounding the accessory drive belt tensioner for lubricant or other contamination. Rectify any leaks before installing a new accessory drive belt tensioner. If the accessory drive belt tensioner is contaminated, do not attempt to clean it as the damping mechanism inside may be damaged. INSTALL a new accessory drive belt tensioner as necessary.

   REFER to:Accessory Drive Belt Tensioner - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).

   TEST the system for normal operation.
2. Detach the accessory drive belt in the area of the accessory drive belt tensioner.
3. **NOTE:The accessory drive belt tensioner has a damping feature, which is usually a friction device, therefore some friction within the system is normal.**

DIAGNOSIS AND TESTING

Using the correct tool, move the accessory drive belt tensioner from its relaxed position through its full stroke and back to the relaxed position to make sure there is no excessive stick, grab or bind, and to make sure there is tension on the accessory drive belt tensioner spring.

4. Rotate the accessory drive belt tensioner pulley and check for damage, freedom of rotation and alignment. INSTALL a new accessory drive belt tensioner as necessary.

   REFER to:Accessory Drive Belt Tensioner - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).

   TEST the system for normal operation.
5. If the accessory drive belt tensioner meets the above criteria, proceed to test the accessory drive belt tensioner dynamically. If the accessory drive belt tensioner does not meet the above criteria, INSTALL a new accessory drive belt tensioner.

   REFER to:Accessory Drive Belt Tensioner - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).

   TEST the system for normal operation.

Accessory Drive Belt Tensioner - Dynamic Check

The accessory drive belt tensioner may be checked dynamically as follows:

1. With the engine running, observe the accessory drive belt tensioner movement. The accessory drive belt tensioner should move (respond) when the engine is accelerated rapidly or when the A/C clutch cycles ON and OFF (the degree of movement can be up to 4 mm). If the accessory drive belt tensioner movement is not constant without engine acceleration or A/C clutch cycling, a pulley or shaft is possibly bent, out of round, or the damping mechanism inside the accessory drive belt tensioner may be damaged. INSTALL a new accessory drive belt tensioner as necessary.

   REFER to:Accessory Drive Belt Tensioner - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).

   TEST the system for normal operation.
2. Excessive accessory drive belt rideout (uneven depth of grooves in the accessory drive belt) may cause excessive accessory drive belt tensioner movement. Check the condition by installing a new accessory drive belt.

   REFER to:Accessory Drive Belt - Vehicles Without: Accessory Drive Belt Tensioner (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles With: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.2L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Air Conditioning (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation)
   / Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

   TEST the system for normal operation.

Generator Decoupler

1. Remove the accessory drive belt.

   REFER to:Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).
2. Using an Allen key or appropriate tool to prevent the generator center shaft from rotating, attempt to rotate the generator decoupler both clockwise and counterclockwise.
3. Make sure that the generator decoupler rotates freely in a counterclockwise direction and is locked in the clockwise direction (as viewed from the crankshaft pulley end of the engine). If the generator decoupler is seized or rotates freely in both directions, install a new generator.

   REFER to:Generator - 2.4L Duratorq-TDCi (Puma) Diesel (414-02 Generator and Regulator, Removal and Installation).

REMOVAL AND INSTALLATION

Accessory Drive Belt — Vehicles Without: Accessory Drive Belt Tensioner (21 567 0)

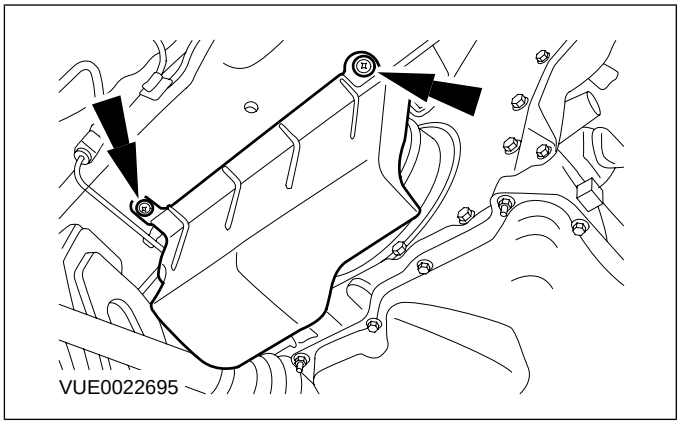
General Equipment

Knife

Removal

CAUTION:The accessory drive belt must not be reused as it is designed to be stretched on to the pulleys once only. Failure to follow this instruction may lead to premature failure of the belt.

1. **Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].**
2. **Remove the crankshaft pulley splash shield.**

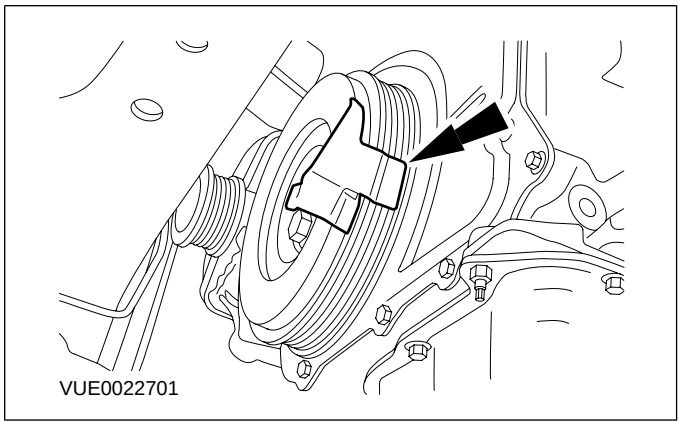


3. **Using a suitable knife, cut the accessory drive belt and remove.**

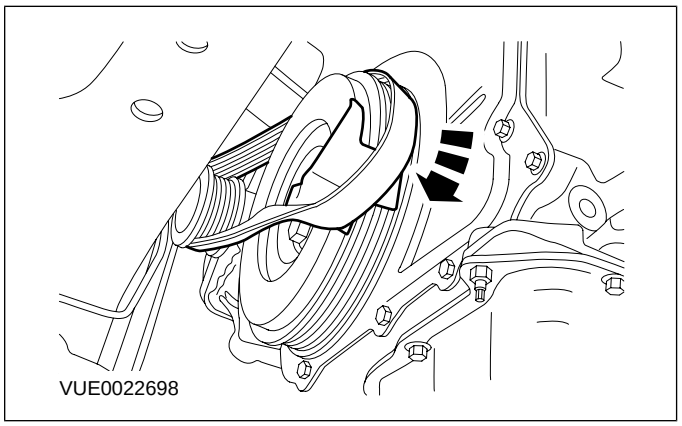
Installation

NOTE: Install a new accessory drive belt.

1. **Wipe all of the pulleys clean to make sure that the accessory drive belt does not slip during installation.**
2. **Install the installation tool (supplied in the parts kit) to the crankshaft pulley at the 3 o'clock position.**
   - Use the holes in the crankshaft pulley to locate the tool.



3. **Install the accessory drive belt around the generator pulley, the top of the crankshaft pulley and the installation tool.**

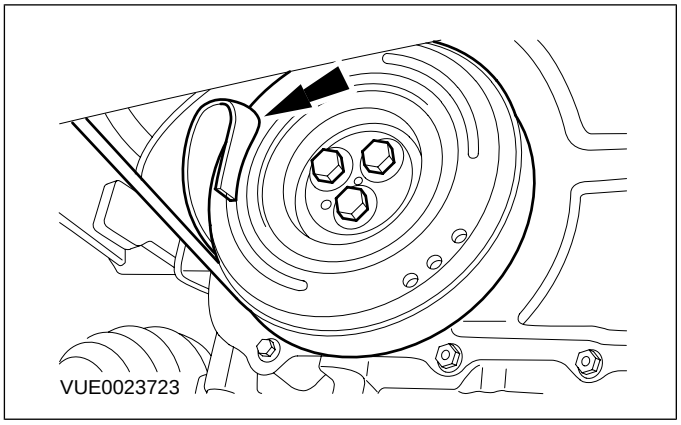


4. **Make sure that the accessory drive belt is correctly positioned in the grooves of the pulleys.**
5. **NOTE:Turn the engine in the normal direction of rotation only.**

Guide the accessory drive belt onto the pulleys as the engine is rotated.

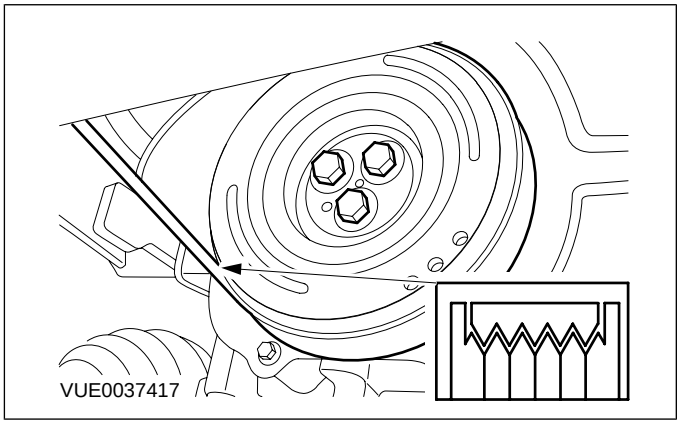
REMOVAL AND INSTALLATION

Turn the engine until the installation tool is at the 9 o'clock position.

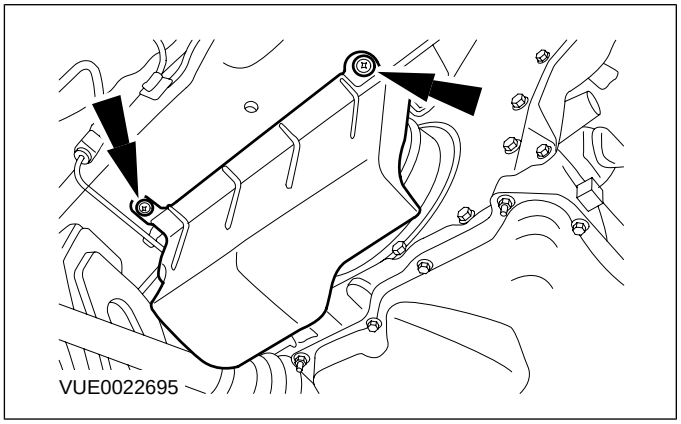


6. **Remove and discard the installation tool.**
7. **NOTE:Only turn the engine in the normal direction of rotation.**

   Turn the engine through 360 degrees.
8. **Check that the accessory drive belt is correctly positioned in the grooves of the pulleys.**
   - Repeat the installation procedure if the accessory drive belt is misaligned.



9. **Install the crankshaft pulley splash shield.**



10. **Lower the vehicle.**

REMOVAL AND INSTALLATION

Accessory Drive Belt — 2.4L Duratorq-TDCi (Puma) Diesel (21 567 0)

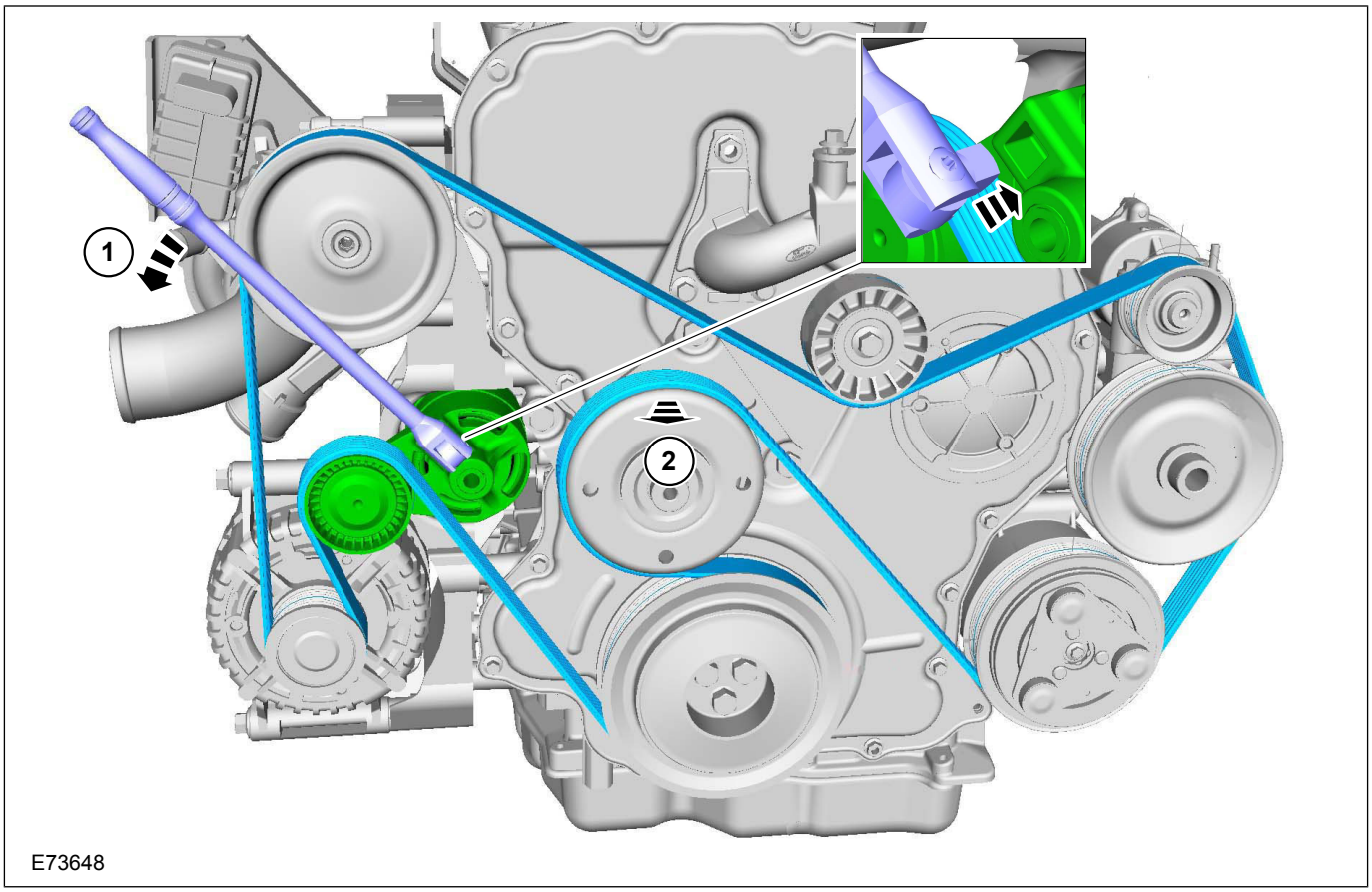
General Equipment

1/2 inch square drive breaker bar

Removal

Vehicles with air conditioning

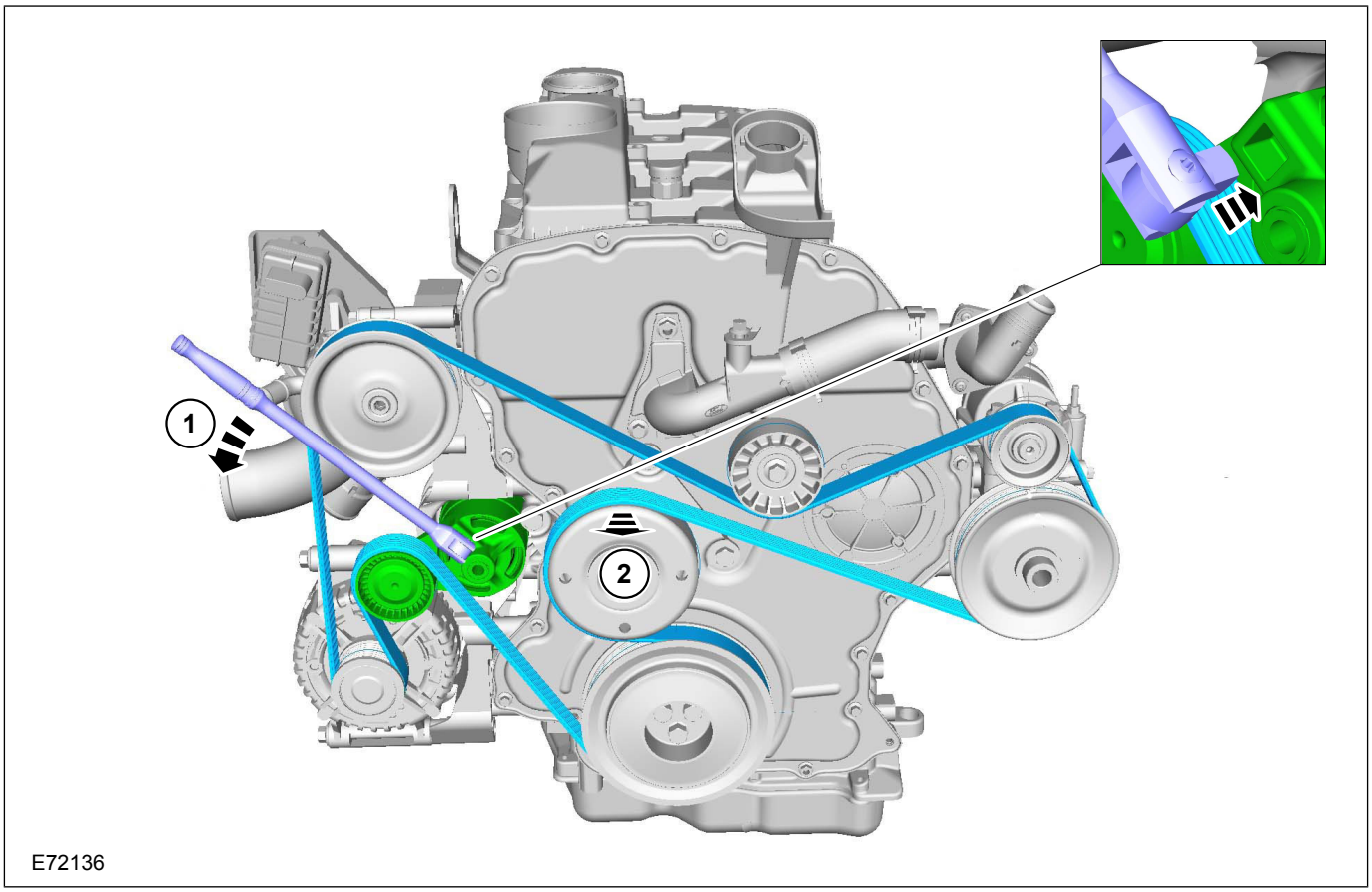
1. General Equipment: 1/2 inch square drive breaker bar



Vehicles without air conditioning

2. General Equipment: 1/2 inch square drive breaker bar

REMOVAL AND INSTALLATION



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Accessory Drive Belt Tensioner — 2.4L Duratorq-TDCi (Puma) Diesel

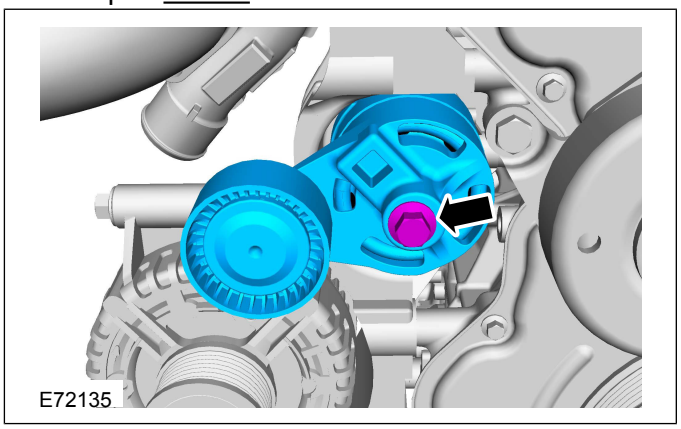
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Remove the accessory drive belt.

   Refer to: Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).

2. Torque: 48 Nm



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

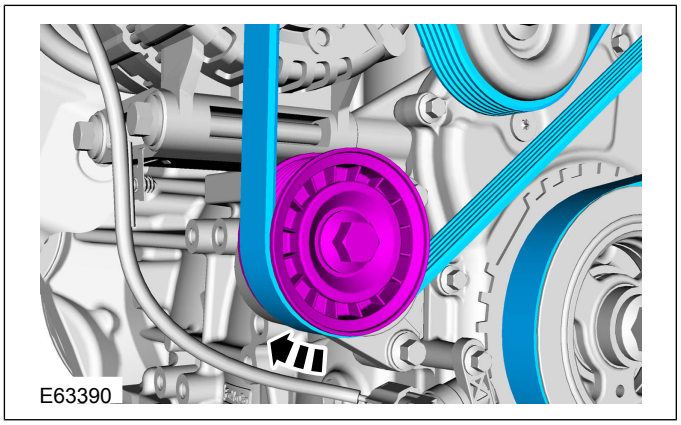
Accessory Drive Belt — 2.3L Duratec-HE (MI4) (21 567 0)

Removal

1. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

2.



Installation

1. To install, reverse the removal procedure.

SECTION 303-06 Starting System

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Starting System 303-06-2
Inspection and Verification 303-06-2
Symptom Chart 303-06-2
Pinpoint Tests 303-06-3

REMOVAL AND INSTALLATION

Starter Motor — 2.4L Duratorq-TDCi (Puma) Diesel 303-06-9
Starter Motor — 2.3L Duratec-HE (MI4) 303-06-10

DIAGNOSIS AND TESTING

Starting System

Refer to Wiring Diagrams Section 303-06,for schematic and connector information.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical damage.

Visual Inspection Chart

Electrical
– Fuse(s) – Wiring harness – Electrical connector(s) – Relay(s) – Switch(es) – Battery – Starter motor

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• The engine does not crank but the relay clicks	• Battery	• REFER to:Charging System (414-00 Charging System - General Information, Diagnosis and Testing).
	• Circuit(s) • Starter relay • Starter motor	• GO to Pinpoint Test A.
• The engine does not crank and the relay does not click	• Battery	• REFER to:Charging System (414-00 Charging System - General Information, Diagnosis and Testing).
	• Passive anti-theft system (PATS).	• REFER to:Anti-Theft - Passive (419-01 Anti-Theft - Passive, Diagnosis and Testing).
	• Circuit(s) • Starter relay • Ignition switch • Engine junction box (EJB) • Powertrain control module (PCM)	• GO to Pinpoint Test B.
• The engine cranks slowly	• Battery	• REFER to:Charging System (414-00 Charging System - General Information, Diagnosis and Testing).
	• Starter motor • Battery cable(s)	• GO to Pinpoint Test C.

DIAGNOSIS AND TESTING

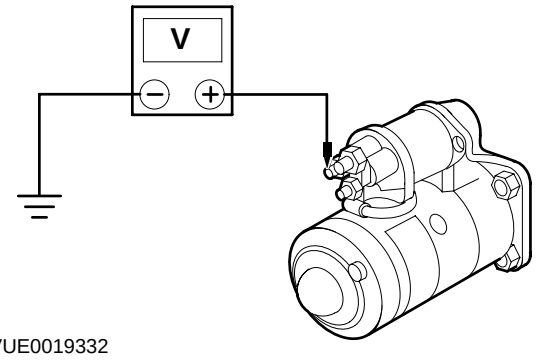
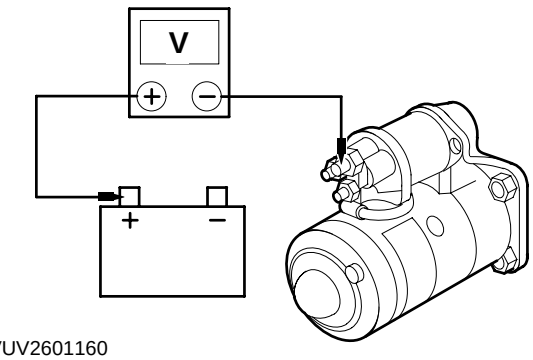
Symptom	Possible Sources	Action
• Unusual starter motor noise	• Starter motor.	• REMOVE the starter motor. REFER to:Starter Motor - 2.2L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation) / Starter Motor - 2.4L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation) / Starter Motor - 2.3L Duratec-HE (MI4) (303-06 Starting System, Removal and Installation). INSPECT the starter motor gear for damage. INSTALL a new starter motor as necessary.
	• Flywheel ring gear.	• Inspect the flywheel ring gear for damage. INSTALL a new flywheel ring gear as necessary.
• The starter spins but the engine does not crank	• Starter motor.	• REMOVE the starter motor. REFER to:Starter Motor - 2.2L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation) / Starter Motor - 2.4L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation) / Starter Motor - 2.3L Duratec-HE (MI4) (303-06 Starting System, Removal and Installation). INSPECT the starter motor gear for damage. INSTALL a new starter motor as necessary.
	• Flywheel ring gear.	• Inspect the flywheel ring gear for damage. INSTALL a new flywheel ring gear as necessary.

Pinpoint Tests

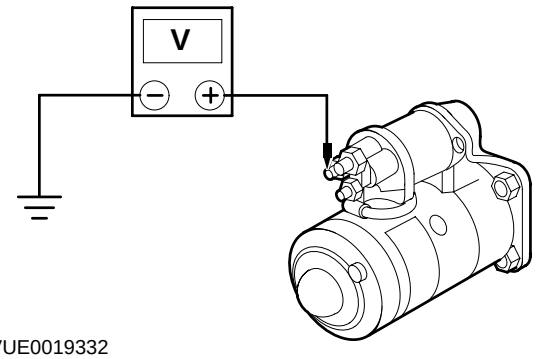
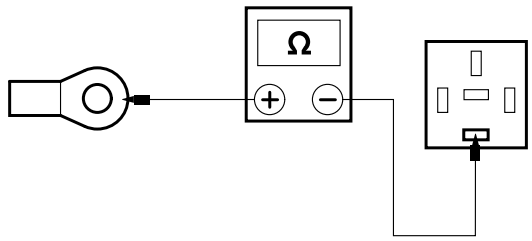
NOTE: Use a digital multimeter for all electrical measurements.

DIAGNOSIS AND TESTING

PINPOINT TEST A : THE ENGINE DOES NOT CRANK BUT THE RELAY CLICKS

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK THE STARTER MOTOR SOLENOID FOR POWER	
	1 Ignition switch in position III.
 VUE0019332	2 Measure the voltage between the starter motor solenoid CDC35B circuit CBB17 (GN/RD) and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A2. → **No** GO to A3.
A2: CHECK CIRCUIT SBFD1A (RD) FOR VOLTAGE DROP	
 VUV2601160	1 Measure the voltage between starter motor solenoid CDC35C circuit SBFD1A (RD) and the battery positive terminal. • Is the voltage less than 2 volts? → **Yes** CLEAN and TIGHTEN all battery positive cable connections. TEST the system for normal operation. If the concern persists, INSTALL a new starter motor. REFER to:Starter Motor - 2.2L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation) / Starter Motor - 2.4L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation) / Starter Motor - 2.3L Duratec-HE (MI4) (303-06 Starting System, Removal and Installation). TEST the system for normal operation. → **No** CLEAN and TIGHTEN all battery positive cables connections. TEST the system for normal operation. If the concern persists, INSTALL a new battery to starter motor solenoid cable. TEST the system for normal operation.
A3: CHECK THE STARTER MOTOR SOLENOID POWER SUPPLY	
	1 Ignition switch in position 0.
	2 Disconnect Starter Relay R4.

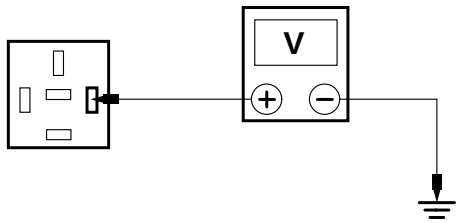
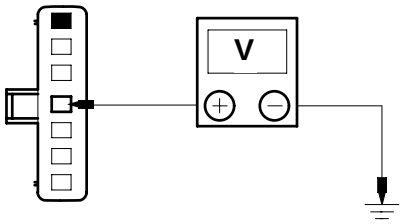
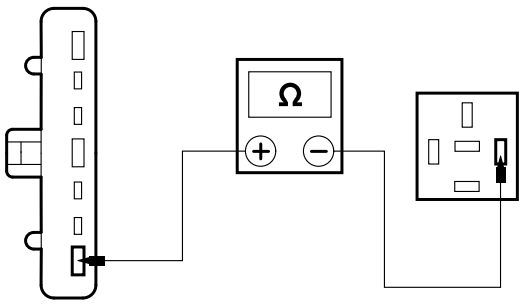
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VUE0019332	3 Measure the voltage between the starter relay R4 connector pin 5 and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A4. → **No** INSTALL a new EJB. TEST the system for normal operation.
A4: CHECK CIRCUIT CBB17 (GN/RD) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 E72256	2 Measure the resistance between the starter relay R4 connector, pin 5 and the starter motor solenoid CDC35B circuit CBB17 (GN/RD). • Is the resistance less than 1 ohm? → **Yes** INSTALL a new starter relay. TEST the system for normal operation. If the concern persists, INSTALL a new starter motor. REFER to:Starter Motor - 2.2L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation) / Starter Motor - 2.4L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation) / Starter Motor - 2.3L Duratec-HE (MI4) (303-06 Starting System, Removal and Installation). → **No** REPAIR circuit CDC35 (GN/RD). TEST the system for correct operation.

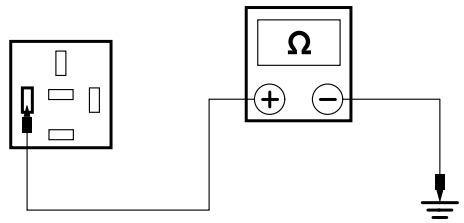
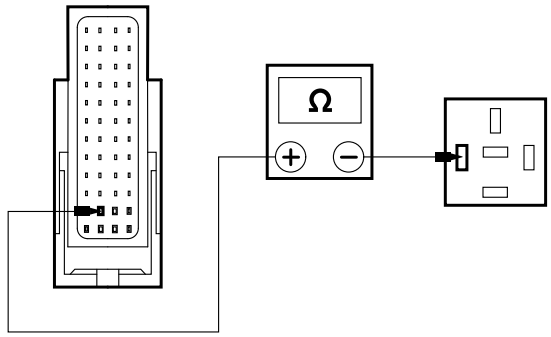
PINPOINT TEST B : THE ENGINE DOES NOT CRANK AND THE RELAY DOES NOT CLICK

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK THE SWITCHED POWER TO THE STARTER RELAY	
	1 Disconnect Starter Relay R4.
	2 Ignition switch in position III.

DIAGNOSIS AND TESTING

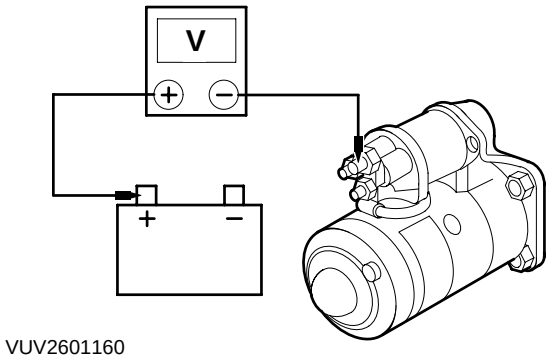
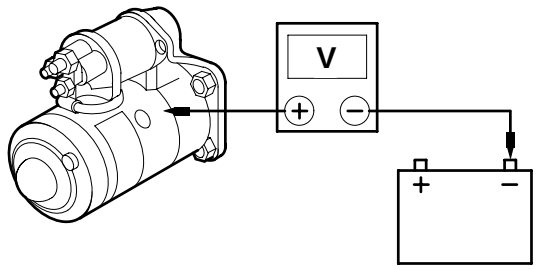
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E72251	3 Measure the voltage between the starter relay R4 pin 1, harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to B4. → **No** GO to B2.
B2: CHECK THE VOLTAGE TO THE IGNITION SWITCH	
	1 Disconnect Ignition Switch CDC32.
 VUE0003162	2 Measure the voltage between the ignition switch CDC32 pin 4, circuit SBP77 (RD/GY), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to B3. → **No** REPAIR circuit SBP77 (RD/GY). TEST the system for normal operation.
B3: CHECK CIRCUIT CDC35 (BU/WH) FOR OPEN	
 E72252	1 Measure the resistance between the ignition switch CDC32 pin 7, circuit CDC35 (BU/WH), harness side and the starter relay R4 pin 1, harness side. • Is the resistance less than 1 ohm? → **Yes** GO to B4. → **No** REPAIR the circuit. TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B4: CHECK THE STARTER RELAY COIL FOR GROUND	
 E72275	1 Measure the resistance between the starter relay R4 connector pin 2, circuit CDC12A and ground. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new starter relay. TEST the system for normal operation. → **No** GO to B5.
B5: CHECK CIRCUIT CDC12A (YE) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect PCM CE104B (2.2L/2.4L Duratorq-TDCi (Puma) Diesel Engines) .
	3 Disconnect PCM CE512B (2.3L Duratec-HE (MI4)).
 E72211	4 Measure the resistance between: • the starter relay R4 connector pin 2, circuit CDC12A (YE), harness side and the PCM CE104B pin L2, circuit CDC12A (YE), harness side (2.2L/2.4L Duratorq-TDCi (Puma) Diesel Engines) or • the starter relay R4 connector pin 2, circuit CDC12A (YE), harness side and the PCM CE512B pin L2, circuit CDC12A (YE), harness side (2.3L Duratec-HE (MI4)). • Is the resistance less than 1 ohm? → **Yes** Using the WDS, CHECK for current DTCs. CORRECT all DTCs. TEST the system for normal operation. If the concern persists, INSTALL a new PCM. REFER to:Powertrain Control Module (PCM) - Vehicles Without: PCM Security Shield (303-14 Electronic Engine Controls, Removal and Installation). → **No** REPAIR the circuit. TEST the system for normal operation. It the concern persists, INSTALL a new EJB

DIAGNOSIS AND TESTING

PINPOINT TEST C : THE ENGINE CRANKS SLOWLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CHECK SBF01A (RD) FOR VOLTAGE DROP	
	1 Ignition switch in position III.
 VUV2601160	2 Measure the voltage between starter motor solenoid CDC35A circuit SBF01A (RD) and the battery positive terminal. • Is the voltage less than 0.5 volts? → **Yes** GO to C2. → **No** CLEAN and TIGHTEN all battery positive cables connections. TEST the system for normal operation. If the concern persists, INSTALL a new battery to starter motor solenoid cable. TEST the system for normal operation.
C2: CHECK STARTER MOTOR FOR GROUND CONNECTION	
	1 Ignition switch in position III.
 VUV9510063	2 Measure the voltage between the starter motor housing and the battery negative terminal. • Is the voltage less than 0.5 volts? → **Yes** INSTALL a new starter motor. REFER to:Starter Motor - 2.2L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation) / Starter Motor - 2.4L Duratorq-TDCi (Puma) Diesel (303-06 Starting System, Removal and Installation) / Starter Motor - 2.3L Duratec-HE (MI4) (303-06 Starting System, Removal and Installation). TEST the system for normal operation. → **No** CLEAN and TIGHTEN all battery negative cable connections, starter motor mounting and body to ground straps. TEST the system for normal operation. If the concern persists, INSTALL a new battery negative cable. TEST the system for normal operation.

REMOVAL AND INSTALLATION

Starter Motor — 2.4L Duratorq-TDCi (Puma) Diesel

Removal

NOTE: Removal steps in this procedure may contain installation details.

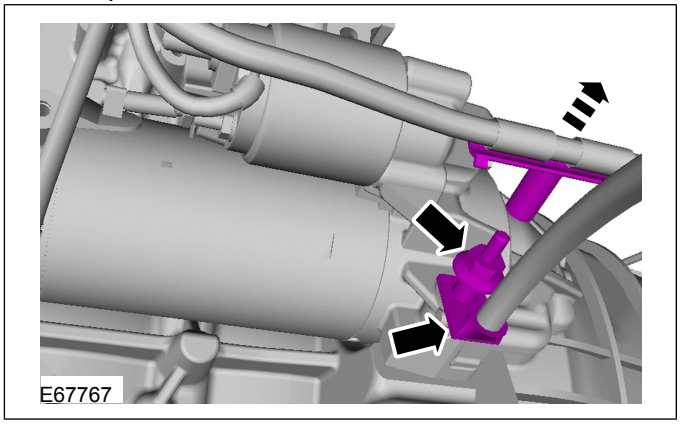
1. Disconnect the battery ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

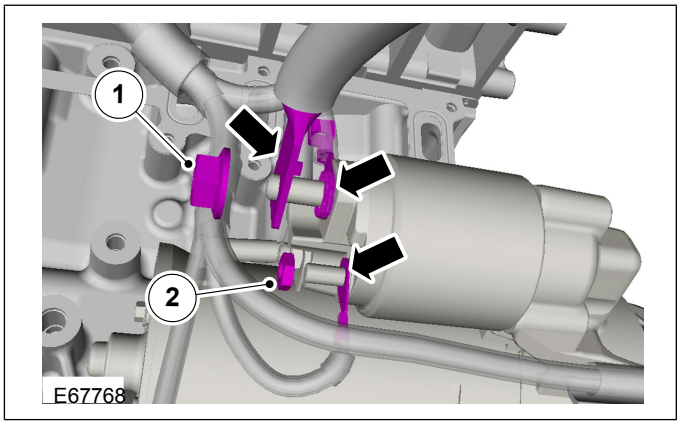
2. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

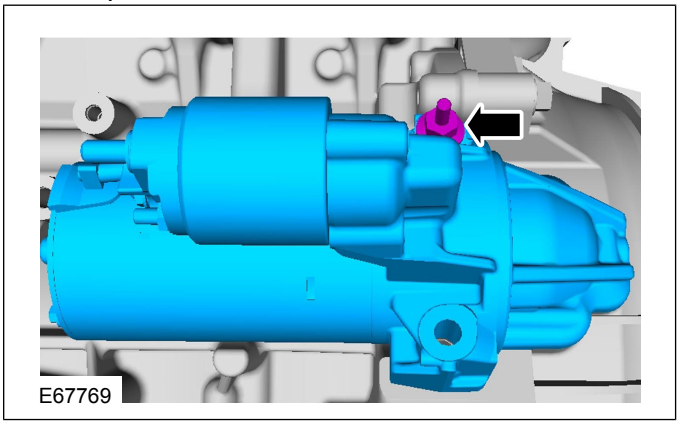
3. Torque: 35 Nm



4. 1. Torque: 12 Nm
   2. Torque: 8 Nm



5. Torque: 35 Nm



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Starter Motor — 2.3L Duratec-HE (MI4)

Removal

NOTE: Removal steps in this procedure may contain installation details.

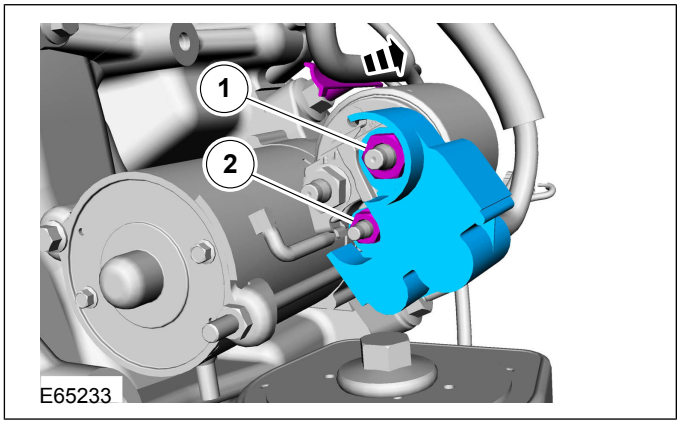
1. Disconnect the battery ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

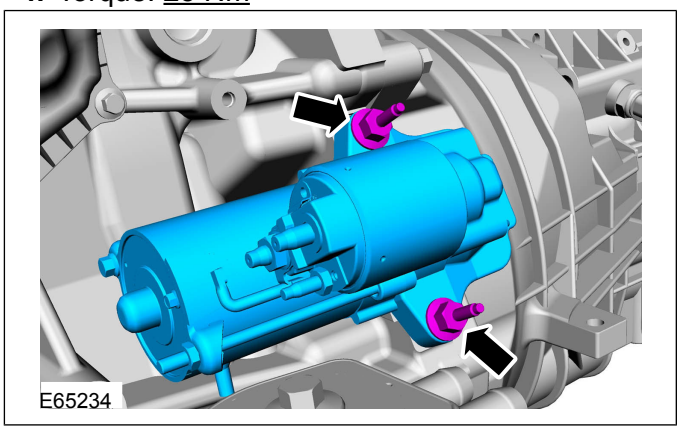
2. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

3. 1. Torque: 12 Nm
   2. Torque: 8 Nm



4. Torque: 25 Nm



Installation

1. To install, reverse the removal procedure.

SECTION 303-07A Glow Plug System — 2.4L Duratorq-TDCi (Puma) Diesel

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Glow Plug System 303-07A-2

DIAGNOSIS AND TESTING

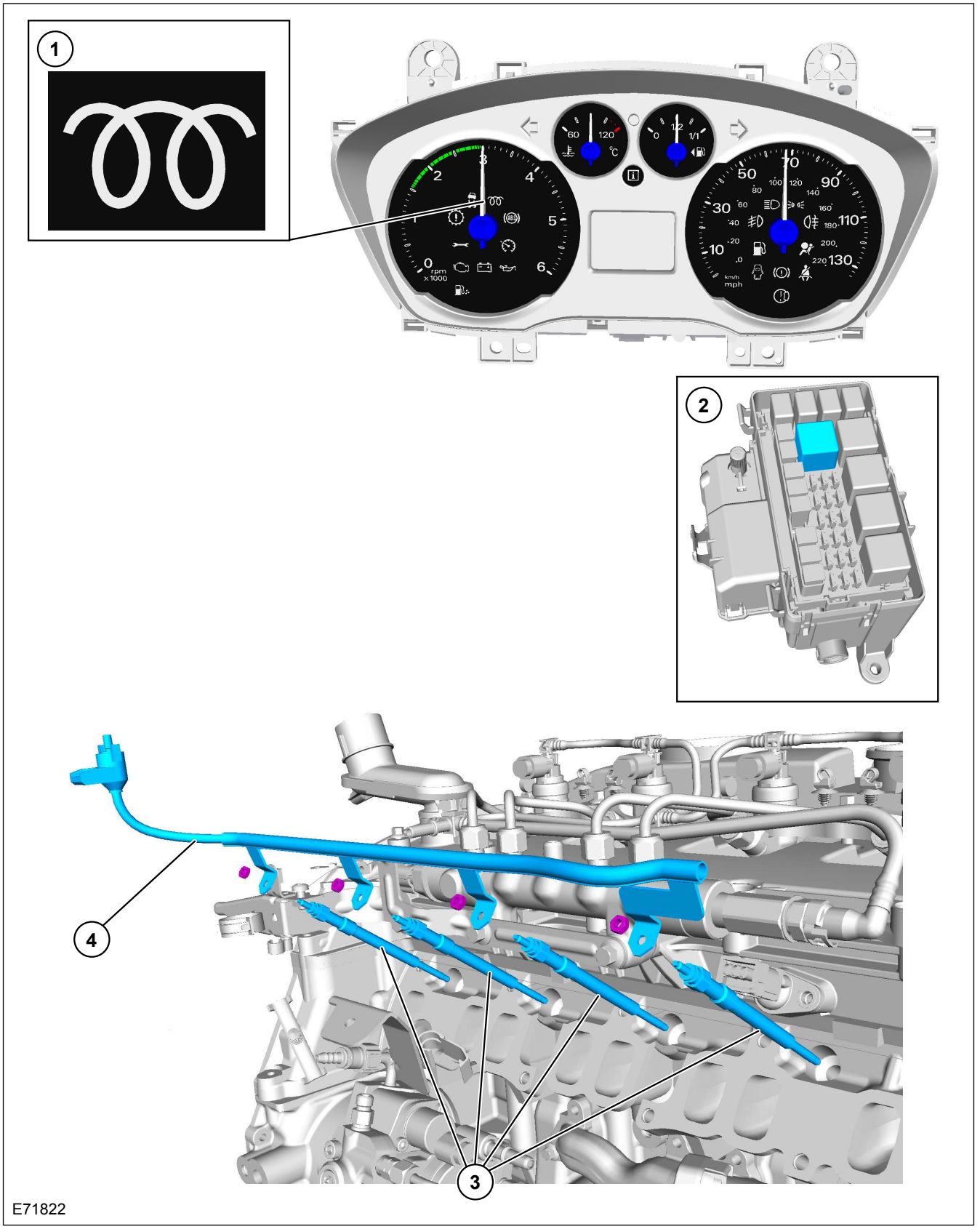
Glow Plug System 303-07A-4
Inspection and Verification 303-07A-4

REMOVAL AND INSTALLATION

Glow Plugs 303-07A-5

DESCRIPTION AND OPERATION

Glow Plug System



DESCRIPTION AND OPERATION

Item	Part Number	Description
1		Glow plug indicator lamp
2		Glow plug relay
3		Glow plug(s)
4		Glow plug wire

Glow Plugs

The glow plugs are located in the side of the cylinder head and aid engine starting and efficiency. The glow plugs and the glow plug indicator lamp are controlled by the powertrain control module (PCM).

The glow plugs preheat the combustion chambers, which aids cold starting. During the preheat stage, the PCM receives an engine temperature signal from the cylinder head temperature (CHT) sensor and this determines the preheat time. The lower the temperature, the longer the preheat time. There is a maximum preheat time of 8 seconds at -20°C or lower. At temperatures above 80°C there is no preheat phase.

Once the engine has started, the glow plugs enter an after-glow phase. The after-glow phase helps to improve idling and reduce hydrocarbon emissions through more efficient combustion just after starting. The after-glow phase only operates at engine speeds below 2500 RPM, above that, the after-glow phase is interrupted to increase the durability of the glow plugs. There is a maximum after-glow time of 30 seconds at -20°C or lower. At temperatures above 50°C there is no after-glow phase.

DIAGNOSIS AND TESTING

Glow Plug System

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical damage.

Visual Inspection Chart

Electrical
– Fuse(s) – Relay – Wiring harness – Electrical connector(s) – Glow plug(s) – Glow plug wire – Powertrain control module (PCM)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to WDS to diagnose the system.

REMOVAL AND INSTALLATION

Glow Plugs

Removal

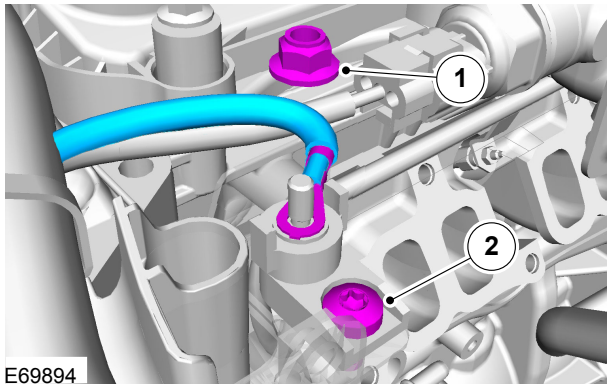
NOTE: Removal steps in this procedure may contain installation details.

1. Remove the intake manifold.

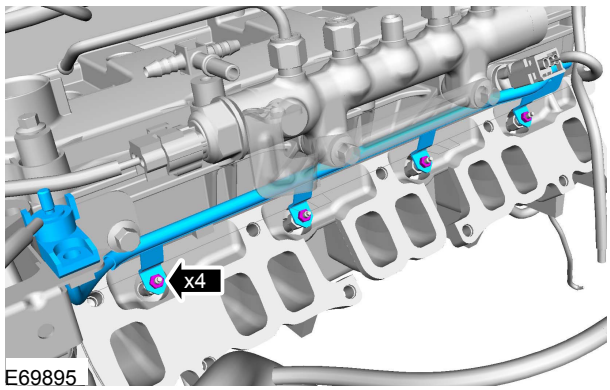
   Refer to:Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

CAUTION:Make sure that all openings are sealed.

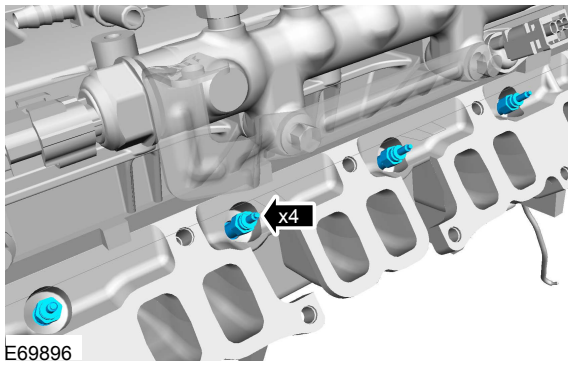
2. 1. Torque: 10 Nm
   2. Torque: 8 Nm



3. Torque: 3 Nm



4. Torque: 13 Nm



Installation

1. To install, reverse the removal procedure

SECTION 303-07B Engine Ignition — 2.3L Duratec-HE (MI4)

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Engine Ignition..... 303-07B-2
Inspection and Verification..... 303-07B-2
Symptom Chart..... 303-07B-2

DIAGNOSIS AND TESTING

Engine Ignition

General Equipment

Worldwide Diagnostic System (WDS)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical damage.

Visual Inspection Chart

Electrical
• Wiring harness • Electrical connector(s) • Spark plug(s) • Spark plug wire(s) • Ignition coil-on-plug • Powertrain control module (PCM)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• Engine misfire	• Spark plug(s). • Spark plug wire(s).	• Using the WDS CARRY OUT a KV test.
	• Ignition coil-on-plug. • PCM. • PCM calibration.	• REFER to the WDS.
• Engine stumbling	• Spark plug(s). • Spark plug wire(s).	• Using the WDS CARRY OUT a KV test.
	• Ignition coil-on-plug. • PCM. • PCM calibration.	• REFER to the WDS.
• Engine lacks power	• Spark plug(s). • Spark plug wire(s).	• Using the WDS CARRY OUT a KV test.
	• Ignition coil-on-plug.	• REFER to the WDS.

SECTION 303-08 Engine Emission Control

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Engine Emission Control 303-08-2
Vehicles with 2.3L Duratec-HE (MI4) engine 303-08-2
Vehicles with 2.2L Duratorq-TDCi (Puma) diesel engine 303-08-3
Vehicles with 2.4L Duratorq-TDCi (Puma) diesel engine 303-08-4

DIAGNOSIS AND TESTING

Engine Emission Control 303-08-5
Inspection and Verification 303-08-5
Engine Emission Control — 2.3L Duratec-HE (MI4) 303-08-6
Inspection and Verification 303-08-6
Symptom Chart 303-08-6

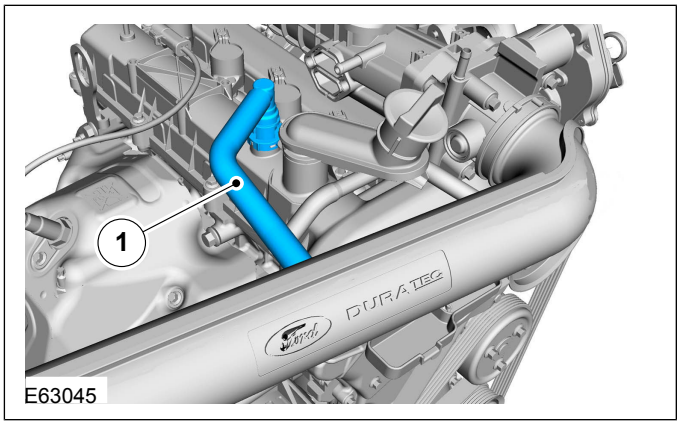
REMOVAL AND INSTALLATION

Crankcase Vent Oil Separator — 2.3L Duratec-HE (MI4) 303-08-7
Exhaust Gas Recirculation (EGR) Valve — 2.4L Duratorq-TDCi (Puma) Diesel 303-08-8
Exhaust Gas Recirculation (EGR) Cooler — 2.4L Duratorq-TDCi (Puma) Diesel 303-08-9
Exhaust Gas Recirculation (EGR) Valve Outlet Tube — 2.4L Duratorq-TDCi (Puma) Diesel 303-08-11

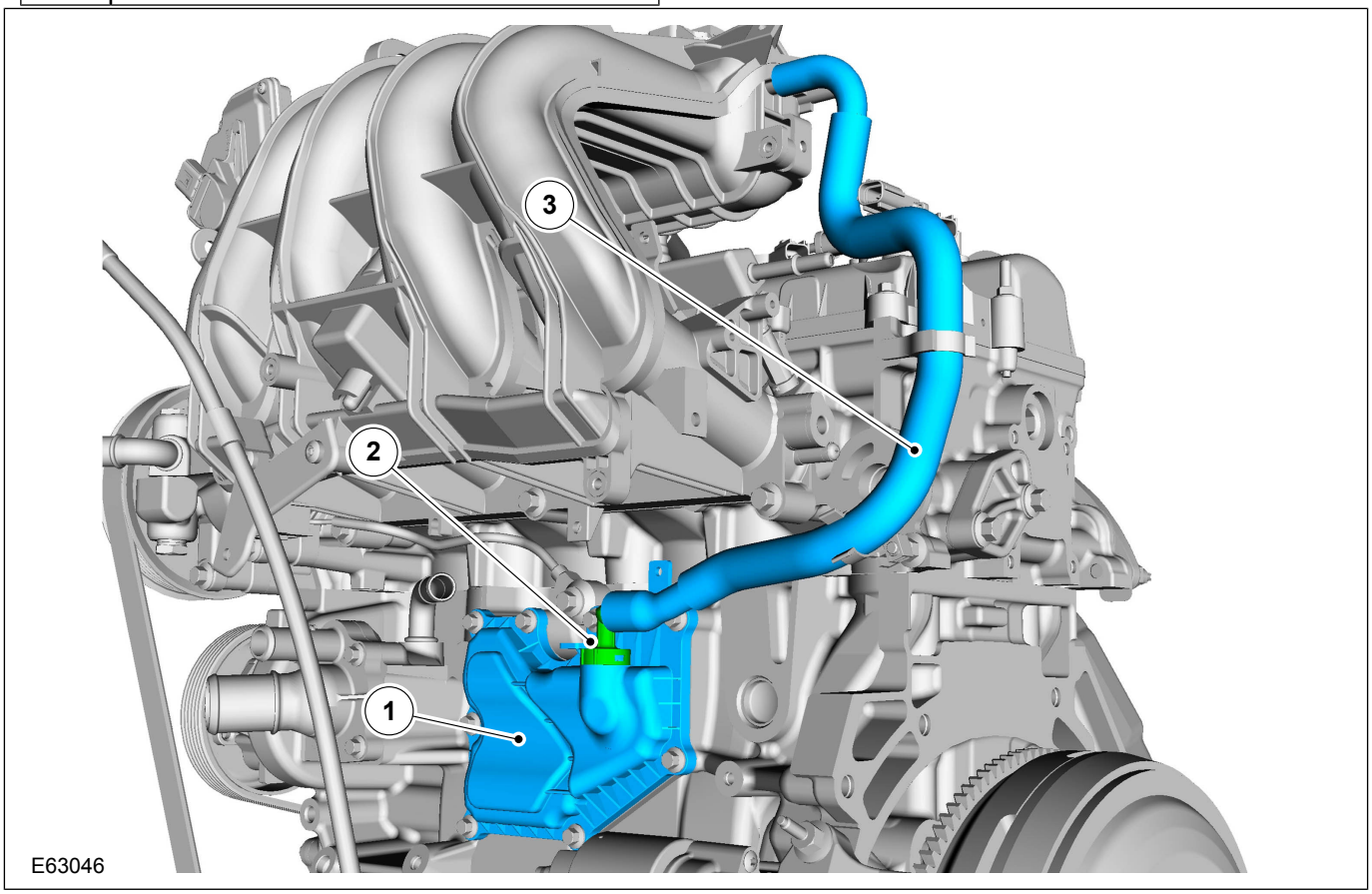
DESCRIPTION AND OPERATION

Engine Emission Control

Vehicles with 2.3L Duratec-HE (MI4) engine



Item	Description
1	Valve cover to air cleaner outlet pipe positive crankcase ventilation (PCV) hose



Item	Description
1	Crankcase vent oil separator
2	PCV valve to intake manifold PCV hose
3	PCV valve

PCV System

The PCV system consists of a valve mounted in the crankcase vent oil separator (attached to the cylinder block) and two hoses. One PCV hose

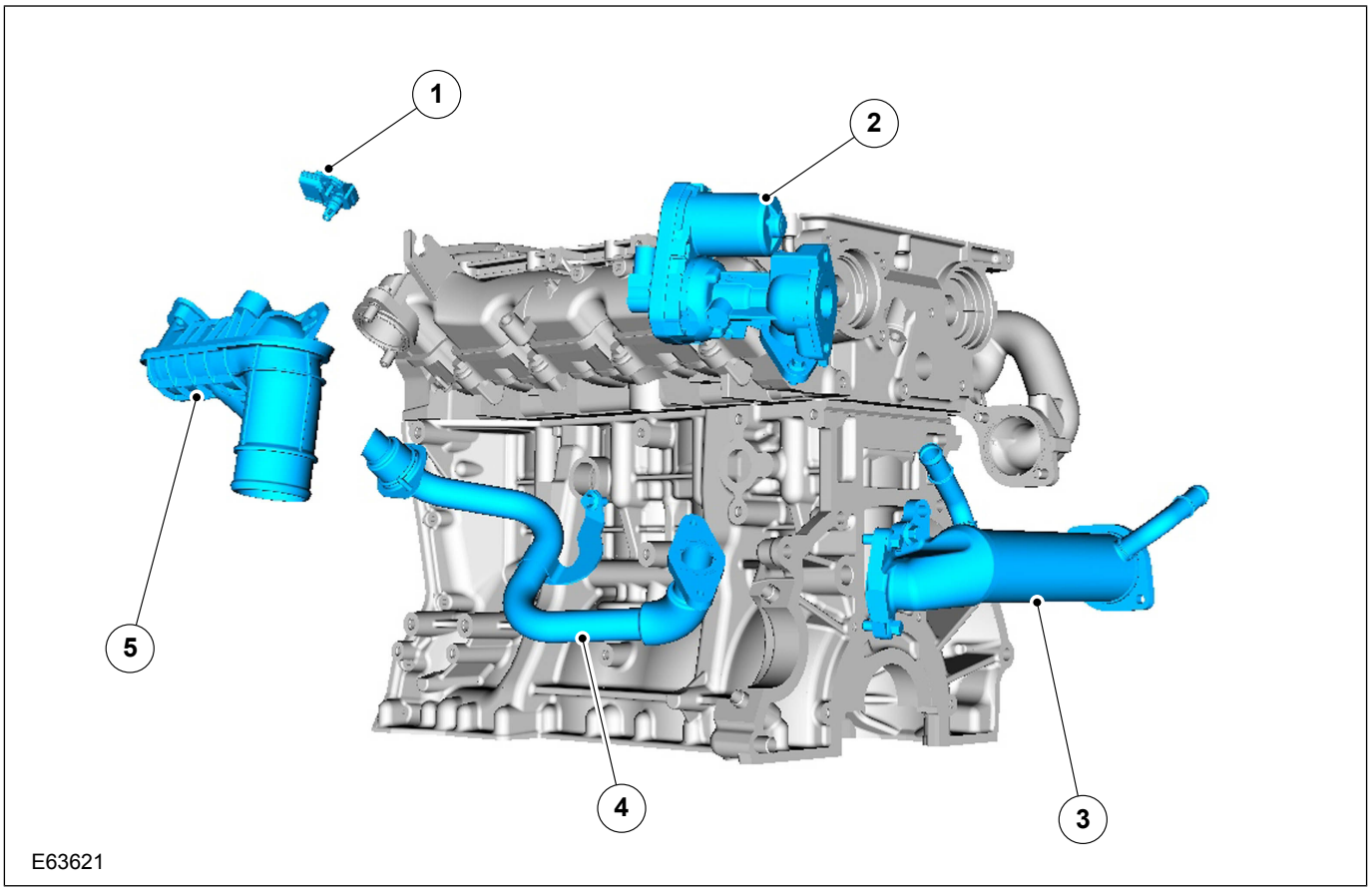
DESCRIPTION AND OPERATION

connects the PCV valve to the intake manifold, the other PCV hose connects the valve cover to the air cleaner outlet pipe.

Under idle and part throttle conditions, the crankcase vapor flows from the crankcase vent oil separator to the intake manifold and into the combustion chambers where the vapor is burnt during combustion.

Under full throttle conditions, the crankcase vapor flows from the valve cover into the air cleaner outlet pipe through the PCV hose.

Vehicles with 2.2L Duratorq-TDCi (Puma) diesel engine

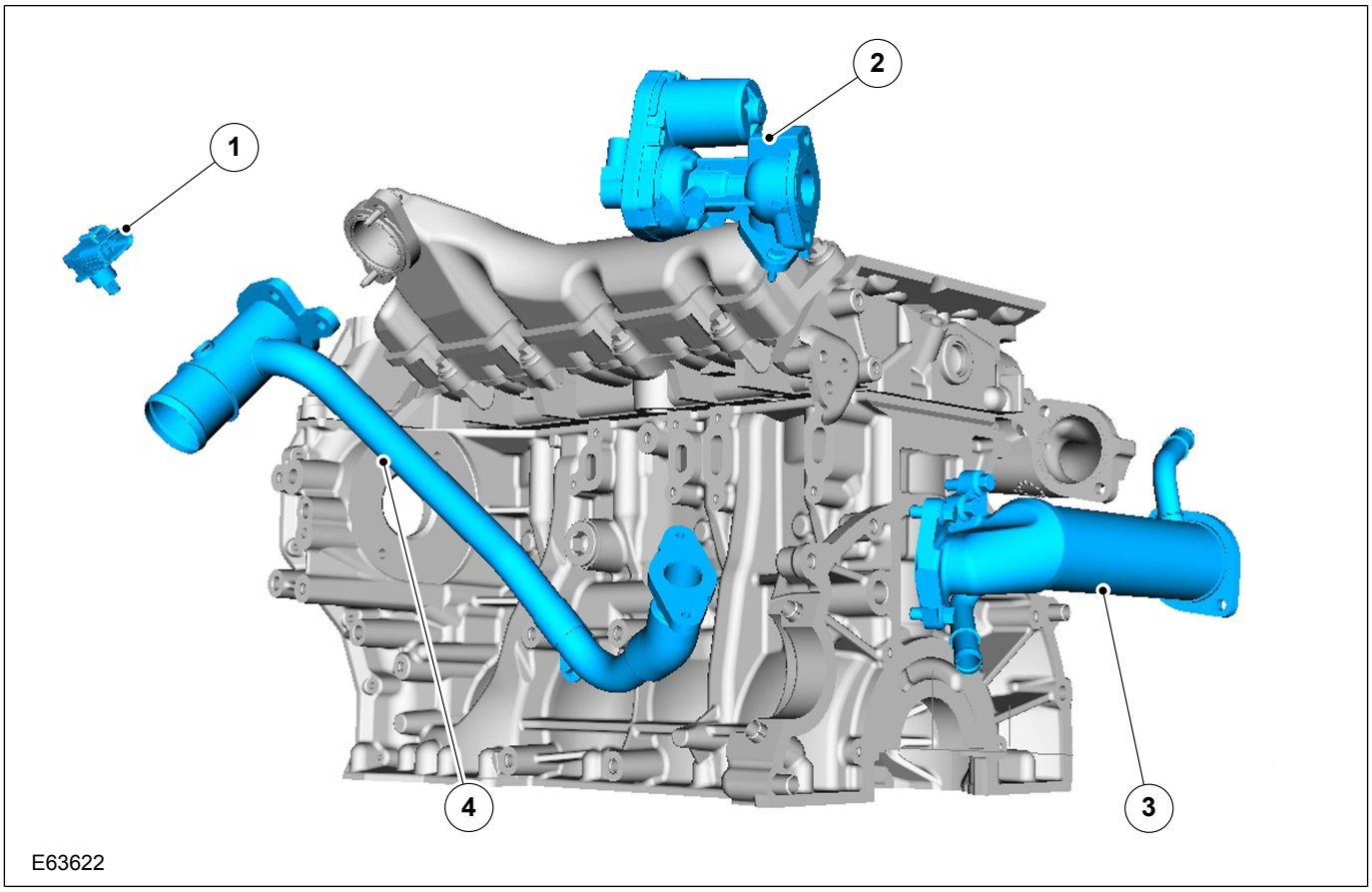


Item	Description
1	Intake air temperature (IAT) sensor
2	Exhaust gas recirculation (EGR) valve

Item	Description
3	EGR cooler
4	EGR valve outlet tube
5	EGR mixer tube

DESCRIPTION AND OPERATION

Vehicles with 2.4L Duratorq-TDCi (Puma) diesel engine



Item	Description
1	Intake air temperature (IAT) sensor
2	EGR valve
3	EGR cooler
4	EGR valve outlet tube

DIAGNOSIS AND TESTING

Engine Emission Control

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
• Exhaust gas recirculation (EGR) valve • EGR valve tube • EGR mixer tube • EGR cooler • Gaskets/seals • Hose(s)/hose joints	• Fuse(s) • Wiring harness • Electrical connector(s) • Relay(s) • Sensor(s) • Powertrain control module (PCM)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the WDS to diagnose the system.

DIAGNOSIS AND TESTING

Engine Emission Control — 2.3L Duratec-HE (MI4)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical damage.
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Visual Inspection Chart

Mechanical
• Hose(s)/hose joints • Gasket(s) • Positive crankcase ventilation (PCV) valve • PCV separator

Symptom Chart

Symptom	Possible Sources	Action
• Excessive crankcase pressure	• Blocked or damaged PCV hose(s). • Blocked crankcase vent oil separator.	• CHECK the PCV system components for blockages, CLEAN or INSTALL new components as necessary.
	• Worn or damaged engine components.	• REFER to:Engine (303-01 Engine - 2.3L Duratec-HE (MI4), Diagnosis and Testing).

REMOVAL AND INSTALLATION

Crankcase Vent Oil Separator — 2.3L Duratec-HE (MI4)

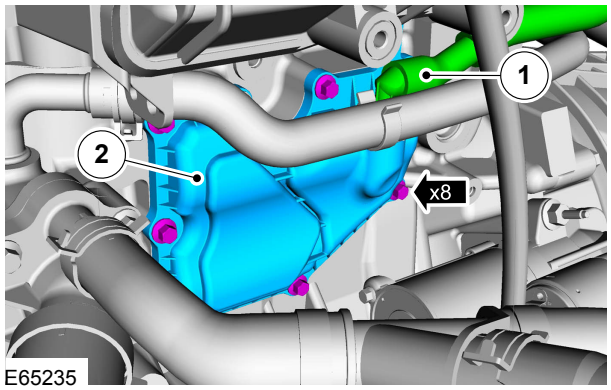
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. **NOTE:**The gasket is to be reused unless damaged.

   NOTE: Make sure that the mating faces are clean and free of foreign material.

   Torque: 11 Nm



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

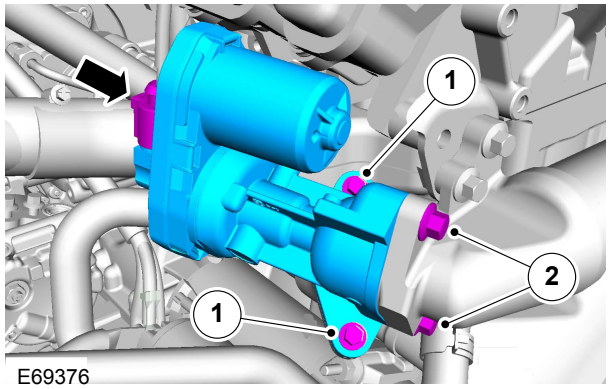
Exhaust Gas Recirculation (EGR) Valve — 2.4L Duratorq-TDCi (Puma) Diesel

Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Raise and support the vehicle.

   Refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).
2. 1. Torque: 10 Nm
   2. Torque: 24 Nm



Installation

NOTE: Install all the bolts finger tight before final tightening.

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Exhaust Gas Recirculation (EGR) Cooler — 2.4L Duratorq-TDCi (Puma) Diesel

General Equipment

Coolant hose clamp remover/installer

Removal

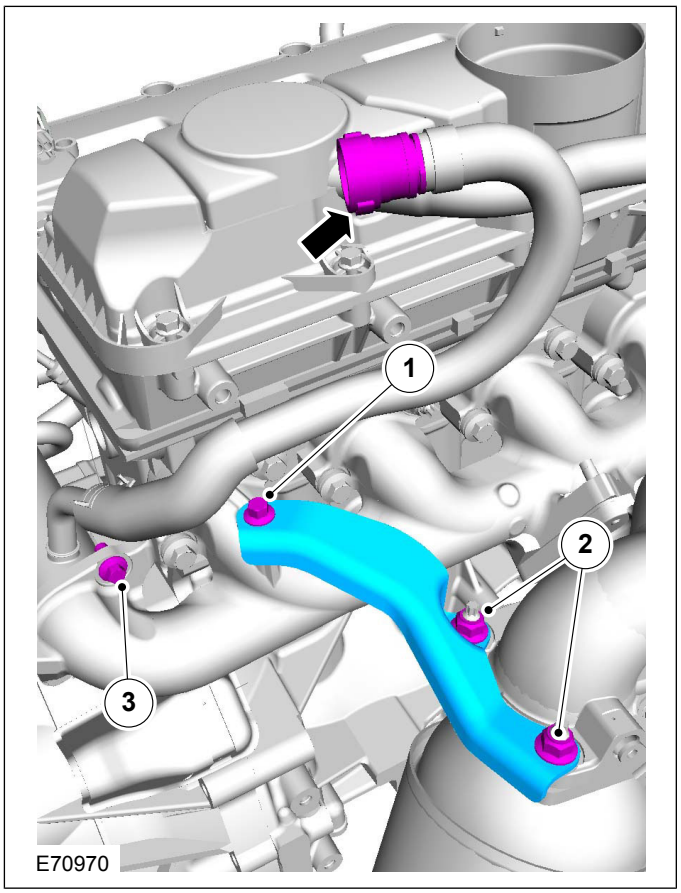
NOTE: Removal steps in this procedure may contain installation details.

1. Drain the cooling system.

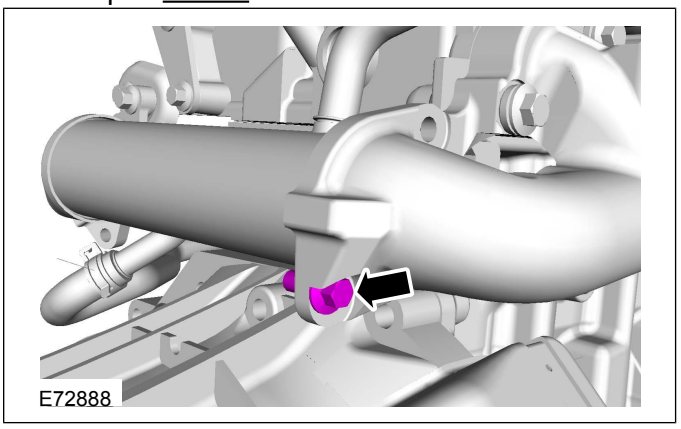
   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

   Refer to: Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

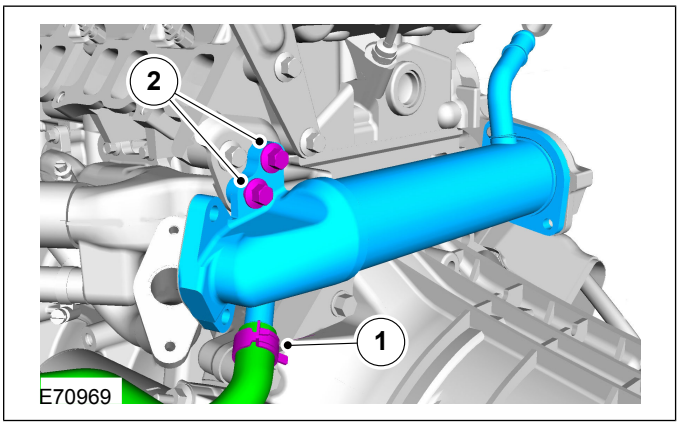
2. Lower the vehicle.
3. 1. Torque: 25 Nm
   2. Torque: 48 Nm
   3. Torque: 23 Nm



4. Raise and support the vehicle.
5. Torque: 23 Nm

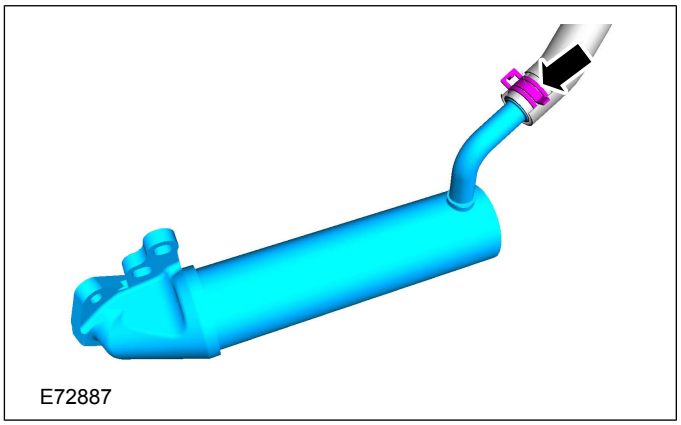


6. 1. General Equipment: Coolant hose clamp remover/installer
   2. Torque: 23 Nm



REMOVAL AND INSTALLATION

7. General Equipment: Coolant hose clamp remover/installer



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Exhaust Gas Recirculation (EGR) Valve Outlet Tube — 2.4L Duratorq-TDCi (Puma) Diesel

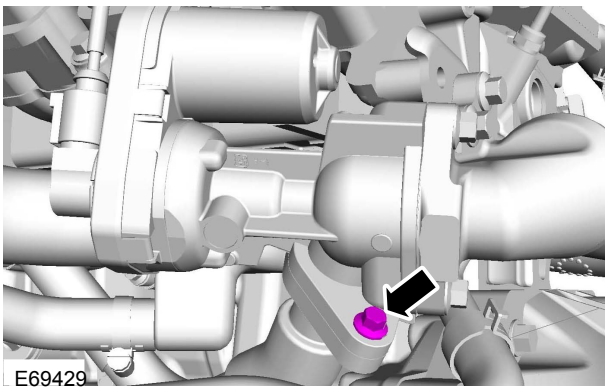
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Raise and support the vehicle.

   Refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

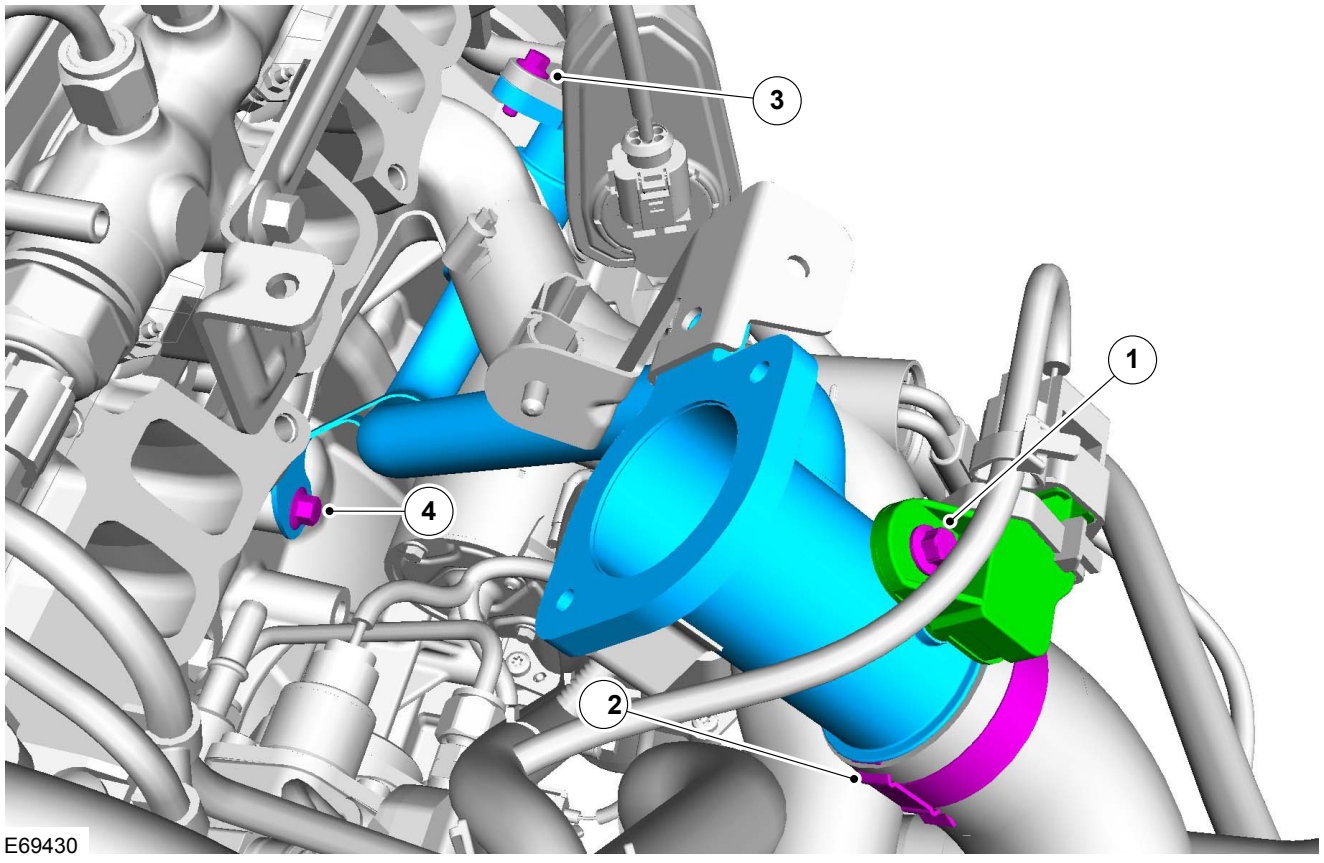
2.



3. Remove the intake manifold.

   Refer to: Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

4.



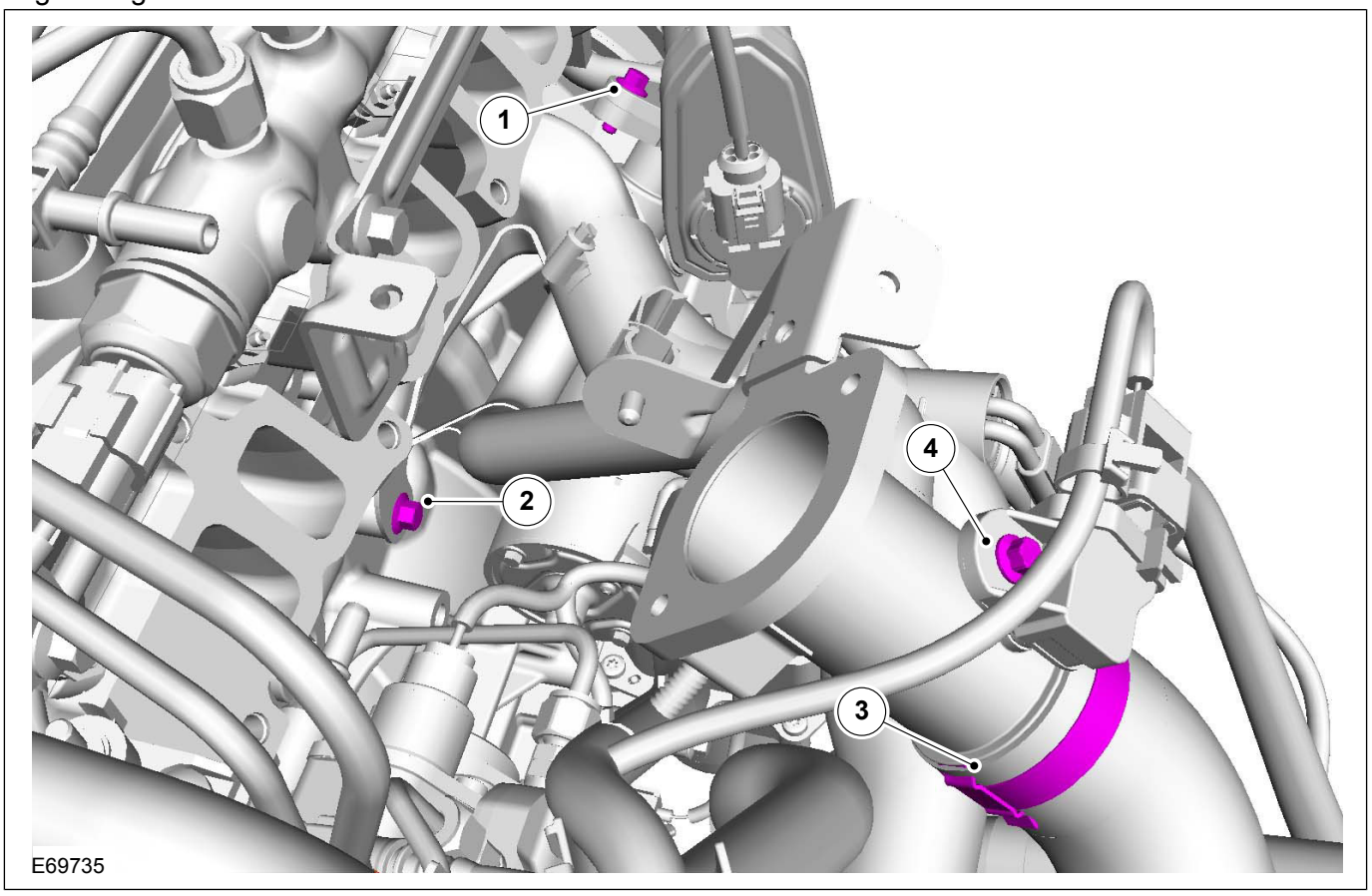
REMOVAL AND INSTALLATION

Installation

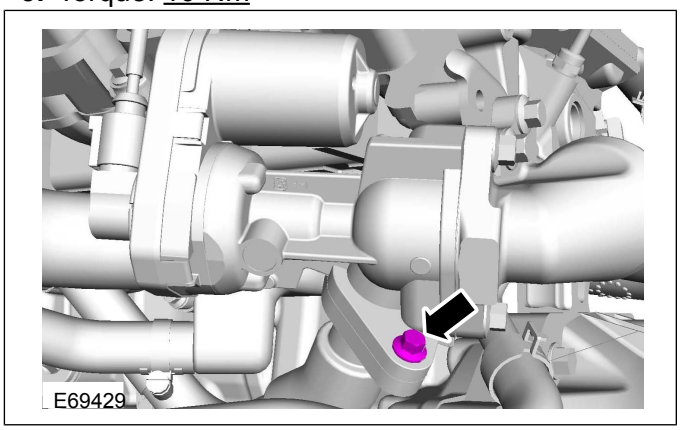
1. To install, reverse the removal procedure.

NOTE: Install all the bolts finger tight before final tightening.

2. 1. Torque: 10 Nm
2. Torque: 23 Nm
3. Torque: 6 Nm
4. Torque: 6 Nm



3. Torque: 10 Nm



SECTION 303-12 Intake Air Distribution and Filtering

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Intake Air Distribution and Filtering..... 303-12-2

DIAGNOSIS AND TESTING

Intake Air Distribution and Filtering..... 303-12-5
Inspection and Verification..... 303-12-5
Component Test..... 303-12-5

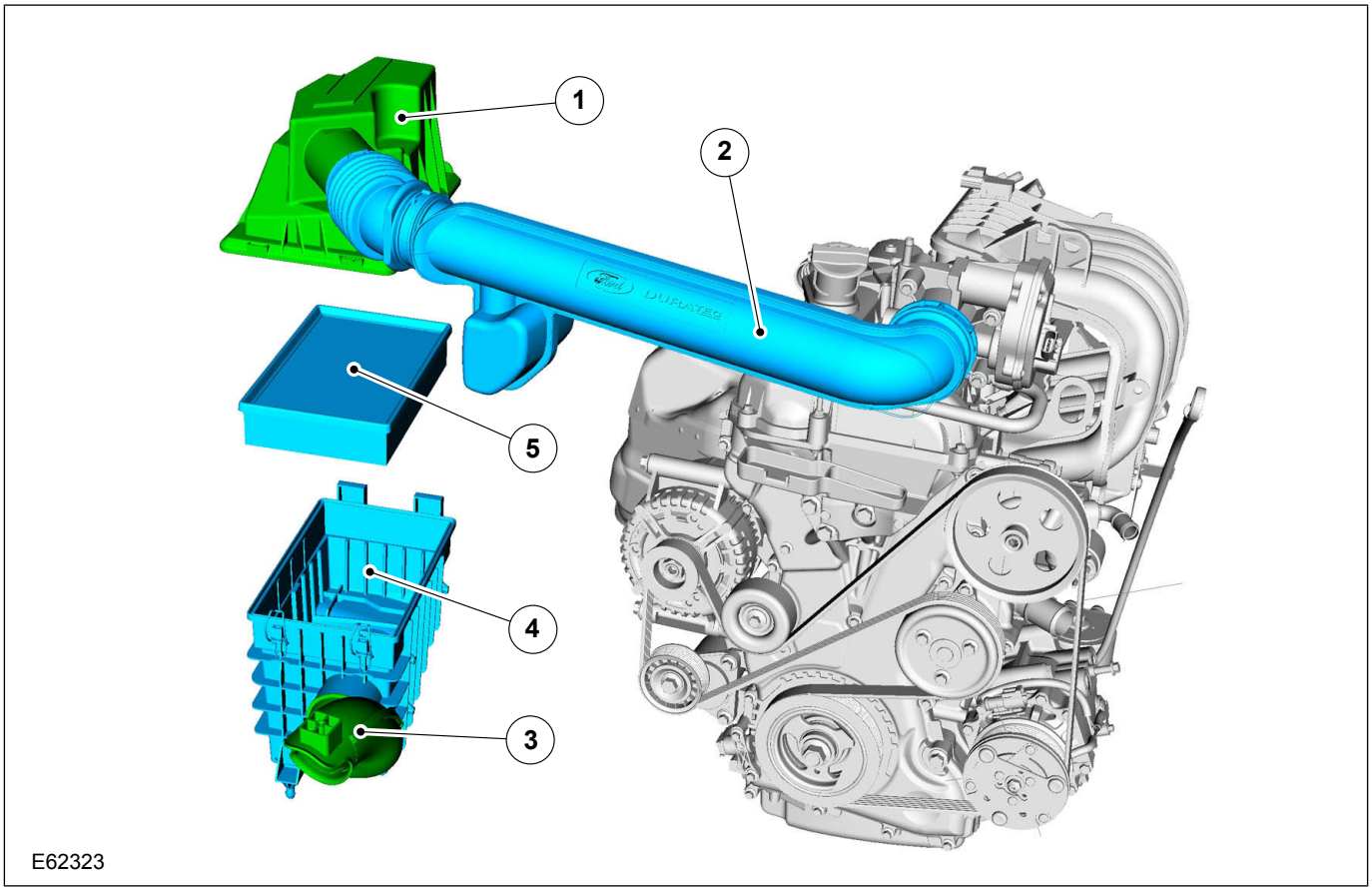
REMOVAL AND INSTALLATION

Air Cleaner — 2.3L Duratec-HE (MI4)/2.4L Duratorq-TDCi (Puma) Diesel..... 303-12-6
Charge Air Cooler..... 303-12-7

DESCRIPTION AND OPERATION

Intake Air Distribution and Filtering

Vehicles with 2.3L Duratec-HE (MI4) engine

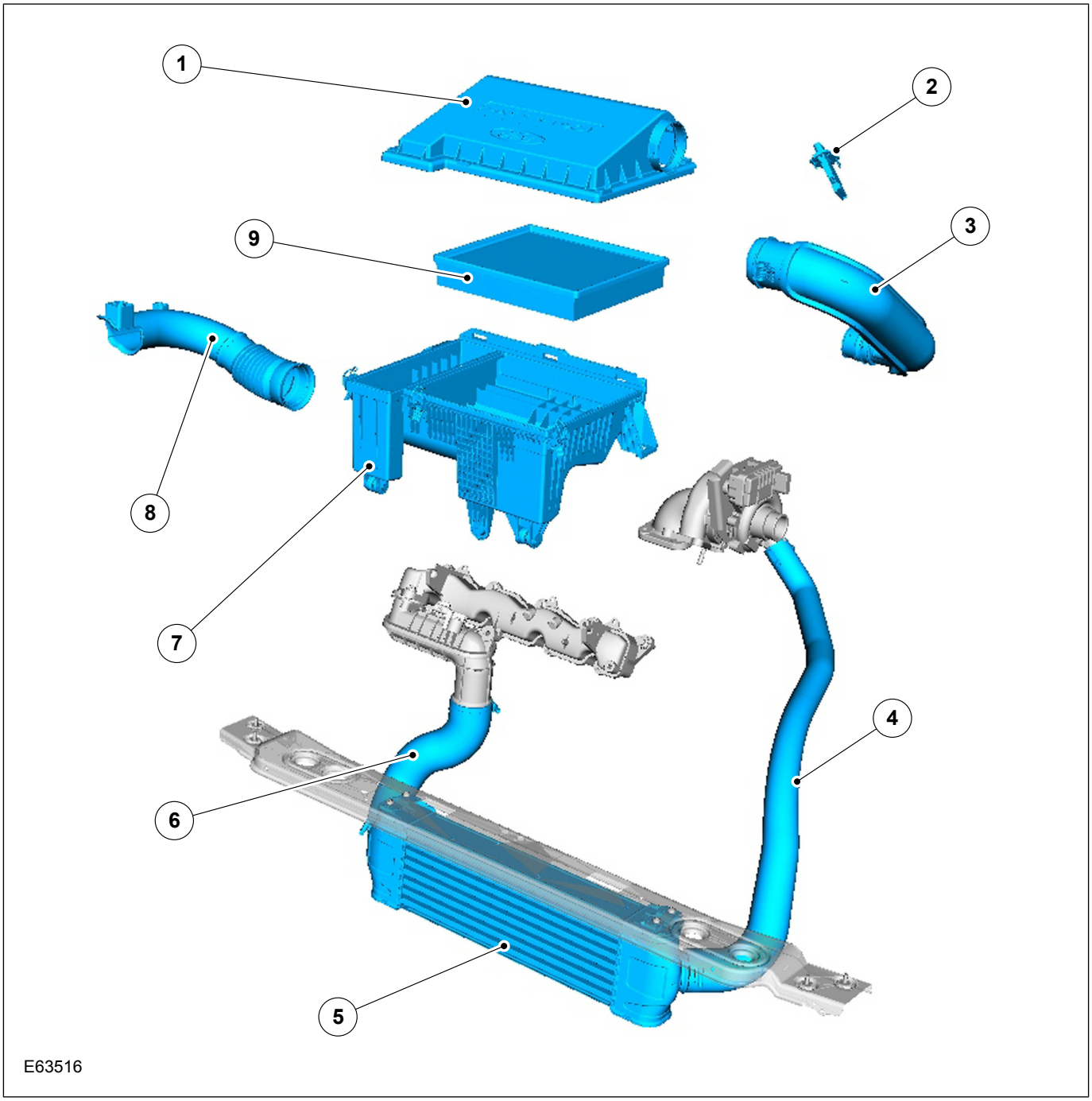


Item	Description
1	Air cleaner housing cover
2	Air cleaner outlet pipe

Item	Description
3	Air cleaner intake pipe
4	Air cleaner housing
5	Air cleaner element

DESCRIPTION AND OPERATION

Vehicles with 2.2L Duratorq-TDCi (Puma) diesel engine

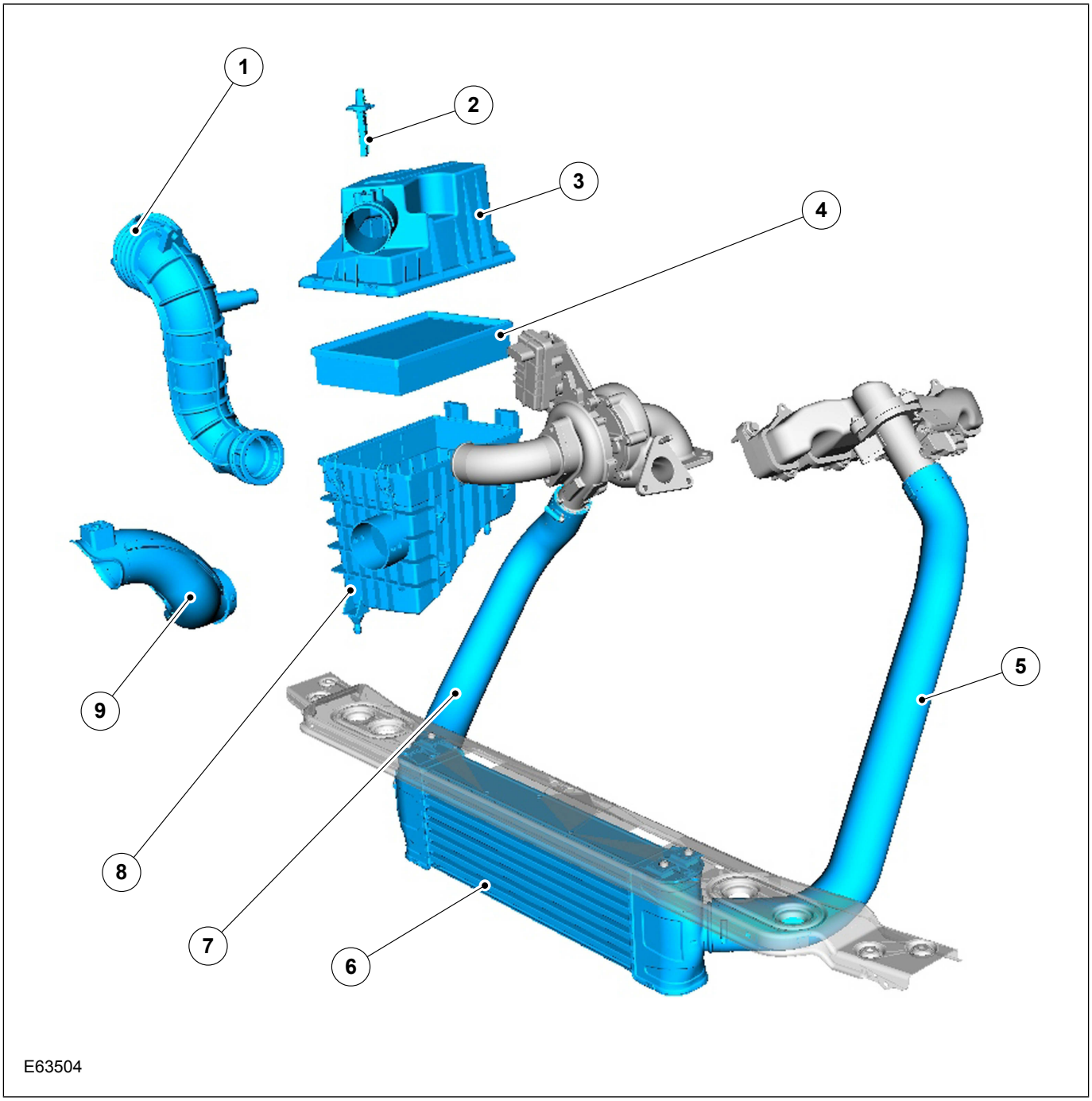


Item	Description
1	Air cleaner housing cover
2	Mass air flow (MAF) sensor
3	Air cleaner outlet pipe
4	Charge air cooler intake pipe

Item	Description
5	Charge air cooler
6	Charge air cooler outlet pipe
7	Air cleaner housing
8	Air cleaner intake pipe
9	Air cleaner element

DESCRIPTION AND OPERATION

Vehicles with 2.4L Duratorq-TDCi (Puma) diesel engine



Item	Description
1	Air cleaner outlet pipe
2	Mass air flow (MAF) sensor
3	Air cleaner housing cover
4	Air cleaner element
5	Charge air cooler outlet pipe
6	Charge air cooler
7	Charge air cooler intake pipe

Item	Description
8	Air cleaner housing
9	Air cleaner intake pipe

DIAGNOSIS AND TESTING

Intake Air Distribution and Filtering

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical damage.

Visual Inspection Chart

Mechanical
– Collapsed pipe(s) – Air cleaner – Air cleaner element – Air cleaner element minder gauge – Charge air cooler

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to WDS to diagnose the system.

Component Test

Air Cleaner Element

NOTE: Extremely moist operating conditions may produce a false reading in the air cleaner element minder gauge. If a new air cleaner element has been installed recently, the yellow plunger in the air cleaner element minder gauge should be near or in the red zone until reset by pressing the yellow button on the top of the air cleaner element minder gauge. The yellow plunger should then return to the top of the green zone.

NOTE: The air cleaner element component test should only be carried out if the yellow plunger has reached the bottom line of green zone, or is in the clear or red zones.

Carry out the following test to determine if a new air cleaner element should be installed .

1. Press the yellow button on the top of the air cleaner element minder gauge and hold for 3 seconds to reset it.
2. Start the engine. and gently raise and hold the engine speed to 4000 rpm for approximately 15 seconds.
3. If the yellow plunger returns to the bottom line of the green zone, or to the clear or red zones, INSTALL a new air cleaner element and RESET the air cleaner element minder gauge.

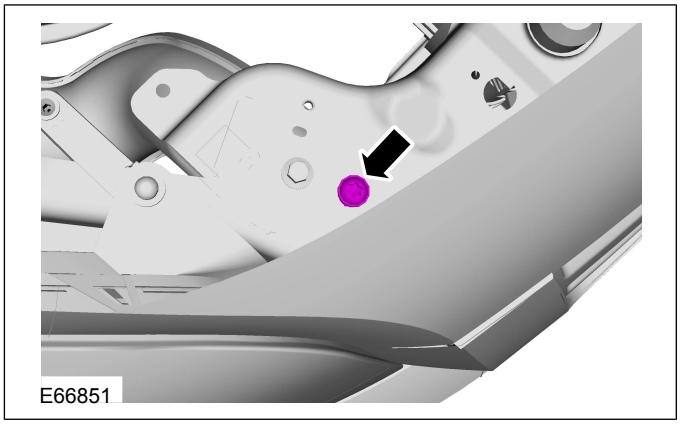
REMOVAL AND INSTALLATION

Air Cleaner — 2.3L Duratec-HE (MI4)/2.4L Duratorq-TDCi (Puma) Diesel

Removal

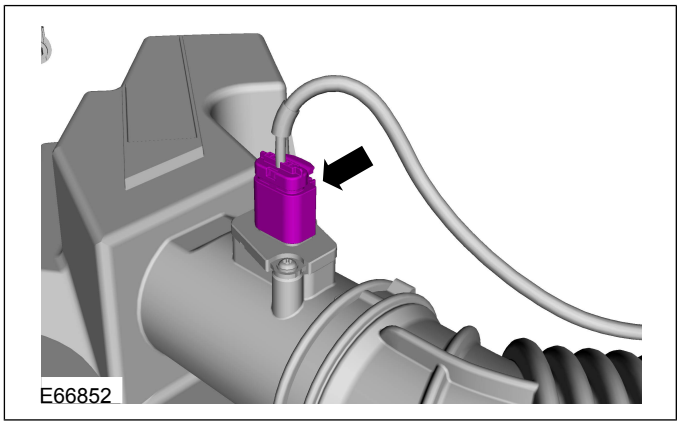
All vehicles

1.



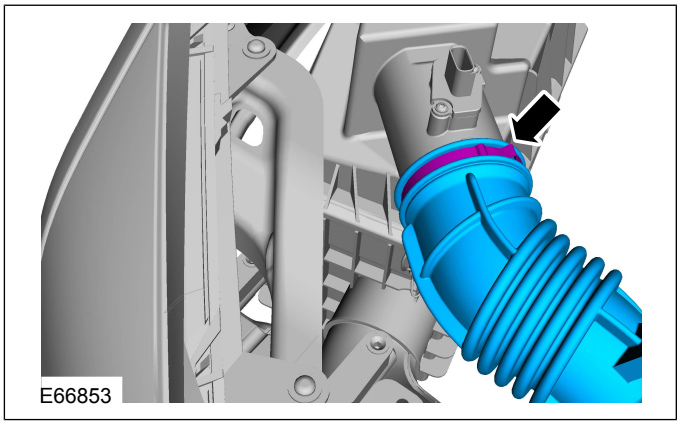
Vehicles with 2.4L diesel engine

2.

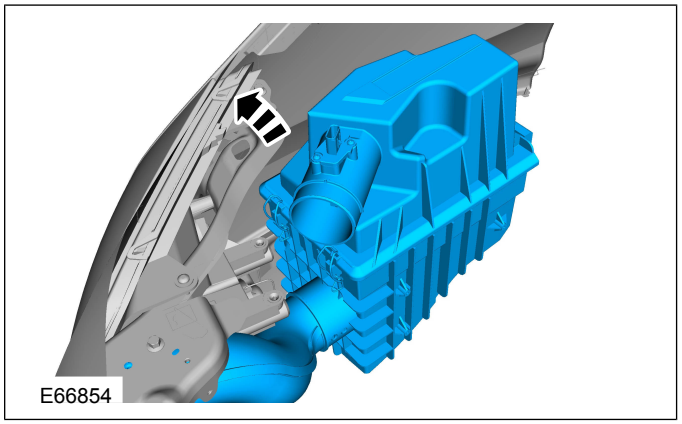


All vehicles

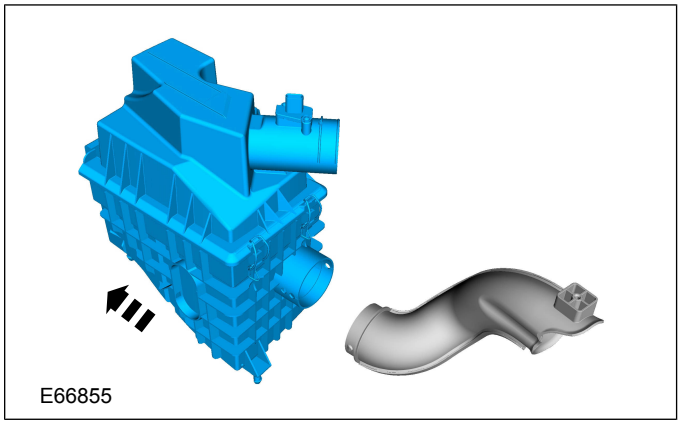
3.



4.



5.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Charge Air Cooler

Removal

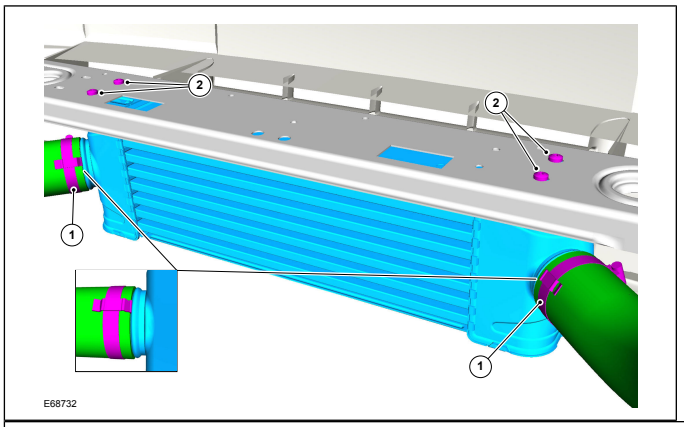
All vehicles

1. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

All vehicles

2.



3. **CAUTION:Make sure that the inside of the pipe ends are clean and free of oil residue.**
   1. Torque: 6 Nm
   2. Torque: 8 Nm

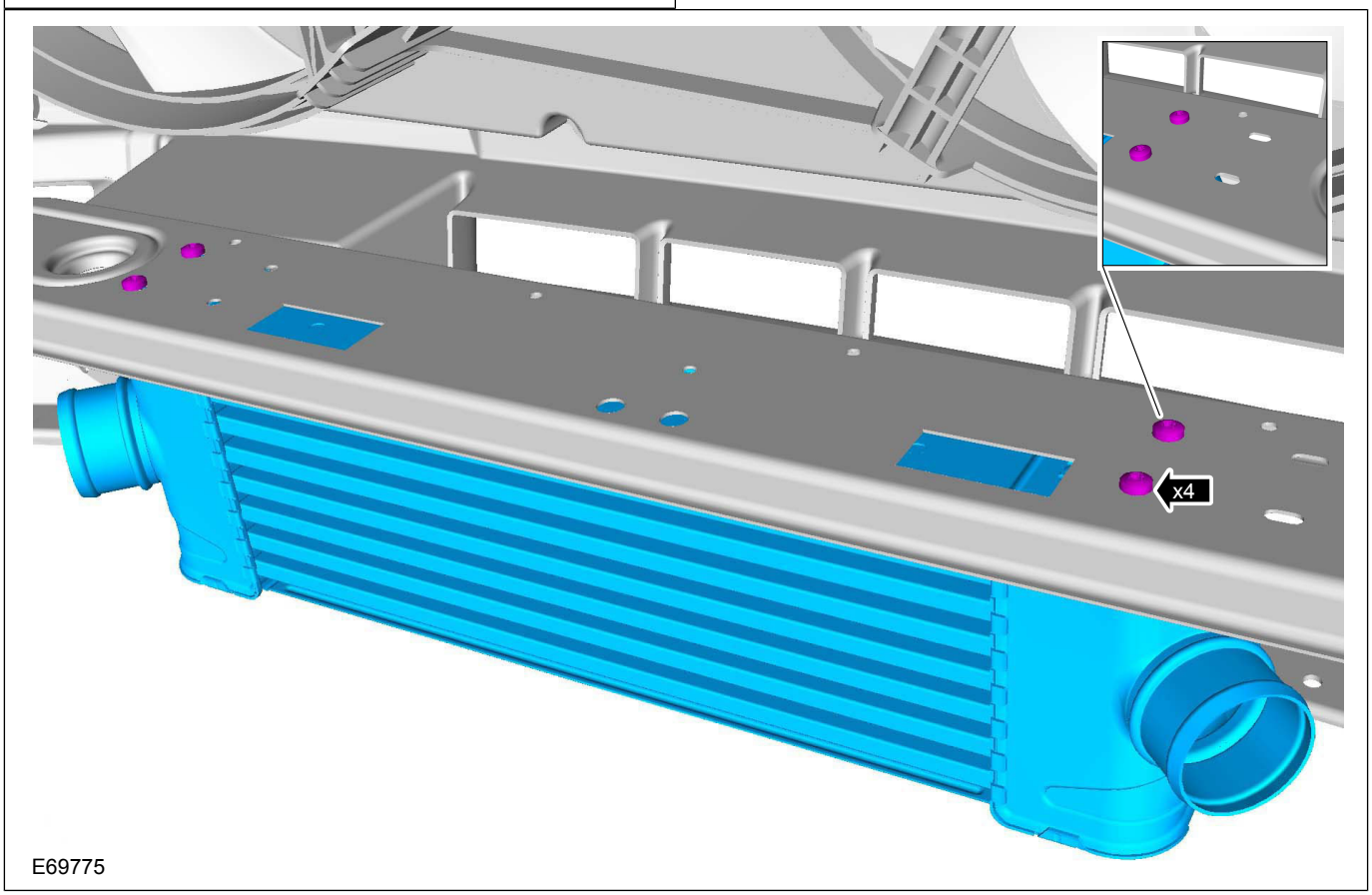
Installation

All vehicles

1. To install, reverse the removal procedure.

Vehicles with 2.2L diesel engine

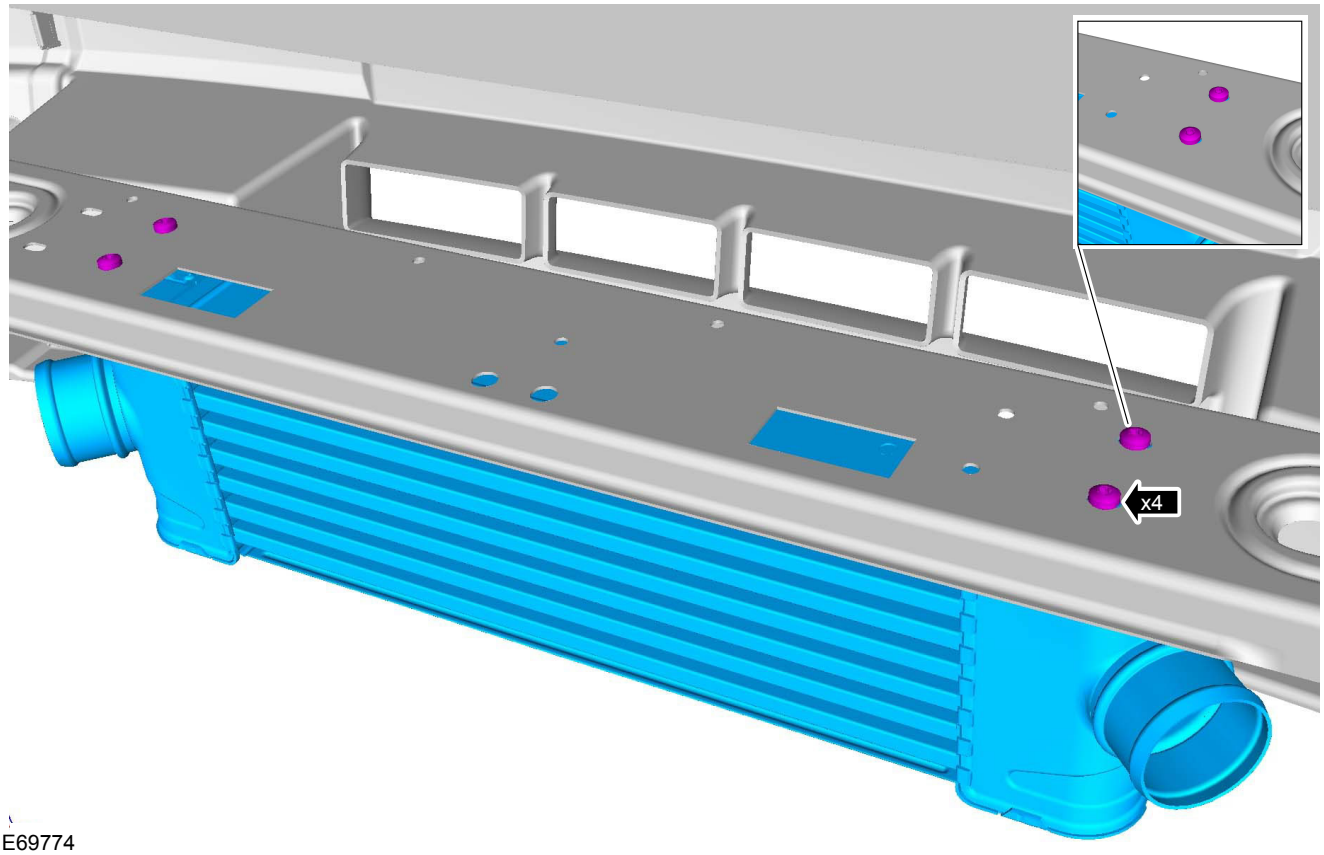
2.



REMOVAL AND INSTALLATION

Vehicles with 2.4L diesel engine

3.



SECTION 303-13 Evaporative Emissions

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Evaporative Emissions..... 303-13-2

DIAGNOSIS AND TESTING

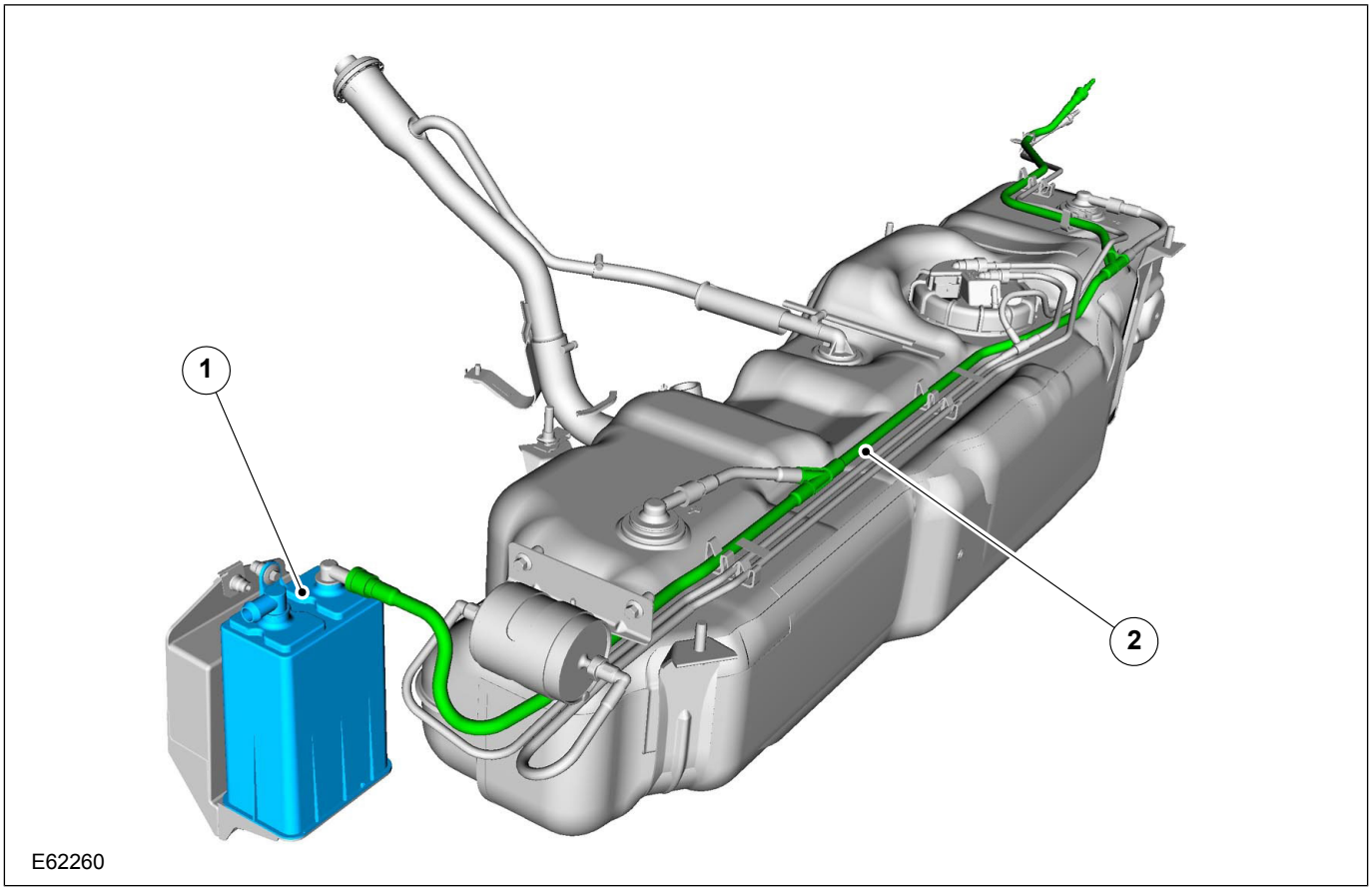
Evaporative Emissions..... 303-13-4
Inspection and Verification..... 303-13-4

REMOVAL AND INSTALLATION

Evaporative Emission Canister..... 303-13-5

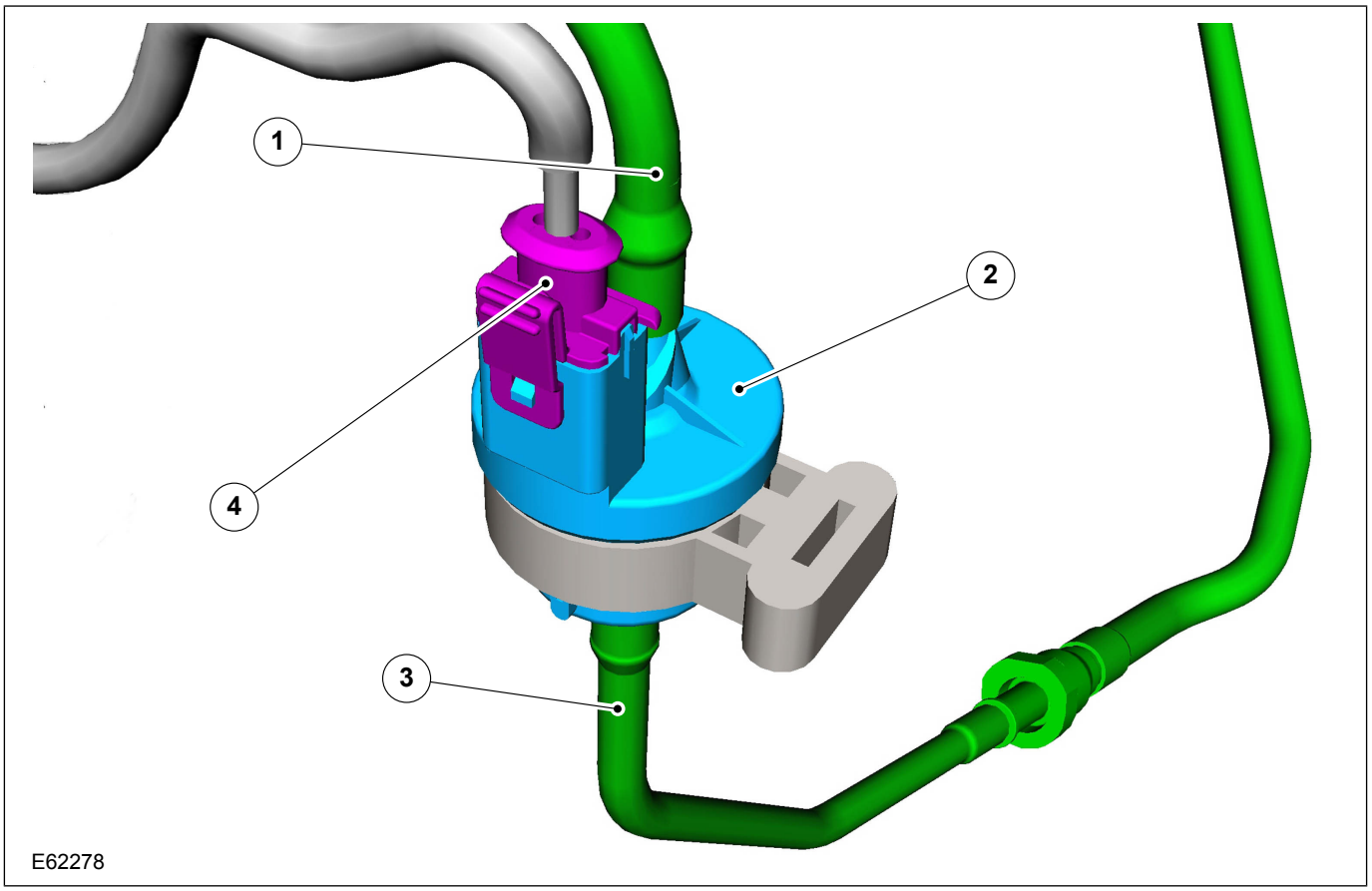
DESCRIPTION AND OPERATION

Evaporative Emissions



Item	Part Number	Description
1		Evaporative emission canister
2		Evaporative emission canister to evaporative emission canister purge valve vapor line

DESCRIPTION AND OPERATION



Item	Description
1	Evaporative emission canister purge valve to intake manifold vapor line
2	Evaporative emission canister purge valve
3	Evaporative emission canister to evaporative emission canister purge valve vapor line
4	Evaporative emission canister purge valve electrical connector

DIAGNOSIS AND TESTING

Evaporative Emissions

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Vacuum line(s) – Evaporative emission (EVAP) system canister – EVAP system hose(s) – EVAP system canister purge valve	– Fuse(s) – Wiring harness – Electrical connector(s)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to WDS to diagnose the system.

REMOVAL AND INSTALLATION

Evaporative Emission Canister

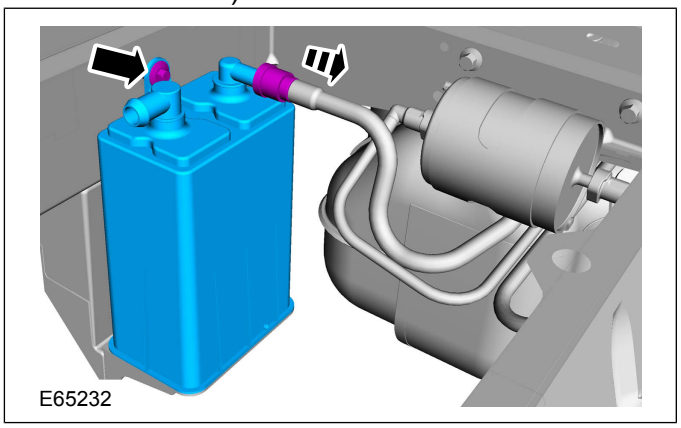
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

2. Refer to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).



Installation

1. To install, reverse the removal procedure.

SECTION 303-14 Electronic Engine Controls

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Electronic Engine Controls 303-14-2
Vehicles with 2.3L Duratec-HE (MI4) 303-14-2
Vehicles with 2.2L Duratorq-TDCi (Puma) diesel engine 303-14-5
Vehicles with 2.4L Duratorq-TDCi (Puma) diesel engine 303-14-7

DIAGNOSIS AND TESTING

Electronic Engine Controls 303-14-9
Principles of Operation 303-14-9
MIL Code List 303-14-12
Inspection and Verification 303-14-16

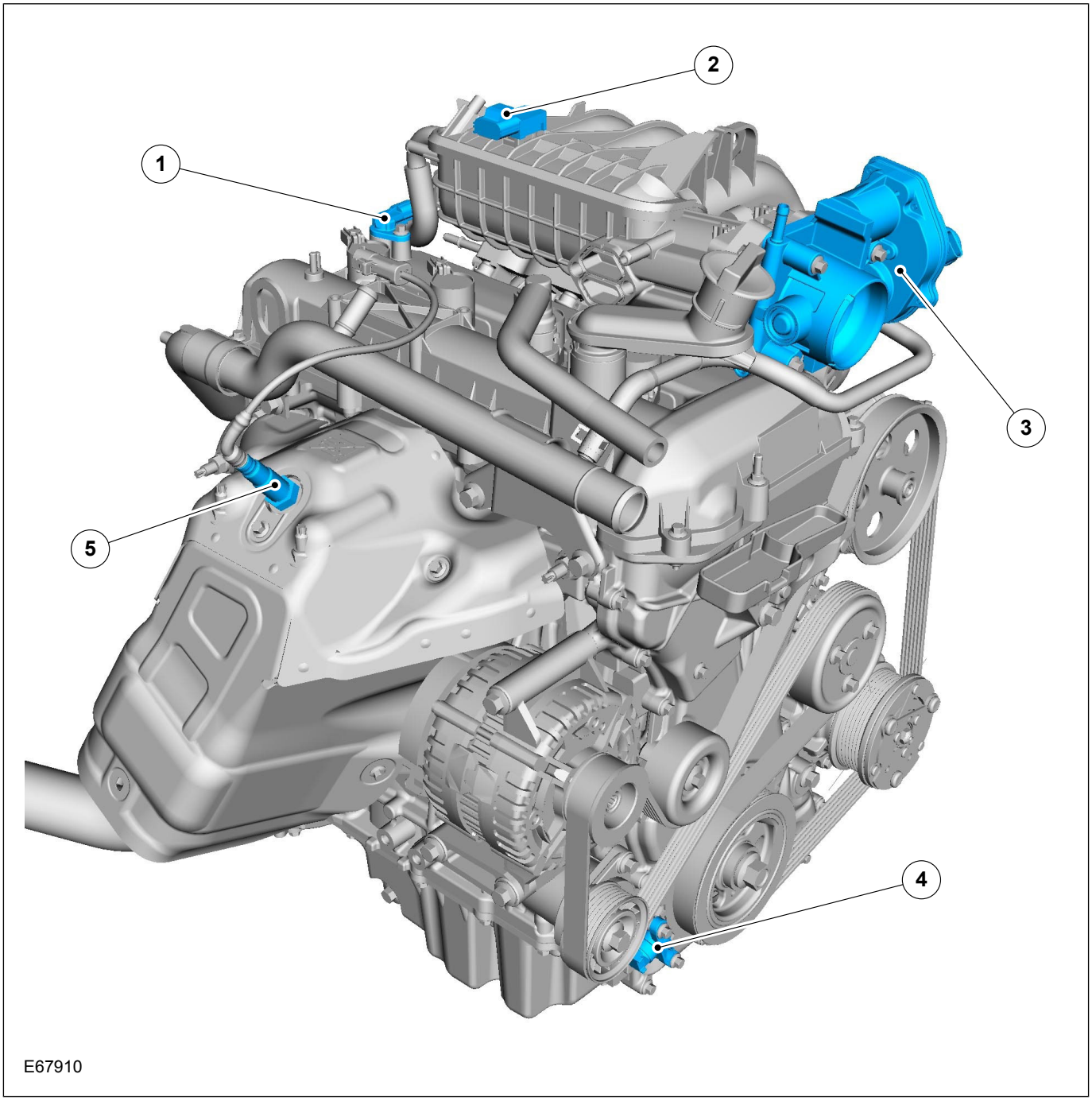
REMOVAL AND INSTALLATION

Powertrain Control Module (PCM) — Vehicles Without: PCM Security Shield 303-14-17
Cylinder Head Temperature (CHT) Sensor — 2.4L Duratorq-TDCi (Puma) Diesel 303-14-18
Camshaft Position (CMP) Sensor — 2.4L Duratorq-TDCi (Puma) Diesel 303-14-19
Knock Sensor (KS) — 2.3L Duratec-HE (MI4) 303-14-20
Camshaft Position (CMP) Sensor 303-14-21
Heated Oxygen Sensor (HO2S) 303-14-22
Engine Coolant Temperature (ECT) Sensor — 2.3L Duratec-HE (MI4) 303-14-23
Catalyst Monitor Sensor 303-14-24
Manifold Absolute Pressure (MAP) Sensor 303-14-25
Crankshaft Position (CKP) Sensor — 2.3L Duratec-HE (MI4) 303-14-26
Crankshaft Position (CKP) Sensor — 2.4L Duratorq-TDCi (Puma) Diesel 303-14-28

DESCRIPTION AND OPERATION

Electronic Engine Controls

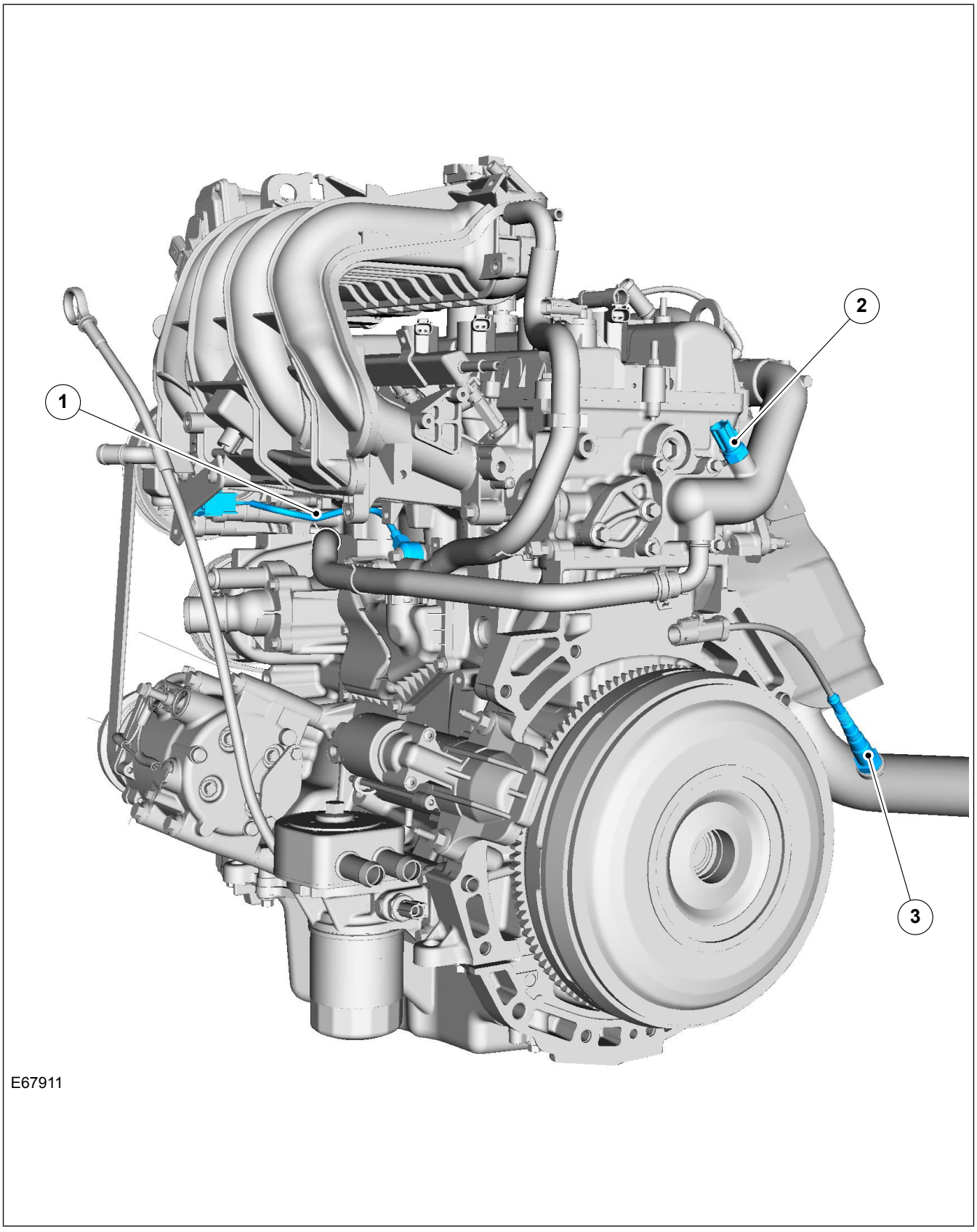
Vehicles with 2.3L Duratec-HE (MI4)



Item	Description
1	Camshaft position (CMP) sensor
2	Manifold absolute pressure and temperature (MAPT) sensor

Item	Description
3	Throttle body
4	Crankshaft position (CKP) sensor
5	Heated oxygen sensor (HO2S)

DESCRIPTION AND OPERATION



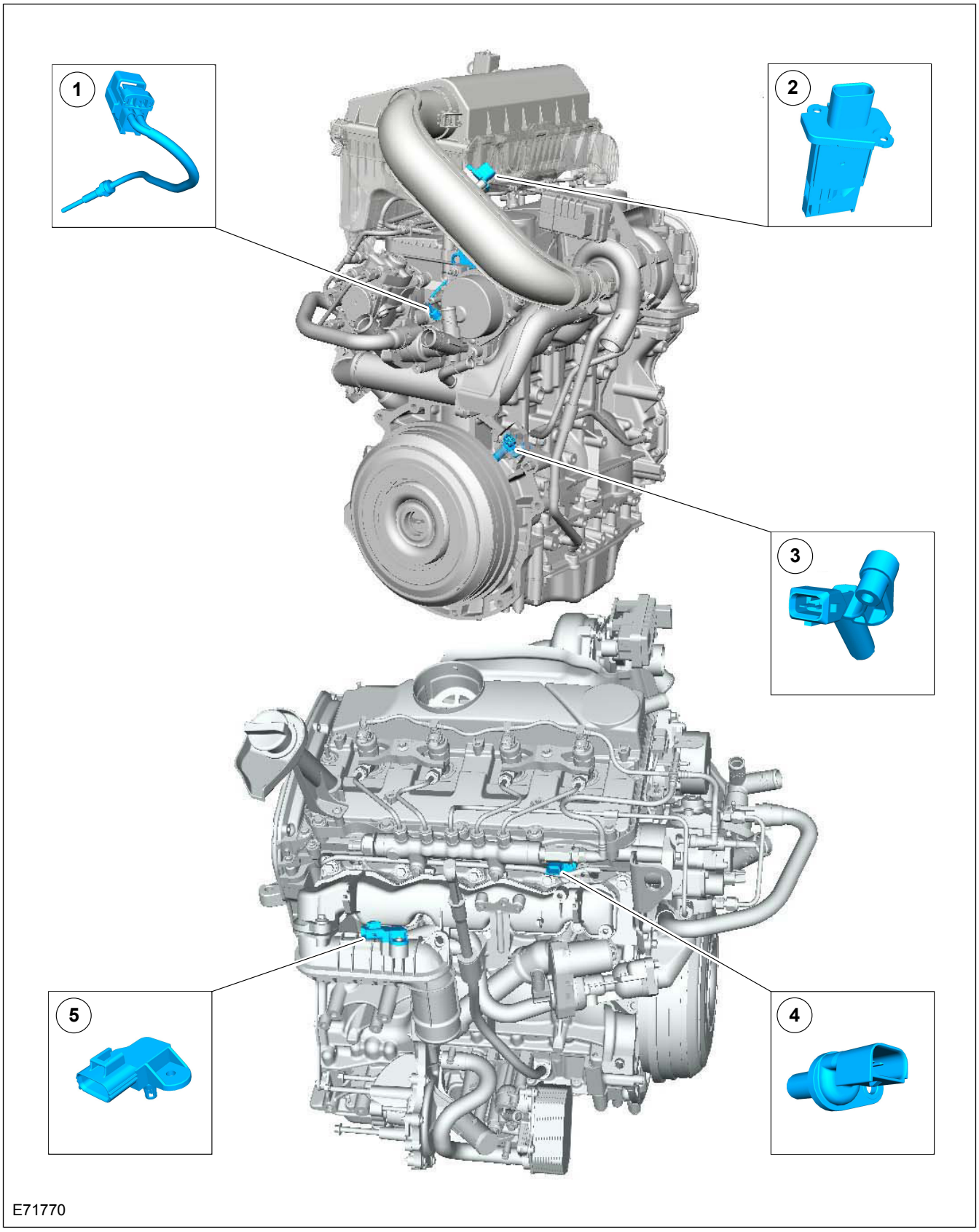
DESCRIPTION AND OPERATION

Item	Description
1	Knock sensor (KS)
2	Engine coolant temperature (ECT) sensor

Item	Description
3	Catalyst monitor sensor

DESCRIPTION AND OPERATION

Vehicles with 2.2L Duratorq-TDCi (Puma) diesel engine



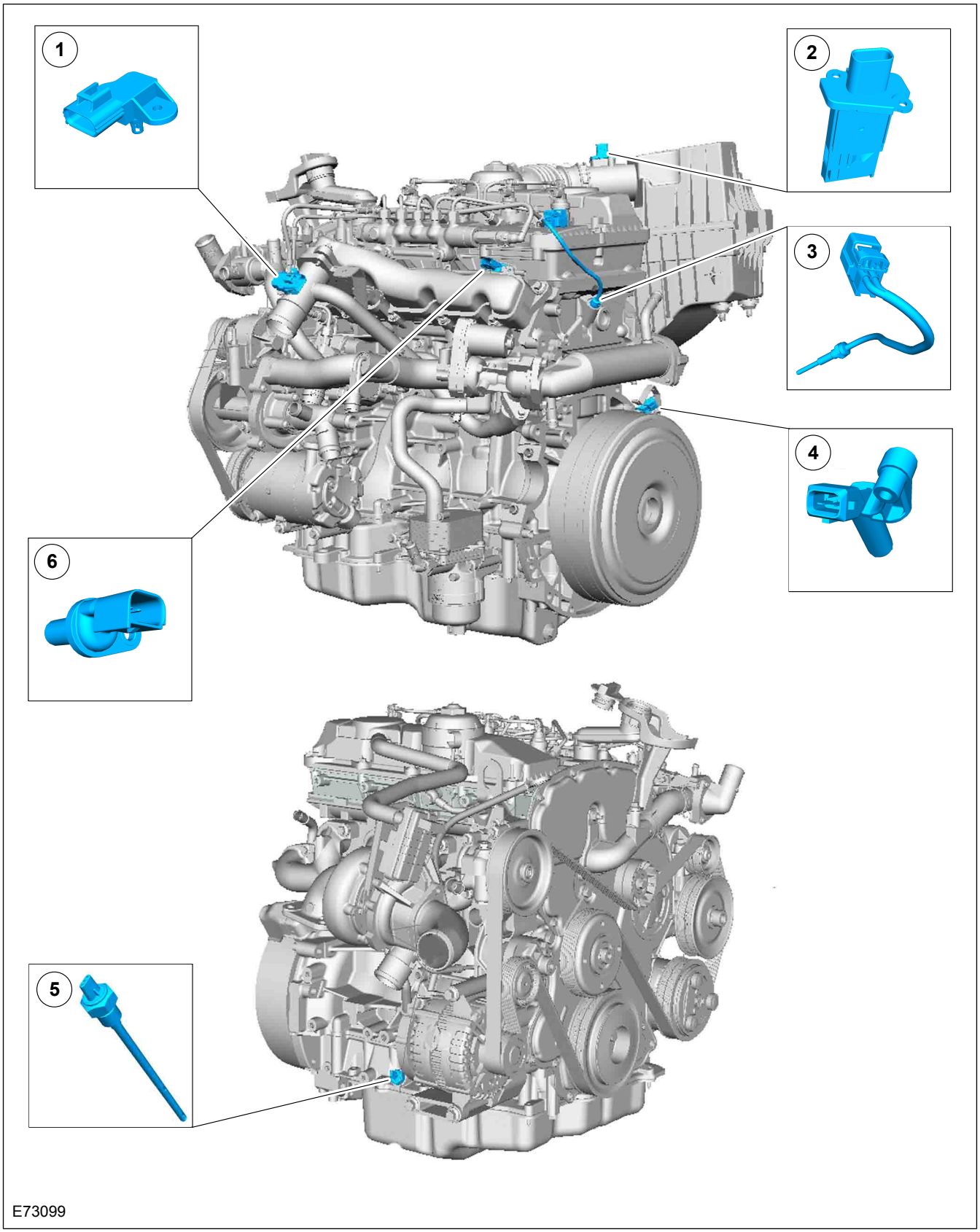
DESCRIPTION AND OPERATION

Item	Description
1	Cylinder head temperature (CHT) sensor
2	Mass air flow (MAF) sensor
3	Crankshaft position (CKP) sensor

Item	Description
4	Camshaft position (CMP) sensor
5	Manifold absolute pressure and temperature (MAPT) sensor

DESCRIPTION AND OPERATION

Vehicles with 2.4L Duratorq-TDCi (Puma) diesel engine



DESCRIPTION AND OPERATION

Item	Description
1	Manifold absolute pressure and temperature (MAPT) sensor
2	Mass air flow (MAF) sensor
3	Cylinder head temperature (CHT) sensor
4	Crankshaft position (CKP) sensor
5	Engine oil level sensor
6	Camshaft position (CMP) sensor

DIAGNOSIS AND TESTING

Electronic Engine Controls

General Equipment

Worldwide Diagnostic System (WDS)

Principles of Operation

European On-Board Diagnostics (EOBD)

EOBD is a diagnostic system integrated into the powertrain control module (PCM). This system continuously monitors vehicle emission components. The system includes a malfunction indicator lamp (MIL) which indicates when there is a concern that can affect emissions or the system malfunctions. Data stored within the module DTC memory can be accessed using a generic scan tool or WDS.

EOBD is mandated within European Union regulations from the year 2000 for passenger vehicles with petrol engines and from 2003 onwards for passenger vehicles with diesel engines.

EOBD Functions:

- Establishes when and how emissions control faults must be indicated.
- Actuates emission control malfunction indicator lamp (MIL) and fault memory.
- Indicates operating conditions in which the concern occurred (freeze frame data).
- Standardized output of operating data such as engine speed, engine coolant temperature etc.
- Standardized names and abbreviations for components and systems.
- Standardized DTCs for all manufacturers.
- Standardized communication with the diagnostic equipment.
- Standardized 16-pin data link connector (DLC) in area of the instrument panel.
- Concern display must be possible using a generic scan tool.

EOBD consists of the following elements:

Warm-up Cycle

The warm-up cycle is an operation that consists of key on, engine start and a coolant temperature increase of 22°C, exceeding 71°C on completion.

Drive Cycle

A drive cycle commences when the engine is started (cold or warm) and ends when the engine is switched off.

Trip

A trip begins when the engine is started and is complete when all the EOBD monitors have completed a self-test. This may take place over a number of drive cycles. On diesel variants, the information gathered from one drive cycle is not carried over to a subsequent cycle or cycles.

When a concern has been rectified, particularly after electronic engine control components have been changed, the DTC memory, which is part of the EEPROM must be cleared of all trouble codes. When the DTC memory has been cleared, the code P1000 (known as the readiness code) is set in the PCM memory, which indicates that since the EEPROM has been cleared, not all of the monitoring systems have completed their tests. P1000 can only be cleared by carrying out a trip, which includes driving the vehicle under variable conditions of speed, load and time so that all of the monitors are completed. As P1000 will not illuminate the MIL it is not necessary to carry out the trip before returning the vehicle to the customer.

Freeze Frame Data

When a concern is detected, various data is stored depending on application including:

- Diagnostic trouble code.
- Vehicle speed.
- Engine coolant temperature.
- Engine speed.
- Engine load.
- Mixture formation trim value (trim value for engine wear) (All except vehicles with diesel engine).
- State of oxygen sensor control (open and closed loop) (All except vehicles with diesel engine).
- Distance covered since the concern was first registered.

Monitors

The purpose of the monitors is to continuously check the operation of the emission related sensors and actuators. It then establishes if they are operating within specified tolerances. All monitors

DIAGNOSIS AND TESTING

carry out their functions in such a way as to be unnoticeable by the driver of the vehicle. Each one is carried out under specific conditions of load, speed and engine temperature. The Comprehensive Component Monitor, Combustion Misfire Monitor and Air/Fuel Ratio Monitor operate continuously. The remaining monitors are only invoked under certain operating conditions. On diesel variants, all of the monitors operate under normal driving conditions: There are no monitors which intervene and cause special operating modes to enable the monitors to work. Some diesel monitors are non-continuous. This means that in a drive cycle, monitoring is done as and when suitable driving conditions exist and potential faults are accumulated and compared with acceptance criteria. Examples of this type are the turbocharger boost pressure and exhaust gas recirculation (EGR) monitors on vehicles with common rail fuel injection.

Comprehensive Component Monitor (CCM)

When the CCM detects a component operating out of tolerance, it sets a Diagnostic Trouble Code (DTC), which is stored in the EEPROM. If the same concern is confirmed during the next trip the MIL will be switched on. The CCM monitors many components, sub-systems and signals. The following is a list of those that can effect emissions depending on application:

- Electronic Ignition (EI) System.
- Crankshaft Position (CKP) Sensor.
- Ignition Coil.
- Electronic Throttle Control Unit.
- Camshaft Position (CMP) Sensor.
- Air Conditioning (A/C) Clutch.
- Idle Air Control (IAC) Valve.
- Mass Air Flow (MAF) Sensor.
- Manifold Absolute Pressure (MAP) Sensor.
- Intake Air Temperature (IAT) Sensor.
- Engine Coolant Temperature (ECT) Sensor.
- Cylinder Head Temperature (CHT) Sensor.
- Heated Oxygen Sensor (HO2S).
- Catalyst Monitor Sensor.
- Charge Air Temperature Sensor.
- Knock Sensor (KS).
- Throttle Position (TP) Sensor.
- Vehicle Speed Sensor (VSS).
- Boost Pressure Sensor.
- Cam-Crank Phasing Sensor.
- EEPROM.
- High Pressure Fuel Injection Pump.
- Exhaust Gas Recirculation (EGR) Valve Monitor.
- Fuel Injectors.
- Turbocharger.
- Combustion Noise Monitor.
- Barometric Pressure (BARO) Sensor.

Combustion Misfire Monitor (All except vehicles with diesel engine)

The combustion misfire monitor operates independently of the others, and can detect misfires caused by the ignition system, fuel system or mechanical engine components. As each cylinder fires, a characteristic crankshaft acceleration is produced. The monitor detects irregularities in the acceleration pattern using the crankshaft position (CKP) sensor, thus detecting the misfire. It can also detect which cylinder has misfired. Combustion misfires can be categorized as follows:

Type A: These can cause catalytic converter damage due to excessive internal temperatures. If a certain number of misfires occur over a pre-determined number of engine revolutions, the MIL will be switched on to alert the driver of the concern.

Type B: These can lead to an increase in emissions to a point above the EOBD threshold. If the misfire is detected during a second trip, over a pre-determined number of engine revolutions, the MIL will be switched on. If the misfire does not occur over the next three trips, the MIL will be extinguished

Air/Fuel Ratio (AFR) Monitor (All except vehicles with diesel engine)

The HO2S fitted before the catalytic converter (upstream) measures the oxygen content of the exhaust gas and the variations in it. This then enables the PCM to adjust the opening times of the fuel injectors to maintain the correct AFR. This is known as Short Term Fuel Trim (STFT). If the same variation is registered a pre-determined number of times, a permanent correction factor is applied. This is known as Long Term Fuel Trim (LTFT), which is stored in the EEPROM. When the correction factors exceed pre-determined limits a DTC will be set in the EEPROM. If a concern is detected in either the STFT or LTFT, and it is still present on a second trip, the MIL will be switched on.

DIAGNOSIS AND TESTING

Heated Oxygen Sensor (HO2S) Monitor (All except vehicles with diesel engine)

This monitors the operation of the pre (upstream) and post (downstream) catalytic converter HO2S sensors. It will detect deviations in air/fuel ratios (AFR) and sensor faults.

The HO2S will cause emission increase when its response time increases too much. To diagnose a sensor a period is measured and the number of lean/rich transitions are counted. The sum of valid periods is then calculated. To avoid non-representative measurements, the period is valid only if the HO2S has been below a low threshold and above a high threshold between 2 consecutive lean/rich transitions. A failure is declared when the sum of the measured periods exceeds the sum of the corresponding limit (held within the PCM) and the MIL is illuminated.

Catalytic Converter Efficiency Monitor (All except vehicles with diesel engine)

The efficiency of a catalytic converter is measured by its ability to store and later release oxygen to convert harmful gases. The efficiency is reduced if the converter becomes contaminated as it ages, and at high gas flow rates, because the exhaust gas does not remain in the converter long enough to complete the conversion process.

This monitor checks for the oxygen storage capacity (OSC) of the catalytic converter. During a controlled period, the catalyst monitor sensor signal is analyzed to evaluate the OSC of the catalyst. It represents the quantity of oxygen that is really used for the oxidation-reduction reaction by the catalytic converter If a fault has occurred with the catalyst monitor sensor during the catalyst diagnosis, a sensor diagnosis is carried out. During the controlled diagnosis phase, the catalyst monitor sensor activity is measured and is compared to the OSC of the catalyst. If this activity is high (low OSC) the MIL will be illuminated. If throughout the controlled phase, repeated several times, the downstream sensor output has not moved, the closed loop mode is delayed in order to test the sensor. If the catalyst monitor sensor is set to rich, the injection time is forced to lean and conversely if the downstream sensor is set to lean, the injection time is forced to rich until the sensor switches over or until the end of a delay. If this delay expires or the sensor does not switch, the sensor is treated as failed.

Combustion Noise Monitor (Vehicles with common rail fuel injection)

In diesel variants, the Combustion Noise Monitor is used to trim the fuel injection pulse lengths. Each fuel injector has an associated set of correction data that is determined during a production end of line test. The Combustion Noise Monitor is used to determine how the fuel injector characteristic changes from this initial calibration over the life of the fuel injector.

EGR Monitor (Vehicles with diesel engine)

The functionality of the EGR system is checked by comparing either the MAP sensor output or EGR valve lift potentiometer output (depending upon application) with expected values.

Diagnostic Requirements

Vehicles equipped with EOBD, can be diagnosed using the WDS. In order for the EOBD system to be invoked, a number of criteria must be met. After any repair, which could affect emissions, a trip must be carried out on the vehicle, to make sure that engine management system operates correctly.

Malfunction Indicator Lamp (MIL)

The MIL is located in the instrument cluster and is fitted to alert the driver to the fact that an abnormal condition has developed in the engine management system, that is having an adverse effect on emissions. In cases of misfires which are likely to cause catalytic converter damage, it is switched on immediately. With all other faults it will illuminate continuously from the second trip after the condition occurred. Under normal operation it should illuminate at key-on and go out almost as soon as the engine is started.

Diagnostic Trouble Codes (DTCs)

The DTCs given by the PCM are standardized, which means that generic scan tools can read results from all vehicles.

- The DTC is always a 5 digit alphanumerical code, for example ”P0100".
- The first digit of a code (letter) identifies the system which has set the code. Provision has been made for a total of four systems to be identified although only the 'P' code is required for EOBD.
  - 'B' for the body
  - 'C' for the chassis
  - 'P' for the powertrain
  - 'U' for the network communications systems

DIAGNOSIS AND TESTING

- All of the ”x0xxx" codes are standardized codes. However, any manufacturer can use additional codes over and above the standardized codes. These will be labelled ”x1xxx"
- The third digit of a code (numeric) identifies the sub-system which has set the code.
  - 'Px1xx' for metering of fuel and air supply
  - 'Px2xx' for metering of fuel and air supply
  - 'Px3xx' for ignition system – combustion misfires
  - 'Px4xx' for auxiliary emission control equipment
  - 'Px5xx' for vehicle speed, idle setting and other related inputs
  - 'Px6xx' for trip computer and other related outputs
  - 'Px7xx' for transmission.
  - 'Px8xx' for transmission.
  - 'Px9xx' category to be determined
  - 'Px0xx' category to be determined
- When a concern occurs, the actions taken include storage of the relevant information and actuation of the MIL occurs in line with the relevant legislation.

MIL Code List

MIL Code	Description
P0030	Heated oxygen sensor (HO2S) heater open circuit
P0031	HO2S heater low voltage
P0032	HO2S heater high voltage
P0036	Catalyst monitor sensor heater open circuit
P0037	Catalyst monitor sensor heater low voltage
P0038	Catalyst monitor sensor heater high voltage
P0053	HO2S heater resistance out of limits
P0054	Catalyst monitor sensor heater resistance out of limits
P0106	Manifold absolute pressure (MAP) sensor plausibility malfunction
P0107	MAP sensor circuit low input
P0108	MAP sensor circuit high input
P0109	MAP sensor temporary malfunction
P0112	Intake air temperature (IAT) circuit low input
P0113	IAT circuit high input
P0114	IAT intermittent failure
P0116	Engine coolant temperature (ECT) signal stuck at low level
P0117	ECT circuit low input
P0118	ECT circuit high input

DIAGNOSIS AND TESTING

MIL Code	Description
P0119	ECT intermittent failure
P0122	Throttle position (TP) sensor circuit 1 low input
P0123	TP sensor circuit 1 high input
P0130	HO2S circuit open circuit
P0131	HO2S circuit low voltage
P0132	HO2S circuit high voltage
P0133	HO2S circuit slow response
P0134	HO2S low amplitude
P0136	Catalyst monitor sensor circuit open circuit
P0137	Catalyst monitor sensor circuit low voltage
P0138	Catalyst monitor sensor circuit high voltage
P0139	Catalyst monitor sensor circuit slow response
P0171	Fuel system error, lean limit
P0171	Fuel system error , NOx emissions
P0172	Fuel system error , rich limit
P0172	Fuel system error, HC/CO emissions
P0201	Cylinder No. 1 - injector circuit open circuit
P0202	Cylinder No. 2 - injector circuit open circuit
P0203	Cylinder No. 3 - injector circuit open circuit
P0204	Cylinder No. 4 - injector circuit open circuit
P0222	TP sensor circuit 2 low input
P0223	TP sensor circuit 2 high input
P0231	Fuel pump input low voltage
P0232	Fuel pump input high voltage
P0261	Cylinder No. 1 - injector circuit low voltage
P0262	Cylinder No. 1 - injector circuit high voltage
P0264	Cylinder No. 2 - injector circuit low voltage
P0265	Cylinder No. 2 - injector circuit high voltage
P0267	Cylinder No. 3 - injector circuit low voltage
P0268	Cylinder No. 3 - injector circuit high voltage
P0270	Cylinder No. 4 - injector circuit low voltage
P0271	Cylinder No. 4 - injector circuit high voltage
P0300	Random misfire detected
P0301	Cylinder No. 1 misfire detected
P0302	Cylinder No. 2 misfire detected

DIAGNOSIS AND TESTING

MIL Code	Description
P0303	Cylinder No. 3 misfire detected
P0304	Cylinder No. 4 misfire detected
P0315	Flywheel segment adaptation at the Limit
P0324	Knock sensor (KS) communication error or implausible signal
P0325	KS implausible signal
P0335	Crankshaft position (CKP) sensor implausible signal
P0336	CKP sensor missing teeth
P0336	CKP sensor loss of synchronization
P0336	CKP sensor no signal
P0340	Camshaft position (CMP) sensor no signal
P0341	CMP sensor implausible signal
P0351	Ignition coil A primary malfunction
P0352	Ignition coil B primary malfunction
P0420	Catalyst system efficiency below threshold
P0444	Evaporative mission canister purge valve open circuit
P0458	Evaporative mission canister purge valve low voltage
P0459	Evaporative mission canister purge valve high voltage
P0460	Fuel tank level malfunction from instrument cluster
P0500	Vehicle speed sensor (VSS) signal malfunction
P0500	Vehicle speed via CAN (VS CAN) implausible signal
P0503	VSS signal too high
P0511	Idle air control (IAC) valve circuit malfunction
P0560	Battery system voltage malfunction high voltage
P0562	Battery system voltage malfunction open circuit
P0571	Brake switch plausibility error
P0603	Powertrain control module (PCM) error NVMY or EEPROM error
P0604	PCM error RAM error
P0605	PCM error checksum error
P0610	VID block checksum not correct or not programmed
P0617	Starter relay malfunction
P0620	Generator circuit malfunction
P0625	Generator low voltage
P0626	Generator high voltage
P0628	Fuel pump primary circuit low voltage
P0629	Fuel pump primary circuit high voltage

DIAGNOSIS AND TESTING

MIL Code	Description
P0641	Transmission sensor power supply 1 noisy signal
P0642	Transmission sensor power supply 1 low voltage
P0643	Transmission sensor power supply 1 high voltage
P0646	Air conditioning (A/C) clutch relay circuit low voltage
P0647	A/C clutch relay circuit high voltage
P0651	Transmission sensor power supply 2 noisy signal
P0652	Transmission sensor power supply 2 low voltage
P0653	Transmission sensor power supply 2 high voltage
P0654	Engine run output circuit malfunction
P0686	Main relay malfunction low voltage
P0687	Main relay malfunction high voltage
P0691	Cooling fan 1 control circuit low voltage
P0692	Cooling fan 1 control circuit high voltage
P0693	Cooling fan 2 control circuit low voltage
P0694	Cooling fan 2 control circuit high voltage
P0704	Clutch switch implausible signal
P1000	EOBD system readiness test not complete
P1500	Vehicle speed sensor (VSS) output circuit malfunction
P1632	Generator command malfunction
P1794	Battery voltage malfunction too high or too low
P2100	Engine throttle body H-bridge malfunction
P2107	Safety failure level 3
P2108	Safety failure level 2 error
P2119	Engine throttle body throttle flap malfunction
P2122	Accelerator pedal position (APP) sensor circuit 1 low input
P2123	APP sensor circuit 1 high input
P2127	APP sensor circuit 2 low input
P2128	APP sensor circuit 2 high input
P2128	APP sensor circuits 1 and 2 plausibility error
P2135	TP sensor circuits 1 and 2 plausibility error
P2176	Engine throttle body adaptive algorithm failed
P2280	Air cleaner obstruction or leakage
P2282	Air leakage between throttle and inlet valves
U0001	Control Area Network (CAN) bus-off or mute
U0101	CAN missing frame from TCU

DIAGNOSIS AND TESTING

MIL Code	Description
U0121	CAN missing frame from ABS
U0122	CAN missing frame from ESP
U0155	CAN missing frame from HEC
B1213	Number of Passive Anti-Theft System (PATS) programmed keys is below minimum
B1600	PATS ignition key transponder signal is not received
B1601	PATS received incorrect key-code from ignition key transponder
B1602	PATS received invalid format of key-code from ignition key transponder
B1681	PATS transceiver module signal is not received
B2103	PATS immobilizer antenna not connected
B2139	PATS immobilizer challenge response doesn't match
B2141	PATS immobilizer no PCM-ID transferred
B2431	PATS immobilizer transponder programming failure
U2510	PATS immobilizer problem with messages on data link

Inspection and Verification

1. Verify the customer concern by operating the system.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Sensors – Actuators	– Fuse(s) – Wiring harness – Electrical connector(s) – Powertrain control module (PCM)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the WDS or equivalent scan tool to diagnose the system.

REMOVAL AND INSTALLATION

Powertrain Control Module (PCM) — Vehicles Without: PCM Security Shield

General Equipment

Worldwide Diagnostic System (WDS)

Removal

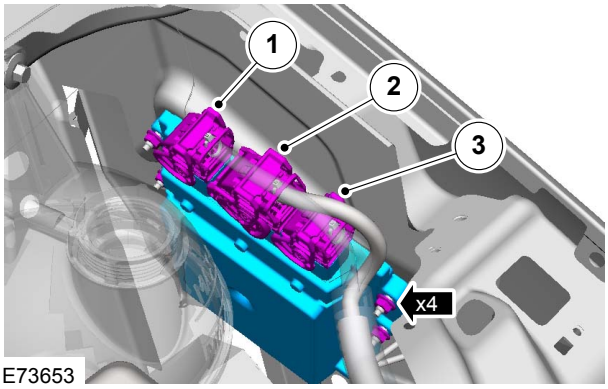
1. If a new PCM is to be installed, connect the WDS and upload the PCM configuration information using the Programmable Modules Installation Routine, prior to commencing the removal of the PCM.

   General Equipment: Worldwide Diagnostic System (WDS)

2. Disconnect the battery the ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

3. Torque: 10 Nm



Installation

1. To install reverse the removal procedure.
2. If a new PCM is to be installed, connect the WDS and download the PCM configuration information using the Programmable Modules Installation Routine, after the installation of the PCM.

   General Equipment: Worldwide Diagnostic System (WDS)

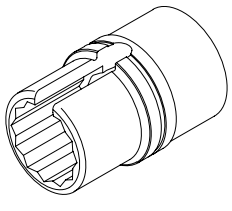
3. Change the engine oil and oil filter.
4. Carry out the oil reset procedure.

   Refer to:Oil Change Reminder Indicator Reset (413-09 Warning Devices, General Procedures).

REMOVAL AND INSTALLATION

Cylinder Head Temperature (CHT) Sensor — 2.4L Duratorq-TDCi (Puma) Diesel

Special Tool(s)

 303680	Socket, Cylinder Head Temperature Sensor 303-680

Special Tool(s)

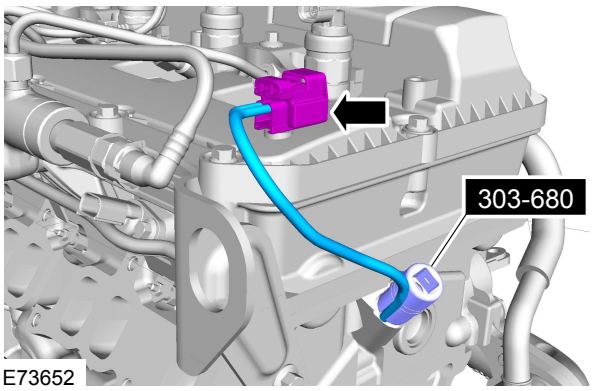
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Remove the intake manifold.

   Refer to: Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

2. Special Tool(s): 303-680
   Torque: 10 Nm



Installation

NOTE: Make sure that a new component is installed.

1. To install, reverse the removal procedure

REMOVAL AND INSTALLATION

Camshaft Position (CMP) Sensor — 2.4L Duratorq-TDCi (Puma) Diesel

Removal

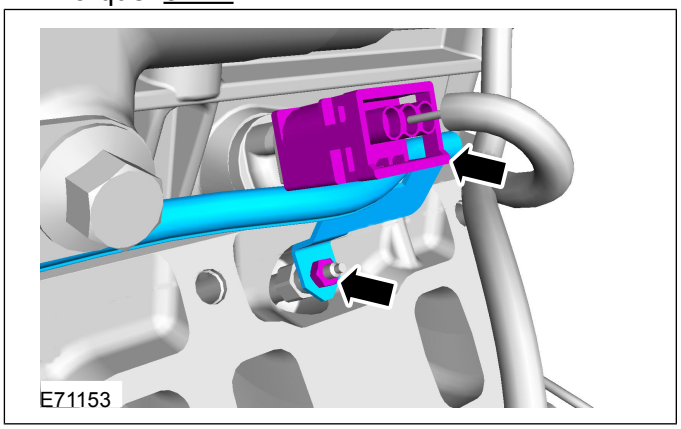
NOTE: Removal steps in this procedure may contain installation details.

1. Remove the intake manifold.

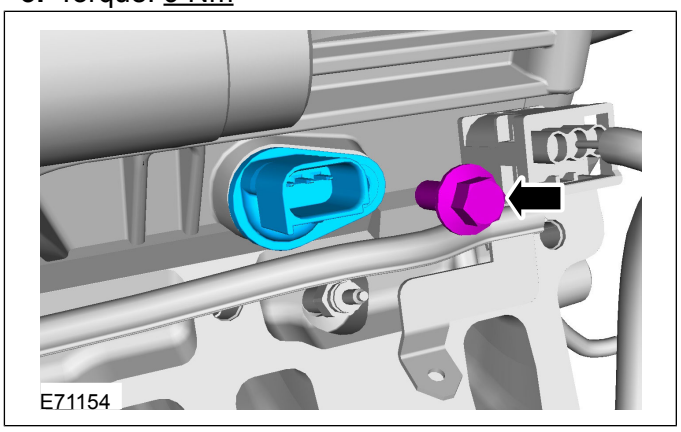
   Refer to:Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi (Puma) Diesel, In-vehicle Repair).

2. ⚠ **CAUTION:Make sure that all openings are sealed.**

   Torque: 3 Nm



3. Torque: 9 Nm



Installation

1. To install, reverse the removal procedure.

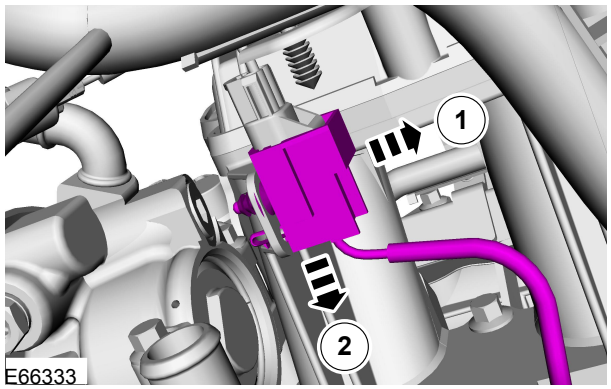
REMOVAL AND INSTALLATION

Knock Sensor (KS) — 2.3L Duratec-HE (MI4)

Removal

NOTE: Removal steps in this procedure may contain installation details.

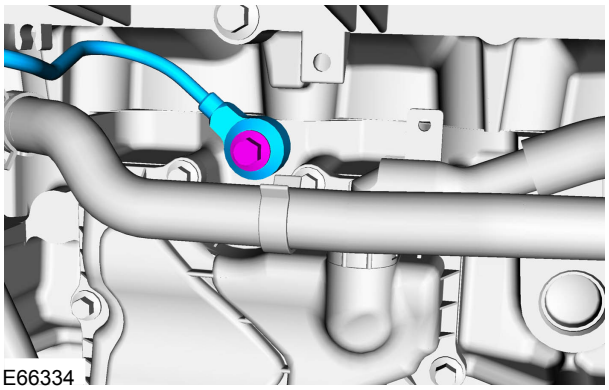
1.



2. **NOTE:**Make sure that the mating faces are clean and free of foreign material.

NOTE: Make sure that the sensor is installed in the same location as when removed.

Torque: 22 Nm



Installation

1. To install, reverse the removal procedure.

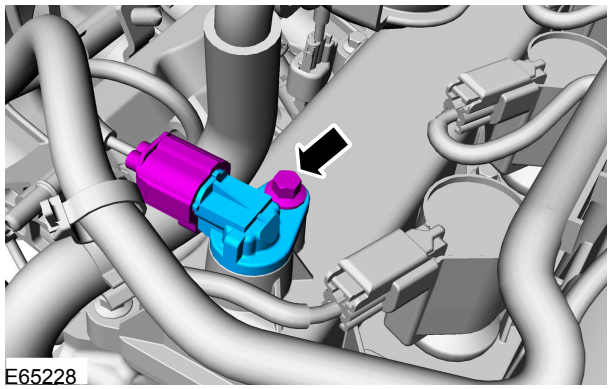
REMOVAL AND INSTALLATION

Camshaft Position (CMP) Sensor

Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Torque: 8 Nm



Installation

1. Lubricate the O-ring seal with clean engine oil.
2. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

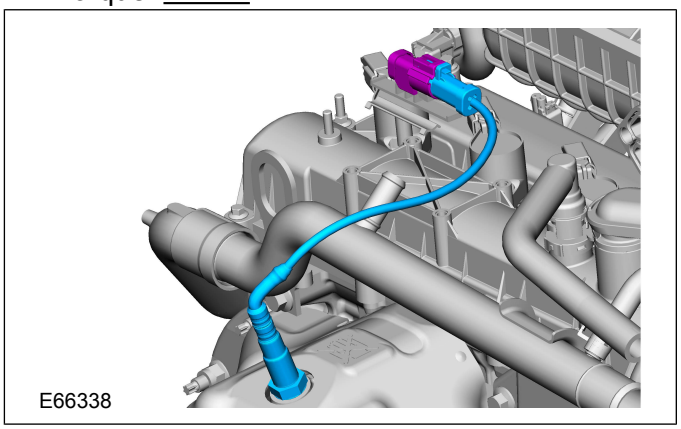
Heated Oxygen Sensor (HO2S)

Removal

NOTE: Removal steps in this procedure may contain installation details.

1. **NOTE:**A new component may be supplied with a longer cable than the one removed. Make sure that the cable is routed and secured in such a way that it cannot be damaged and cause a noise, vibration or harshness (NVH) concern.

   Torque: 42 Nm



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Engine Coolant Temperature (ECT) Sensor — 2.3L Duratec-HE (MI4)

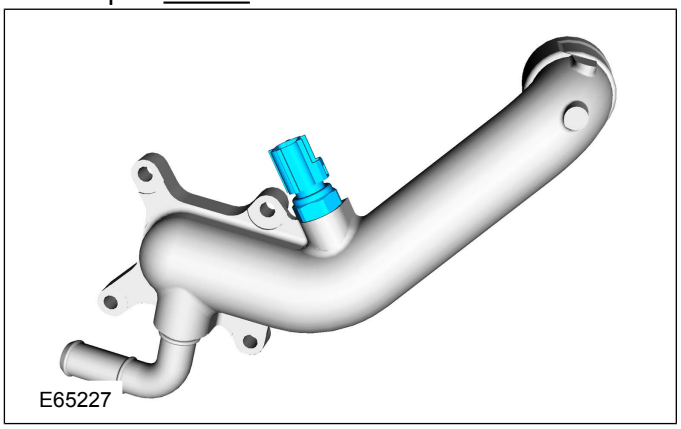
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Remove the coolant outlet connector.

   Refer to:Coolant Outlet Connector - 2.3L Duratec-HE (MI4) (303-03 Engine Cooling, Removal and Installation).

2. Torque: 13 Nm



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Catalyst Monitor Sensor

Removal

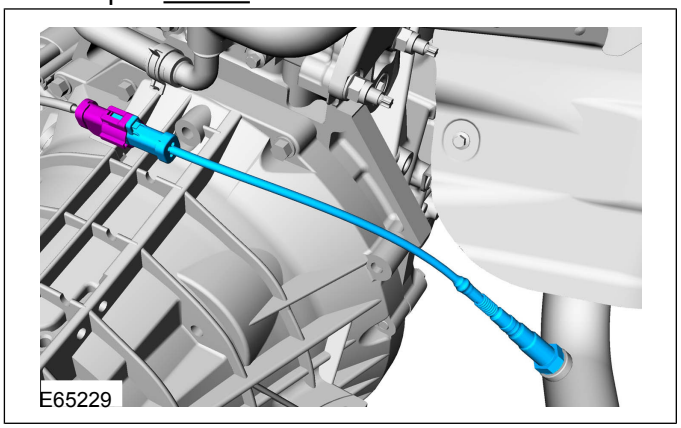
NOTE: Removal steps in this procedure may contain installation details.

1. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

2. **NOTE:**A new component may be supplied with a longer cable than the one removed. Make sure that the cable is routed and secured in such a way that it cannot be damaged and cause a noise, vibration or harshness (NVH) concern.

   Torque: 42 Nm



Installation

1. To install, reverse the removal procedure.

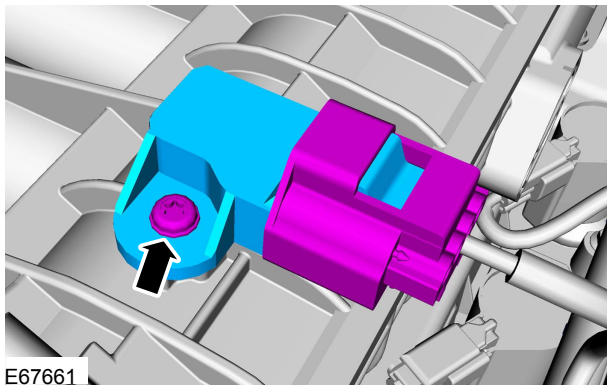
REMOVAL AND INSTALLATION

Manifold Absolute Pressure (MAP) Sensor

Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Torque: 3 Nm



Installation

1. Lubricate the O-ring seal with clean engine oil.
2. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Crankshaft Position (CKP) Sensor — 2.3L Duratec-HE (MI4)

General Equipment

Bolt, M6 x 18 mm
CKP alignment tool

1. **Raise and support the vehicle.**

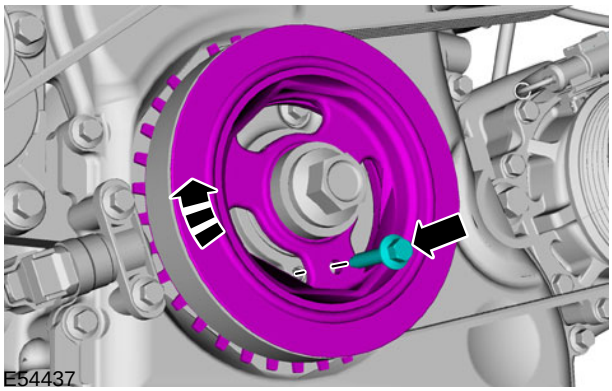
   For additional information, refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

2. **CAUTIONS:**

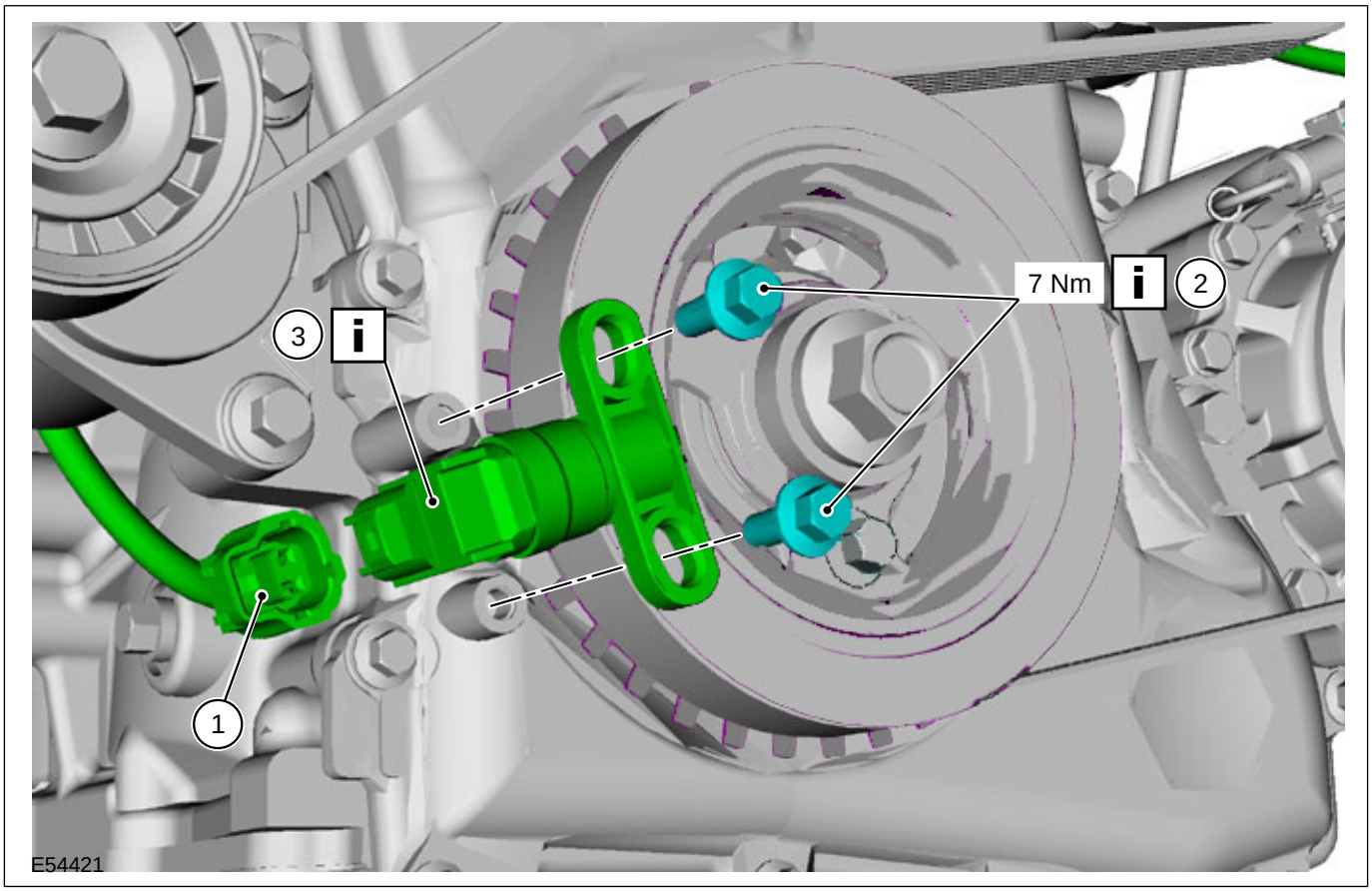
   Only turn the crankshaft pulley in the normal direction of rotation.

   Tighten the M6 x 18 mm bolt finger-tight only.

Rotate the crankshaft pulley clockwise until the crankshaft pulley timing bolt, M6 x 18 mm can be installed through the crankshaft pulley timing hole into the engine front cover.



3. **Remove the components in the order indicated in the following illustration(s) and table(s).**



Item	Description
1	CKP sensor electrical connector
2	CKP sensor retaining bolts

Item	Description
	See Installation Detail
3	CKP sensor

REMOVAL AND INSTALLATION

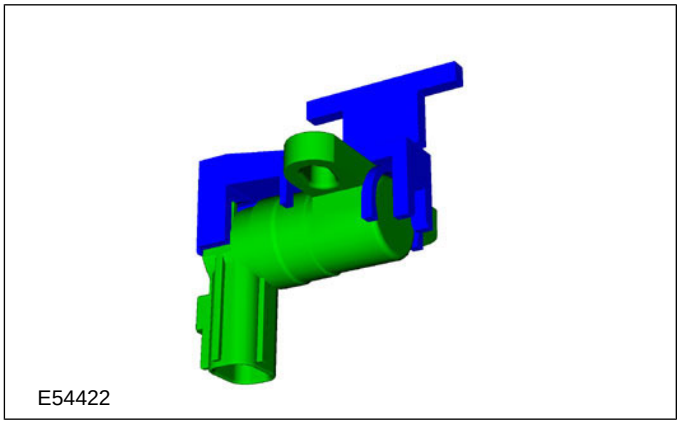
Item	Description
	See Installation Detail

4. To install, reverse the removal procedure.

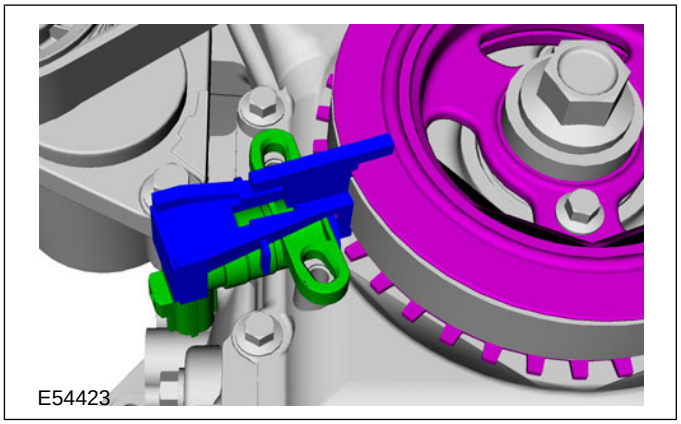
Installation Details

Item 3 CKP sensor

1. Install the CKP sensor alignment tool to the CKP sensor.


E54422

2. Align the CKP sensor with the crankshaft pulley sensor ring.


E54423

Item 2 CKP sensor retaining bolts

1. Install the CKP sensor retaining bolts.
2. Remove the CKP sensor alignment tool.

REMOVAL AND INSTALLATION

Crankshaft Position (CKP) Sensor — 2.4L Duratorq-TDCi (Puma) Diesel

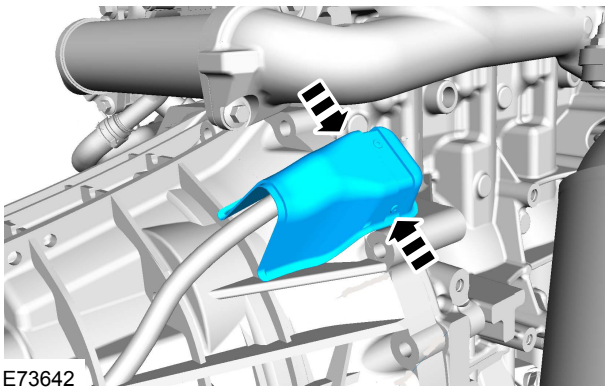
Removal

NOTE: Removal steps in this procedure may contain installation details.

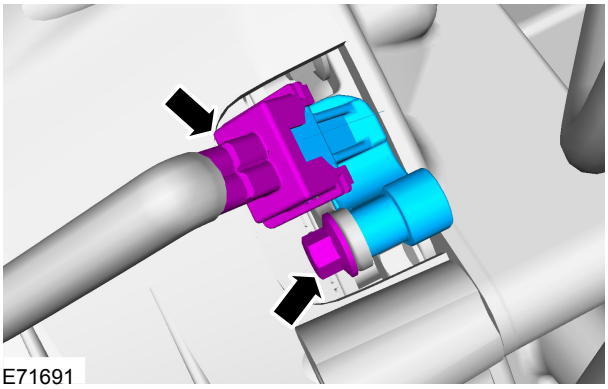
1. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

2.



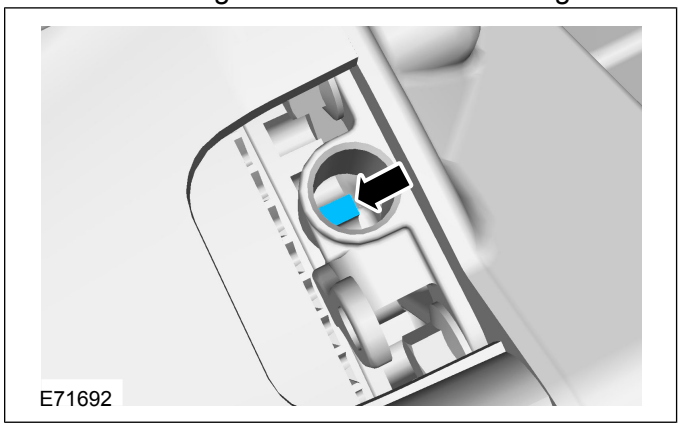
3. Discard the CKP sensor.



Installation

1. **CAUTION:Only rotate the crankshaft clockwise.**

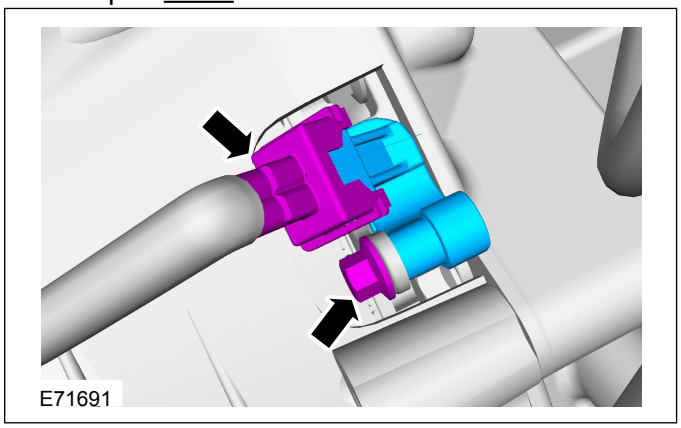
   Rotate the crankshaft until a flywheel tooth is visible through the CKP sensor housing.



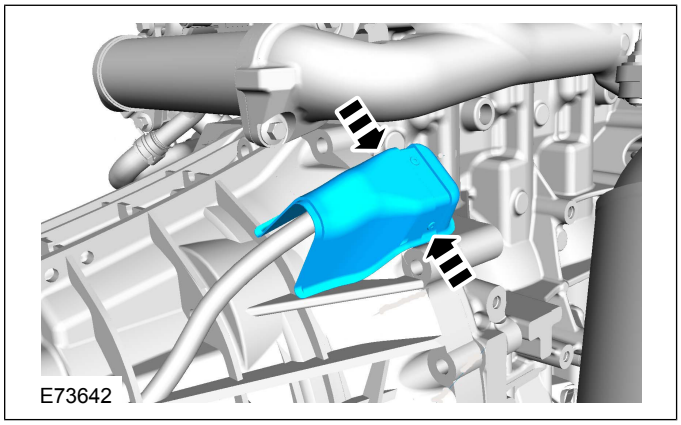
2. **CAUTION:The tip of the sensor must rest on a flywheel tooth.**

   NOTE: Make sure that a new component is installed.

   Torque: 7 Nm



3.



REMOVAL AND INSTALLATION

4. Lower the vehicle.

SECTION 308-00 Manual Transmission/Transaxle and Clutch - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 308-00-2

DIAGNOSIS AND TESTING

Manual Transmission and Clutch — Vehicles With: MT-75 308-00-3
- Inspection and Verification 308-00-3
- Gear shifting concerns 308-00-3
- Transmission noise concerns 308-00-3
- Oil leakage concerns 308-00-5

GENERAL PROCEDURES

Clutch System Bleeding — Vehicles With: MT-75 ..... (16 843 0) 308-00-17
Gearshift Cable Adjustment — Vehicles With: MT-75/MT82 ..... (16 513 0) 308-00-18

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Super DOT 4 brake fluid	ESD-M6C57-A

Clutch

Item	mm	inch
Clutch disc diameter - MT75 Transmission	250	10.4
Clutch disc diameter - MT82 Transmission	258	10.7
Clutch disc diameter - VXT Transaxle (85 PS and 110 PS)	250	10.4
Clutch disc diameter - VXT Transaxle (130 PS)	240	10
New clutch disc nominal thickness - MT75	8.9	0.35
Worn clutch disc discard thickness * - MT75	5.9	0.23
New clutch disc nominal thickness - MT82	8.9	0.35
Worn clutch disc discard thickness * - MT82	5.9	0.23
New clutch disc nominal thickness - VXT75 (85 PS and 110 PS)	8.9	0.35
Worn clutch disc discard thickness * - VXT75 (85 PS and 110 PS)	5.9	0.23
New clutch disc nominal thickness - VXT75 (130 PS)	7.95	0.31
Worn clutch disc discard thickness * - VXT75 (130 PS)	5.45	0,21

* When the discard thickness has been reached, install a new clutch disc.

Torque Specifications

Description	Nm	lb-ft	lb-in
Clutch slave cylinder bleed nipple — vehicles with MT75 or MT82 transmission	6	–	53
Clutch slave cylinder bleed nipple — vehicles with VXT transaxle	21	15	-

DIAGNOSIS AND TESTING

Manual Transmission and Clutch — Vehicles With: MT-75

General Equipment

Ultraviolet fluid leak detection equipment

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical damage.

Visual Inspection Chart

Mechanical
• Oil leaks. • Visibly damaged or worn components. • Loose or missing nuts or bolts.

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not evident, verify the symptom and REFER to the Symptom Chart.

The following checks should be carried out before repairing or installing a new transmission.

The inspection and verification of manual transmission concerns can be considered in three main areas.

Gear shifting concerns

1. Check the operation of the clutch: Position a block of wood approximately 25 mm thick under the clutch pedal and depress the clutch pedal as far as possible. If first or second gear can be selected with the engine running and the parking brake applied, without any concerns, the clutch is OK.
2. If the gear(s) cannot be selected, REFER to the Symptom Chart.

Transmission noise concerns

1. Check the engine and transmission support for insufficient gap between the transmission and the body.
2. Road test the vehicle. Carry out the checks in the following table and record the results.

NOTE: If the answer is "yes" to one or more of the tests, the transmission must be removed and the dual mass flywheel tested according to the REFER to the Pinpoint tests.

DIAGNOSIS AND TESTING

Item	Test /Results	Yes	No
1	Test: Road test the vehicle. Select 5th or 6th gear and fully depress the accelerator pedal to obtain maximum engine torque. REFER to:Specifications (303-01B Engine - 2.0L Duratorq-Di (Puma) Diesel/2.0L Duratorq-TDCi (Puma) Diesel/2.0L Duratorq-TDDi (Puma) Diesel, Specifications). Results: Very harsh vibrations from the drive train? Vibrations disappear if the accelerator pedal is released briefly.	0	0
1a	Test: Road test the vehicle. Drive the vehicle in simulated "stop and go driving conditions" (1st /2nd gear). Gently accelerate and brake to test for rattling noises from the transmission. Results: Noises from the drive train under driving conditions between engine idle speed and a maximum of 2000 rpm, which occur at a particular vehicle related speed?	0	0
2	Test: Raise and support the vehicle. Examine all engine, transmission and exhaust mountings with the engine turned off, during start and at idle. Results: Excessive vibration of the engine/manual transmission or rattling sound during starting? Excessive time until engine speed drops to idle speed.	0	0
3	Test: Test the front axle drive shafts and the manual transmission. Secure the wheels with chocks and engage the parking brake. Start the engine, engage 1st gear and slowly release clutch pedal with engine at idle. Results: Engine speed does not drop, no power transferred, vehicle does not move.	0	0
4	Test: Start the engine, place the gear lever in the neutral position and slowly release the clutch pedal. Stop the engine. Results: Hard, metallic noise from the transmission as the engine is stopping, during the last engine revolution before the engine ceases to turn, is NOT caused by the dual mass flywheel. In vehicles with diesel engines without an inlet manifold solenoid valve, the concern (hard, metallic noise) cannot be resolved by replacing the dual mass flywheel. In diesel engines with an inlet manifold solenoid valve, check the operation of the solenoid valve.	0	0

DIAGNOSIS AND TESTING

Item	Test /Results	Yes	No
	If a rattling noise is heard as the engine stops with the clutch pedal depressed, examine the transmission casing for grease or oil residues (over 2 grams) from the dual mass flywheel (remove starter motor and inspect the transmission casing).		

3. If a noise occurs in various gears at the same engine speed, check if the noise also occurs in the neutral position. If it does, the noise is not caused by the transmission.
4. REFER to the Symptom Chart.

Oil leakage concerns

1. Check the transmission fluid level. If necessary, drain off any excess fluid.
2. Clean the transmission and the adjacent areas carefully and road test the vehicle.

   REFER to: Health and Safety Precautions (100-00 General Information, Description and Operation).
3. Using suitable ultraviolet fluid leak detection equipment, locate the leak and check whether the leaking fluid is transmission fluid, brake fluid (from the hydraulically operated clutch) or engine oil.
4. REFER to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• Clutch slippage	• Clutch master cylinder. • Clutch slave cylinder. • Clutch pressure plate. • Clutch disc. • Crankshaft rear seal. • Transmission input shaft seal.	• GO to Pinpoint Test A.
• Clutch chatter or shudder	• Engine and transmission mounts.	• REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).
	• Clutch pressure plate. • Clutch disc. • Flywheel.	• GO to Pinpoint Test B.
• Clutch drag	• Insufficient brake fluid.	• FILL the brake master cylinder reservoir to the MAX mark. INSPECT the brake and clutch hydraulic systems for leaks. REPAIR as necessary.
	• Air in the clutch hydraulic system.	• BLEED the system. REFER to:Clutch System Bleeding - Vehicles With: MT-75 (308-00 Manual Transmission/Transaxle and Clutch - General Information, General Procedures) / Clutch System Bleeding - Vehicles With: Automated Gearshift (308-00 Manual Transmission/Transaxle and Clutch - General Information, General Procedures).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Clutch pedal free travel. • Clutch pressure plate. • Clutch disc. • Pilot bearing. • Crankshaft end play.	• GO to Pinpoint Test C.
• Clutch pedal pulsation	• Clutch pressure plate. • Clutch disc.	• INSTALL a new clutch disc and pressure plate. REFER to:(308-01A) Clutch Disc and Pressure Plate - 2.4L Duratorq-Di (Puma) Diesel (Removal and Installation), Clutch Disc and Pressure Plate - 2.3L DOHC-16V (Removal and Installation).
	• Crankshaft end play.	• CHECK the crankshaft end play. REFER to:Crankshaft End Play (303-00 Engine System - General Information, General Procedures).
• Hard shifting	• Clutch drag.	• GO to Pinpoint Test C.
	• External controls.	• CHECK the external controls for wear or damage. REFER to:External Controls (308-06A, Diagnosis and Testing). INSTALL new components as necessary.
	• Gear wheels.	• DISASSEMBLE the transmission. REFER to:Transmission (308-03A, Disassembly). INSTALL new components as necessary.
	• Selector mechanism.	• DISASSEMBLE the transmission. REFER to:Transmission (308-03A, Disassembly). INSTALL new components as necessary.
	• Synchronizer(s).	• DISASSEMBLE the transmission. REFER to:Transmission (308-03A, Disassembly). INSTALL new components as necessary.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Excessive noise	• Engine vibrations inadequately damped.	• REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).
	• Transmission fluid level low.	• CHECK the transmission for leaks. TOP UP the transmission fluid. REFER to:Transmission Draining and Filling (308-03 Manual Transmission/Transaxle - Vehicles With: MT-75, General Procedures).
	• Engine or transmission is in contact with the chassis or body.	• REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).
	• Engine and transmission out of alignment.	• REFER to:Noise, Vibration and Harshness (NVH) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).
	• External controls.	• CHECK the external controls for wear or damage. REFER to:External Controls (308-06A, Diagnosis and Testing). INSTALL new components as necessary.
	• Gear wheels and bearings.	• DISASSEMBLE the transmission. REFER to:Transmission (308-03A, Disassembly). INSTALL new components as necessary.
	• Clutch pedal. • Clutch release bearing.	• GO to Pinpoint Test D.
• Fluid leakage	• Clutch master cylinder. • Clutch slave cylinder. • Clutch hydraulic lines.	• INSPECT the brake and clutch hydraulic systems for leaks. REPAIR as necessary.
	• Transmission output shaft seal.	• DISASSEMBLE the transmission and INSTALL a new output shaft seal. REFER to:Transmission (308-03A, Disassembly).

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Transmission input shaft seal.	• DISASSEMBLE the transmission and INSTALL a new input shaft seal. REFER to:Transmission (308-03A, Disassembly).
	• Fluid leak between the transmission housing sections.	• DISASSEMBLE the transmission and clean the mating faces. CHECK the mating faces for damage. SEAL the transmission with sealant. REFER to:Transmission (308-03A, Disassembly).

PINPOINT TEST A : CLUTCH SLIPPAGE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: TEST FOR CLUTCH SLIPPAGE	
	1 Lock the wheels and apply the parking brake.
	2 Start the engine and engage fourth gear.
	3 Run the engine at approximately 2000 rpm.
	4 Release the clutch pedal slowly. • Does the engine stall when the clutch pedal is fully released? → **Yes** Clutch OK. → **No** GO to A2.
A2: CHECK THE CLUTCH PEDAL OPERATION	
	1 Fully depress and release the clutch pedal. • Does the pedal return to the initial position? → **Yes** GO to A3. → **No** INSTALL a new clutch master cylinder. REFER to:Clutch Master Cylinder (308-02 Clutch Controls - Vehicles With: VXT-75, Removal and Installation). TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A3: CHECK THE CLUTCH DISC AND PRESSURE PLATE	
	1 Remove the clutch disc and pressure plate. REFER to:(308-01A) Clutch Disc and Pressure Plate - 2.4L Duratorq-Di (Puma) Diesel (Removal and Installation), Clutch Disc and Pressure Plate - 2.3L DOHC-16V (Removal and Installation). • Is the clutch disc and pressure plate contaminated with oil or hydraulic fluid? → **Yes** Check the engine and transmission for leaks. INSTALL new components as necessary. TEST the system for normal operation. → **No** INSTALL a new clutch disc and pressure plate. REFER to:(308-01A) Clutch Disc and Pressure Plate - 2.4L Duratorq-Di (Puma) Diesel (Removal and Installation), Clutch Disc and Pressure Plate - 2.3L DOHC-16V (Removal and Installation). TEST the system for normal operation.

PINPOINT TEST B : CLUTCH CHATTER OR SHUDDER

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: TEST FOR CLUTCH SHUDDER	
	1 Start the engine.
	2 Engage the clutch and select fourth gear.
	3 Run the engine at approximately 2000 rpm.
	4 Release the clutch pedal slowly. • Does the clutch take up the drive smoothly? → **Yes** Clutch is OK. → **No** GO to B2.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B2: CHECK THE CLUTCH DISC AND PRESSURE PLATE FOR OIL OR HYDRAULIC FLUID CONTAMINATION	
	1 Remove the clutch disc and pressure plate. REFER to:(308-01A) Clutch Disc and Pressure Plate - 2.4L Duratorq-Di (Puma) Diesel (Removal and Installation), Clutch Disc and Pressure Plate - 2.3L DOHC-16V (Removal and Installation). • Is the clutch disc and pressure plate contaminated with oil or hydraulic fluid? → **Yes** Check the engine and transmission for leaks. INSTALL new components as necessary. TEST the system for normal operation. → **No** GO to B3.
B3: CHECK THE CLUTCH DISC AND PRESSURE PLATE	
	1 Visually check the clutch disc and pressure plate. • Is the clutch disc and pressure plate worn or damaged? → **Yes** INSTALL a new clutch disc and pressure plate. REFER to:(308-01A) Clutch Disc and Pressure Plate - 2.4L Duratorq-Di (Puma) Diesel (Removal and Installation), Clutch Disc and Pressure Plate - 2.3L DOHC-16V (Removal and Installation). TEST the system for normal operation. → **No** CARRY OUT the flywheel clutch surface inspection. REFER to:Flywheel Clutch Surface Inspection (303-00 Engine System - General Information, General Procedures). TEST the system for normal operation.

DIAGNOSIS AND TESTING

PINPOINT TEST C : CLUTCH DRAG

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CHECK THE OPERATION OF THE CLUTCH PEDAL	
	1 Depress and release the clutch pedal. • Is excessive force required to depress the clutch pedal? → **Yes** INSTALL a new clutch slave cylinder. REFER to:Clutch Slave Cylinder (308-02 Clutch Controls - Vehicles With: MT-75, Removal and Installation). Refer to the appropriate section in Group308for the procedure. TEST the system for normal operation. → **No** GO to C2.
C2: CHECK THE CLUTCH DISC AND PRESSURE PLATE FOR OIL OR HYDRAULIC FLUID CONTAMINATION	
	1 Remove the clutch disc and pressure plate. REFER to:(308-01A) Clutch Disc and Pressure Plate - 2.4L Duratorq-Di (Puma) Diesel (Removal and Installation), Clutch Disc and Pressure Plate - 2.3L DOHC-16V (Removal and Installation). • Is the clutch disc and pressure plate contaminated with oil or hydraulic fluid? → **Yes** Check the engine and transmission for leaks. INSTALL new components as necessary. TEST the system for normal operation. → **No** GO to C3.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C3: CHECK THE CLUTCH DISC AND PRESSURE PLATE	
	1 Visually check the clutch disc and pressure plate. • Is the clutch disc and pressure plate worn or damaged? → **Yes** INSTALL a new clutch disc and pressure plate. REFER to:(308-01A) Clutch Disc and Pressure Plate - 2.4L Duratorq-Di (Puma) Diesel (Removal and Installation), Clutch Disc and Pressure Plate - 2.3L DOHC-16V (Removal and Installation). TEST the system for normal operation. → **No** GO to C4.
C4: CHECK THE INPUT SHAFT SPLINES	
	1 Check that the clutch disc slides freely on the input shaft splines. • Does the clutch disc stick on the input shaft? → **Yes** CHECK the clutch disc and input shaft splines for damage. INSTALL new components as necessary. TEST the system for normal operation. → **No** Note: Vehicles with 2.3L engine must have a new pilot bearing installed whenever the transmission is removed. - Vehicles with 2.3L engine, MEASURE the crankshaft end play. REFER to:Crankshaft End Play (303-00 Engine System - General Information, General Procedures). - Vehicles with 2.4L engine - GO to C5.

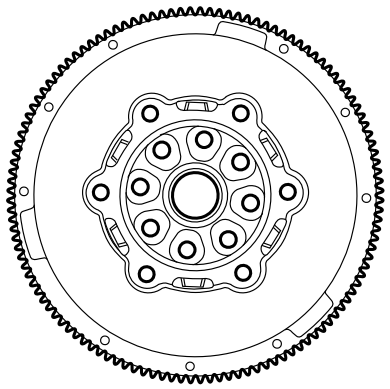
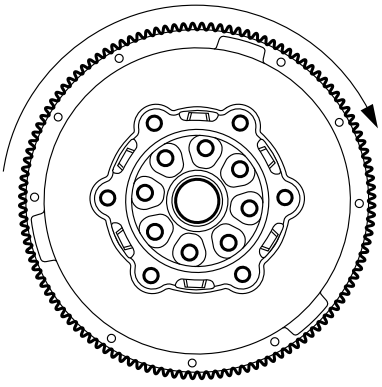
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C5: CHECK THE PILOT BEARING	
	1 Visually check the pilot bearing. • Is the pilot bearing seized or worn? → **Yes** INSTALL a new pilot bearing. REFER to:Pilot Bearing (308-01 Clutch - Vehicles With: MT-75, Removal and Installation). TEST the system for normal operation. → **No** MEASURE the crankshaft end play. REFER to:Crankshaft End Play (303-00 Engine System - General Information, General Procedures).

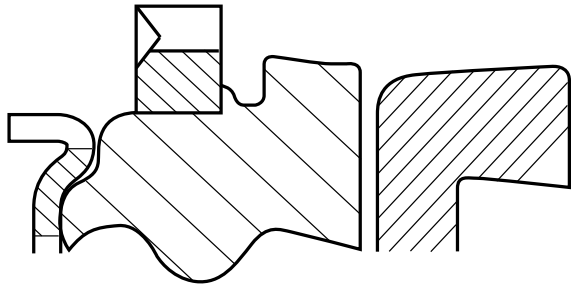
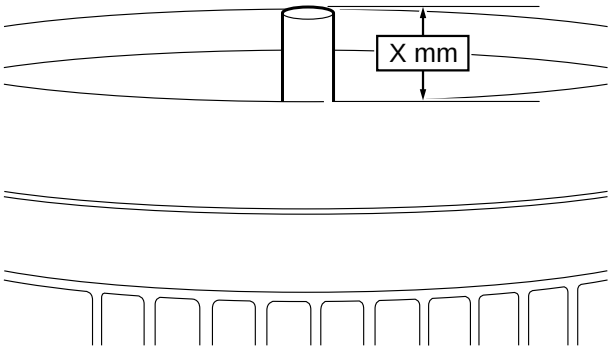
PINPOINT TEST D : EXCESSIVE NOISE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: STATIC CHECK	
	1 Depress and release the clutch pedal. • Is the noise apparent when the clutch is operated? → **Yes** LUBRICATE the clutch and brake pedal shaft. TEST the system for normal operation. → **No** GO to D2.
D2: DYNAMIC CHECK	
	1 Start the engine.
	2 Depress the clutch pedal. • Is the noise apparent when the clutch pedal is depressed? → **Yes** REFER to:Engine (303-00 Engine System - General Information, Diagnosis and Testing). → **No** GO to D3.

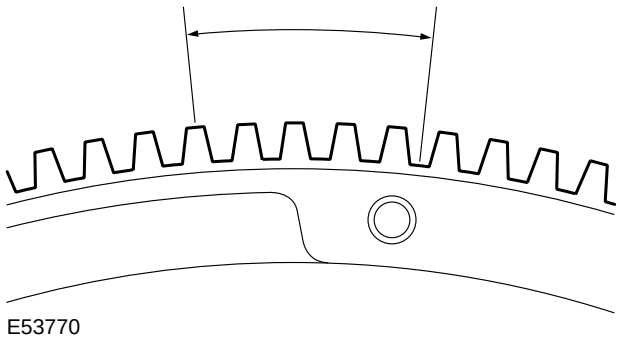
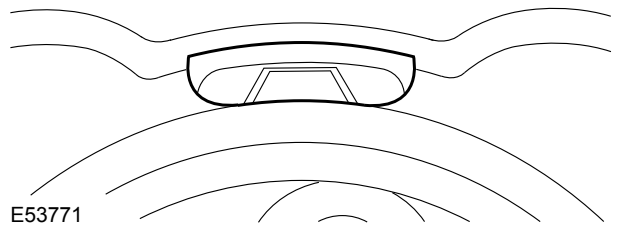
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D3: CHECK DUAL MASS FLYWHEEL SECONDARY MASS	
 E53768	**CAUTIONS:** ⚠ **Do not rework the flywheel if it is distorted.** ⚠ **Do not clean the dual mass flywheel with any kind of fluid. Clean the flywheel with a dry cloth only.** ⚠ **Do not clean the gap between the primary and secondary mass. Only clean the bolt connection surface and the clutch surface.** **NOTE:**Excessive heat marks/blueing is acceptable. Do not install a new dual mass flywheel. 1 Remove the transmission. REFER to:(308-03A Manual Transmission/Transaxle - Vehicles With: MT-75) Transmission - 2.4L Duratorq-Di (Puma) Diesel, Vehicles Without: Automated Gearshift (Removal), Transmission - 2.4L Duratorq-Di (Puma) Diesel, Vehicles With: Automated Gearshift (Removal), Transmission - 2.3L DOHC-16V (Removal). Inspect the dual mass flywheel secondary mass. • Is the secondary mass free from damage? → **Yes** GO to D4. → **No** INSTALL a new dual mass flywheel.
D4: CHECK DUAL MASS FLYWHEEL SECONDARY MASS ROTATION	
 E54979	1 Rotate the dual mass flywheel secondary mass. • Does the secondary mass freely rotate ± 60 degrees? → **Yes** GO to D5. → **No** INSTALL a new dual mass flywheel.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D5: CHECK DUAL MASS FLYWHEEL RING GEAR	
 E53772	1 Inspect the dual mass flywheel ring gear. • Is the ring gear visually OK? → **Yes** GO to D6. → **No** INSTALL a new dual mass flywheel.
D6: CHECK DUAL MASS FLYWHEEL WELD JOINT	
	1 Inspect the dual mass flywheel along the weld joint for grease leakage. • Are there more than 2 grams of grease visible along the weld joint? → **Yes** INSTALL a new dual mass flywheel. → **No** GO to D7.
D7: DUAL MASS FLYWHEEL DOWEL PINS	
	1 Check the installation of the dual mass flywheel dowel pins. • x = 11,5 mm ± 0,5 mm. • Are dowel pins present and correctly installed? → **Yes** GO to D8. → **No** INSTALL a new dual mass flywheel.

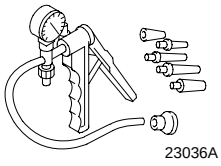
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D8: DUAL MASS FLYWHEEL MOVEMENT	
 E53770	1 Rotate the flywheel secondary mass clockwise and anticlockwise and measure the free movement. • Is there a maximum free movement of 5 ring gear teeth without spring resistance? → **Yes** GO to D9. → **No** INSTALL a new dual mass flywheel.
D9: DUAL MASS FLYWHEEL FRICTION PLATE	
 E53771	1 Inspect the dual mass flywheel friction plate. • Is the friction plate visually OK (no damage to lugs)? → **Yes** Dual mass flywheel OK. → **No** INSTALL a new dual mass flywheel.

GENERAL PROCEDURES

Clutch System Bleeding — Vehicles With: MT-75 (16 843 0)

Special Tool(s)

 23036A	Vacuum Pump Kit 416-D001 (23-036 A)

Materials	
Name	**Specification**
Super DOT 4 brake fluid	ESD-M6C57-A

WARNING:Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold running water. Get medical attention if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

CAUTION:If brake fluid is spilt on the paintwork, the affected area must be immediately washed down with cold water.

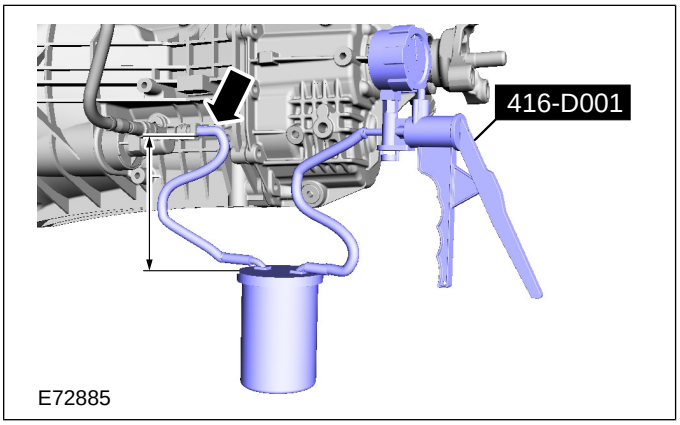
NOTE: If proprietary brake bleeding equipment is available, this can be used to bleed the clutch system, following the method below. The maximum pressure must not exceed 1.5 bar.

NOTE: The clutch control system is self-venting. The components are arranged in such a way that small amounts of air trapped in the system are removed automatically during clutch operation.

1. **Drain the brake fluid reservoir.**
2. **Raise and support the vehicle.**

   For additional information, refer to:Jacking (100-02 Jacking and Lifting, Description and Operation) / Lifting (100-02 Jacking and Lifting, Description and Operation).
3. **Fill the reservoir of the special tool with approximately 100 ml of new brake fluid.**
4. **NOTE:Make sure that the special tool reservoir is positioned lower than the bleed nipple.**

Install the special tool.

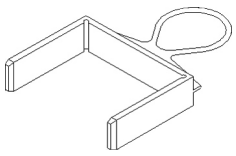


5. **Open the bleed nipple.**
6. **Using the special tool, bleed the clutch system.**
   - Pump approximately 80 ml of brake fluid into the clutch system.
7. **Close the bleed nipple.**
8. **Remove the special tool.**
9. **Lower the vehicle.**
10. **In order to remove any small amounts of trapped air remaining in the system, operate the clutch pedal several times (maximum five times), using the full clutch pedal travel.**
11. **Check the fluid level in the brake fluid reservoir and top up to the MAX mark with brake fluid if necessary.**
12. **Test the clutch control system for normal operation.**
    - Start the engine, depress the clutch pedal, wait two seconds, then carefully engage reverse gear. If there are any abnormal noises, or reverse gear is difficult to engage, repeat the clutch system bleeding procedure.

GENERAL PROCEDURES

Gearshift Cable Adjustment — Vehicles With: MT-75/MT82 (16 513 0)

Special Tool(s)

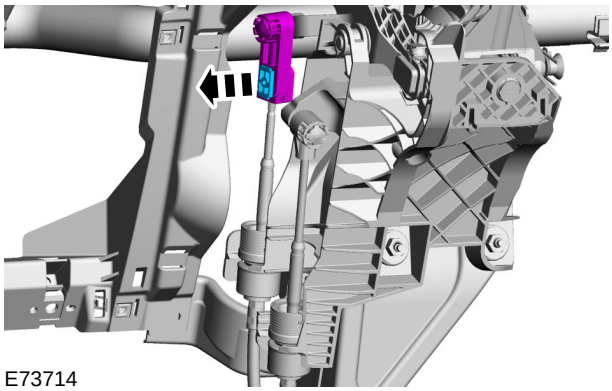
 E68211	Aligner, Gearshift Lever 308-650

All vehicles

1. **Remove the gearshift console cover.**

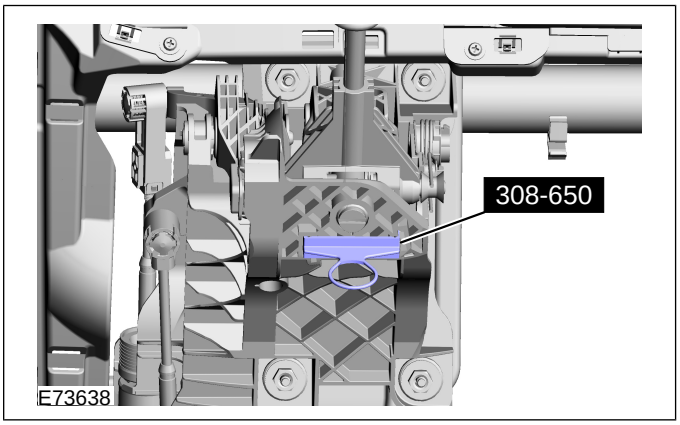

E73400

2. **Release the selector cable adjuster.**


E73714

Vehicles with 5-speed manual transmission

3. **Using the special tool, lock the gear lever in 3rd/4th gear position.**



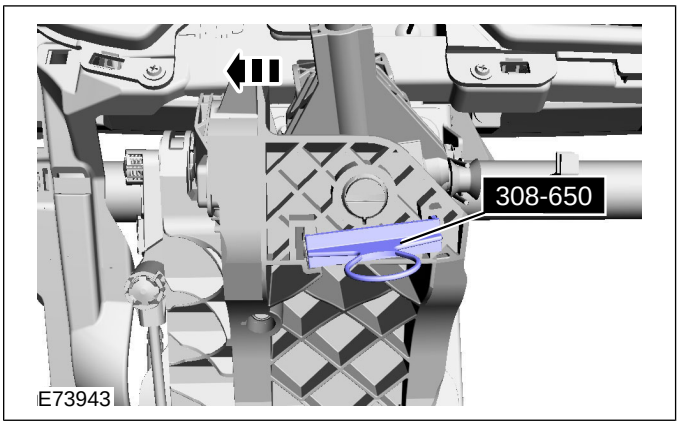
E73638

4. **Shift the lever into 4th gear.**

Vehicles with 6-speed manual transmission

5.

6. **Using the special tool, lock the gear lever in 1st/2nd gear position.**



E73943

7. **Shift the lever into 2nd gear.**

All vehicles

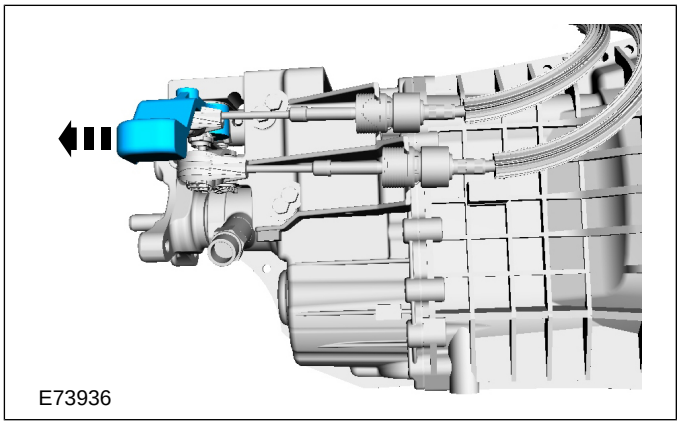
8. **Raise and support the vehicle.**

   For additional information, refer to:Jacking (100-02 Jacking and Lifting, Description and Operation) / Lifting (100-02 Jacking and Lifting, Description and Operation).

GENERAL PROCEDURES

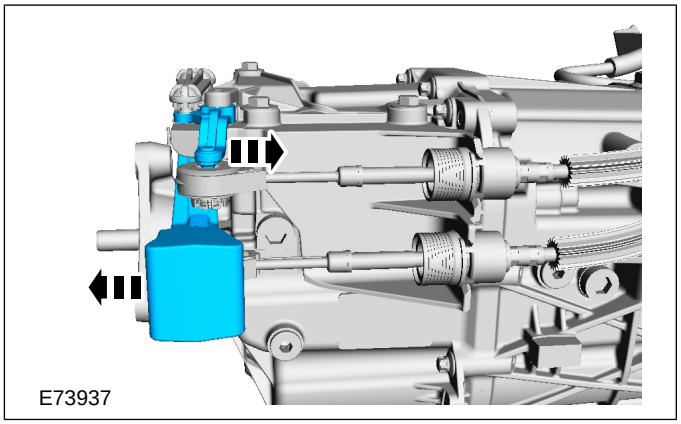
Vehicles with 5-speed manual transmission

9. **Ensure that 4th gear is engaged in the transmission.**



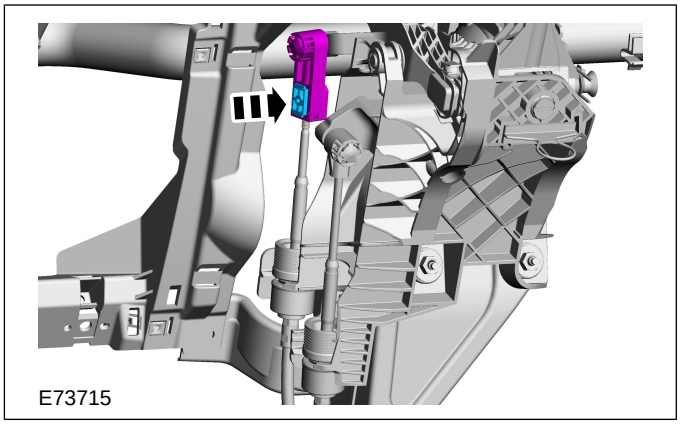
Vehicles with 6-speed manual transmission

10. **Ensure that 2ndgear is engaged in the transmission.**

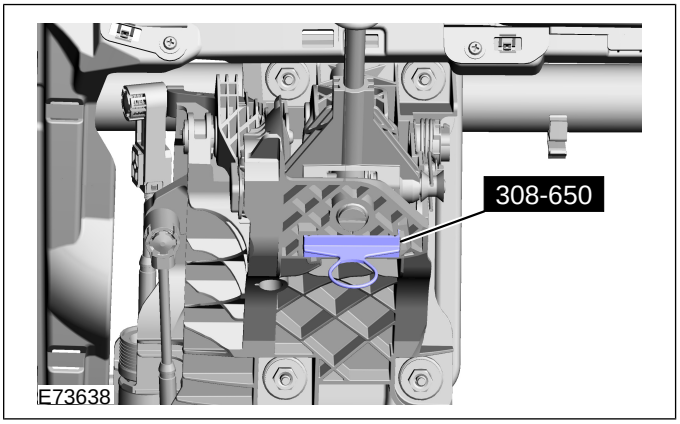


All vehicles

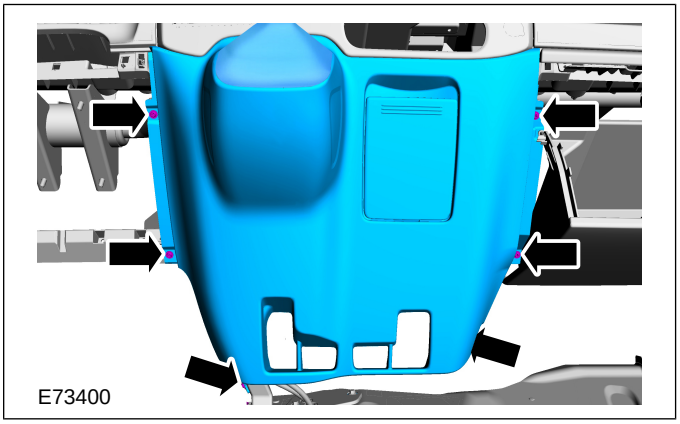
11. **Lower the vehicle.**
12. **Lock the selector cable adjuster.**



13. **Remove the special tool.**



14. **Install the gearshift console cover.**



SECTION 308-01 Clutch — Vehicles With: MT-75

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 308-01-2

DIAGNOSIS AND TESTING

Clutch..... 308-01-3

REMOVAL AND INSTALLATION

Clutch Disc and Pressure Plate..... (16 724 4) 308-01-4
Pilot Bearing..... 308-01-5

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Grease - pilot bearing	WSD-M1C238-A
Grease - input shaft guide sleeve	ESD-M1C220-A

Torque Specifications

Description	Nm	lb-ft	lb-in
Clutch pressure plate retaining bolts	29	21	–
Flywheel retaining bolts	a	–	–
a) Refer to the procedure in this section.			

DIAGNOSIS AND TESTING

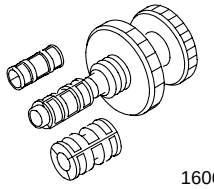
Clutch

REFER to:Manual Transaxle and Clutch - Vehicles With: MT-75 (308-00 Manual Transmission/Transaxle and Clutch - General Information, Diagnosis and Testing).

REMOVAL AND INSTALLATION

Clutch Disc and Pressure Plate (16 724 4)

Special Tool(s)

 16067	Aligner, Clutch Plate 308-204 (16-067)

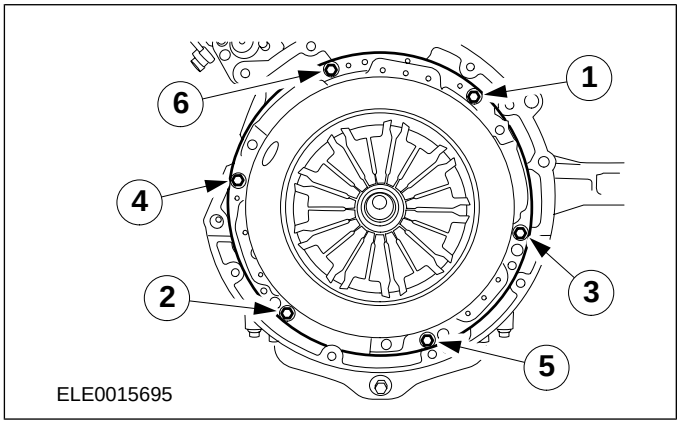
Removal

1. **Remove the transmission.**

   For additional information, refer to:Transmission - 2.4L Duratorq-Di (Puma) Diesel (308-03 Manual Transmission/Transaxle - Vehicles With: MT-75, Removal) / Transmission - 2.3L Duratec-HE (MI4) (308-03 Manual Transmission/Transaxle - Vehicles With: MT-75, Removal).

2. **CAUTION:Loosen the clutch pressure plate retaining bolts by two turns at a time in the sequence shown.**

   Remove the clutch disc and pressure plate.

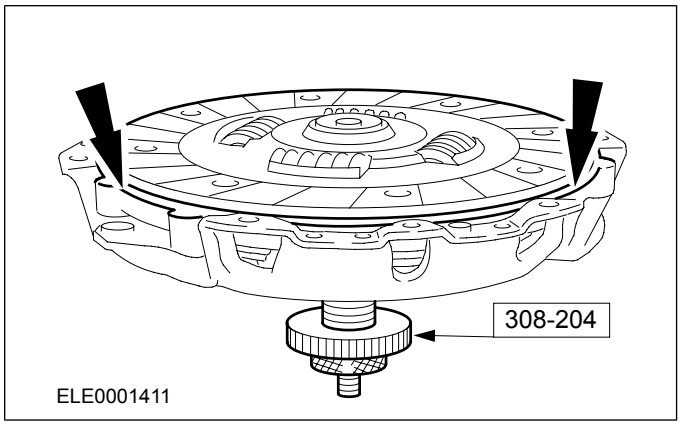


Installation

1. **Install a new pilot bearing.**

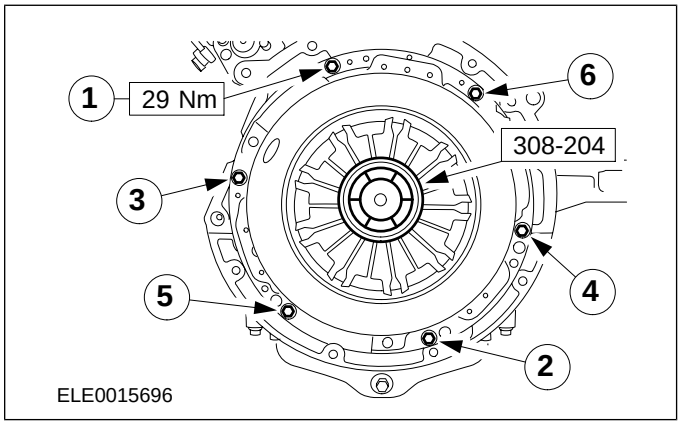
   For additional information, refer to:Transmission - 2.4L Duratorq-Di (Puma) Diesel (308-03 Manual Transmission/Transaxle - Vehicles With: MT-75, Removal) / Transmission - 2.3L Duratec-HE (MI4) (308-03 Manual Transmission/Transaxle - Vehicles With: MT-75, Removal).

2. **Using the special tool, centralize the clutch disc on the pressure plate.**



3. **CAUTION:Tighten the clutch pressure plate retaining bolts finger tight and then by two turns at a time in the sequence shown to the specified torque.**

   Using the special tool, install the clutch disc and pressure plate.



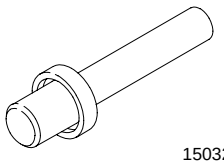
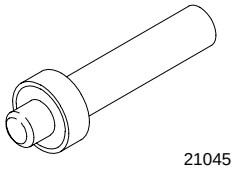
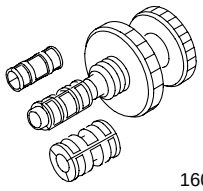
4. **Remove the special tool.**
5. **Install the transmission.**

   For additional information, refer to:Transmission - 2.4L Duratorq-Di (Puma) Diesel (308-03 Manual Transmission/Transaxle - Vehicles With: MT-75, Installation) / Transmission - 2.3L Duratec-HE (MI4) (308-03 Manual Transmission/Transaxle - Vehicles With: MT-75, Installation).

REMOVAL AND INSTALLATION

Pilot Bearing

Special Tool(s)

 15032	Installer, Bearing 205-081 (15-032)
 21045	Installer, Crankshaft Pilot Bearing 303-090 (21-045)
 16067	Aligner, Clutch Disc 308-204 (16-067)

General Equipment

Two leg puller

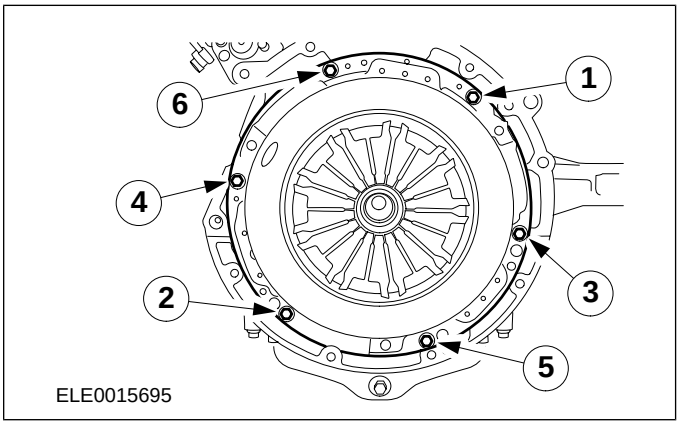
Removal

1. **Remove the transmission. For additional information, refer to:(308-03 Manual Transmission/Transaxle - Vehicles With: MT-75)**

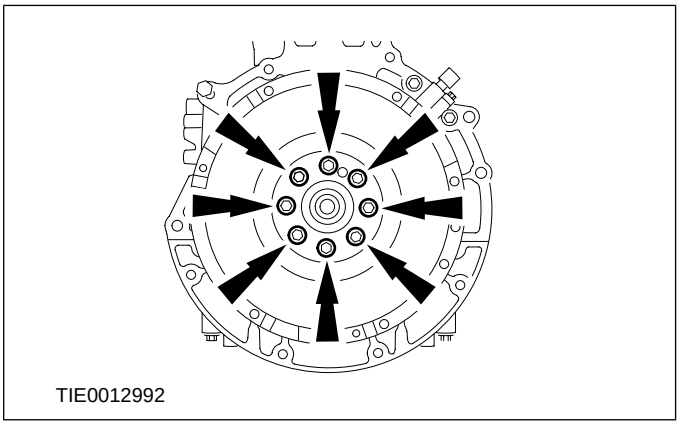
   Transmission - 2.4L Duratorq-Di (Puma) Diesel (Removal),
   Transmission - 2.3L Duratec-HE (MI4) (Removal).

2. **⚠CAUTION:Loosen the clutch pressure plate retaining bolts by two turns at a time in the sequence shown.**

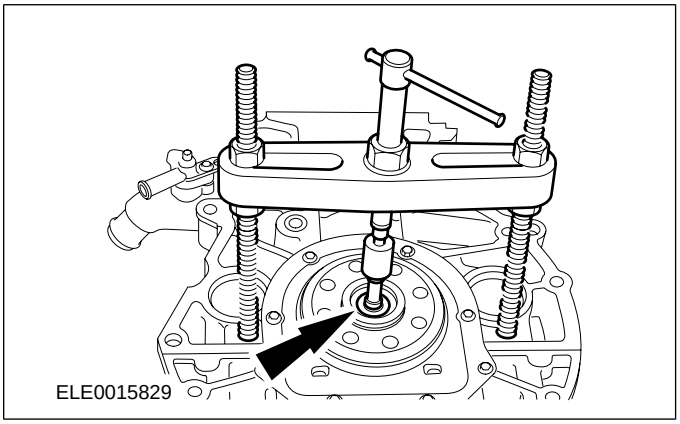
Remove the clutch disc and pressure plate.



3. **Remove the flywheel.**
   - Discard the bolts.



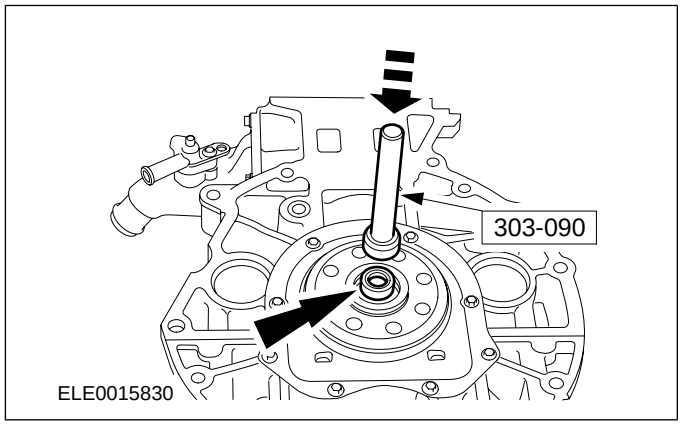
4. **Using a suitable two leg puller, remove the pilot bearing.**



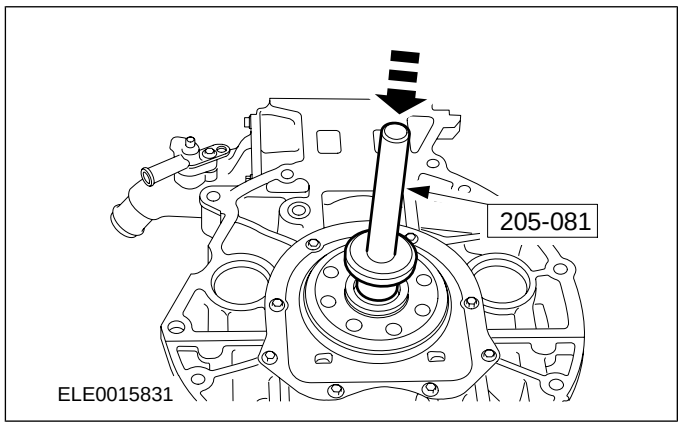
REMOVAL AND INSTALLATION

Installation

1. **Using the special tool, install the pilot bearing into the bore.**



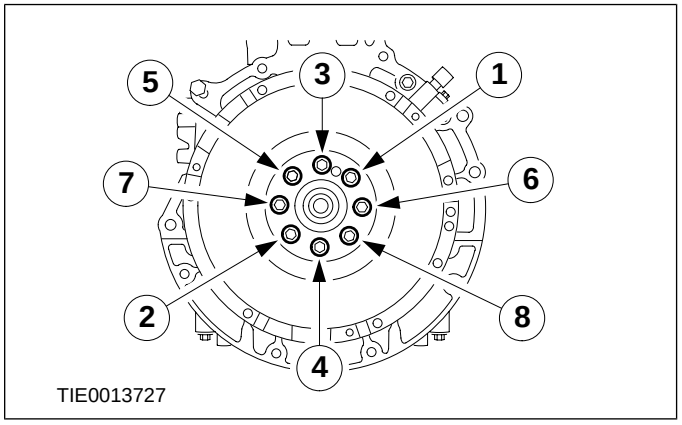
2. **Using the special tool, install the pilot bearing to its final depth.**



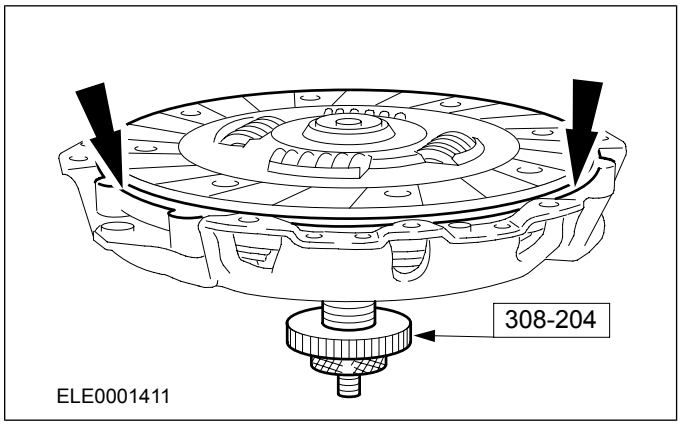
3. **Remove any traces of thread-locking compound from the threaded bores in the crankshaft.**
4. **NOTE:Install new flywheel bolts.**

   Install the flywheel.

   - Tighten the bolts in the sequence shown in three stages.
   - Stage 1: Tighten the bolts 1 through 8 to 25 Nm.
   - Stage 2: Tighten the bolts 1 through 8 to 40 Nm.
   - Stage 3: Tighten the bolts 1 through 8 to 48 degrees.

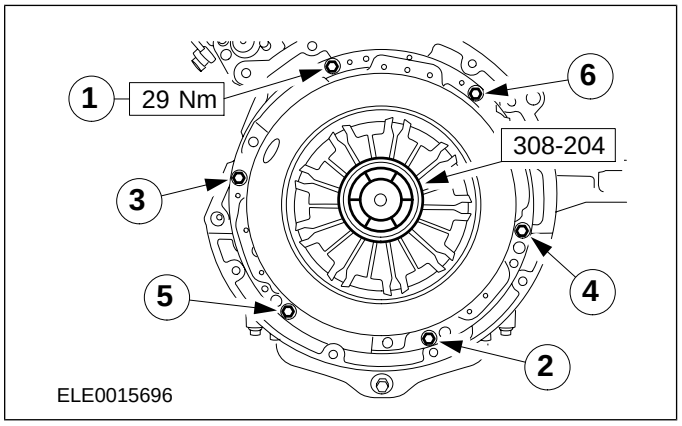


5. **Using the special tool, centralize the clutch disc on the pressure plate.**



6. **⚠CAUTION:Tighten the clutch pressure plate retaining bolts finger tight and then by two turns at a time in the sequence shown to the specified torque.**

   Using the special tool, install the clutch disc and pressure plate.



7. **Remove the special tool.**

REMOVAL AND INSTALLATION

8. Install the transmission. For additional information, refer to:(308-03 Manual Transmission/Transaxle - Vehicles With: MT-75)

   Transmission - 2.4L Duratorq-Di (Puma) Diesel (Removal),
   Transmission - 2.3L Duratec-HE (MI4) (Removal).

SECTION 308-02 Clutch Controls — Vehicles With: MT-75

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 308-02-2

DESCRIPTION AND OPERATION

Clutch Controls 308-02-3

DIAGNOSIS AND TESTING

Clutch Controls 308-02-4

REMOVAL AND INSTALLATION

Clutch Master Cylinder ..... (16 856 0) 308-02-5
Clutch Slave Cylinder ..... (16 862 4) 308-02-6

SPECIFICATIONS

General Specifications

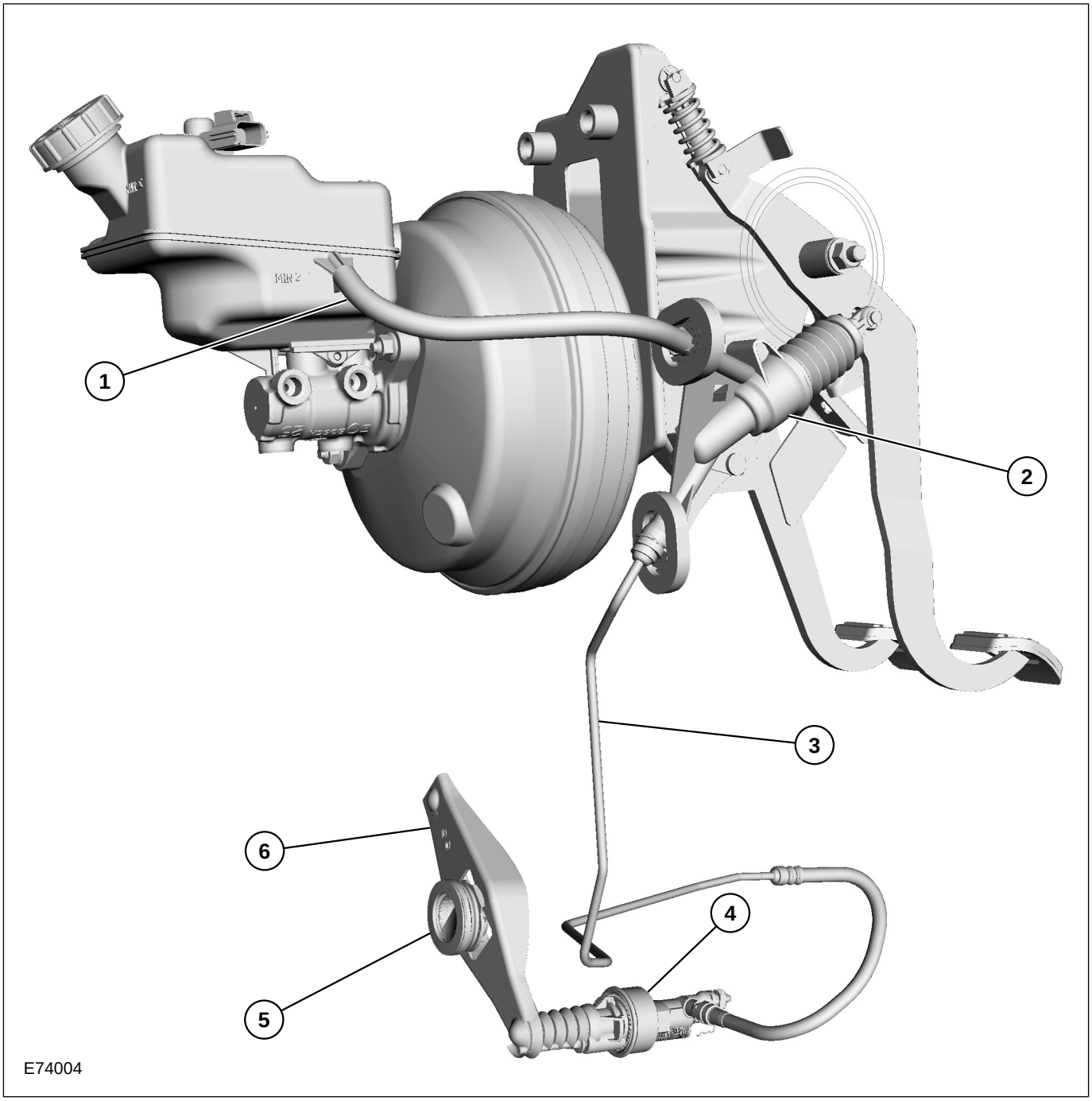
	Specifications
Super Dot 4 brake fluid	ESD-M6C57-A

Torque Specifications

Item	Nm	lb-ft	lb-in
Clutch master cylinder	9	-	80

DESCRIPTION AND OPERATION

Clutch Controls



Item	Part Number	Description
1		Clutch master cylinder supply line
2		Clutch master cylinder
3		High pressure clutch line
4		Clutch slave cylinder

Item	Part Number	Description
5		Clutch release bearing
6		Clutch release lever

DIAGNOSIS AND TESTING

Clutch Controls

REFER to: Manual Transaxle and Clutch (308-00, Diagnosis and Testing).

REMOVAL AND INSTALLATION

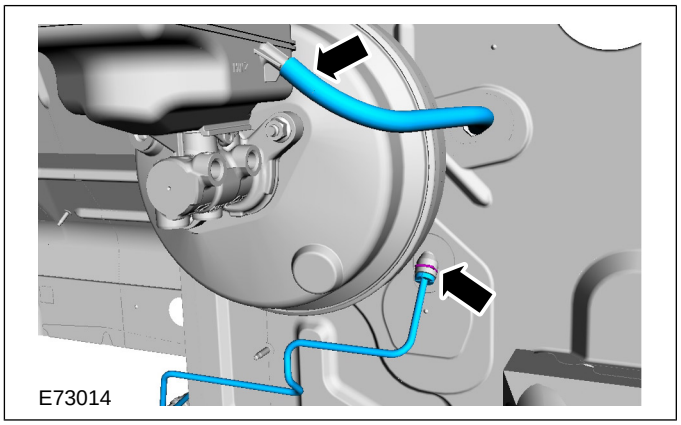
Clutch Master Cylinder (16 856 0)

Removal

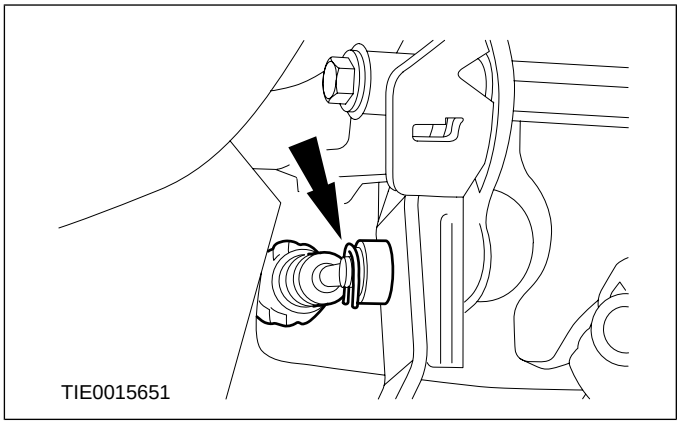
CAUTION:If brake fluid is spilt on the paintwork, the affected area must be immediately washed down with cold water.

1. **Drain the brake fluid reservoir.**
   - Allow the fluid to drain into a suitable container.
2. **NOTE:Cap the clutch master cylinder supply hose to prevent fluid loss or dirt ingress.**

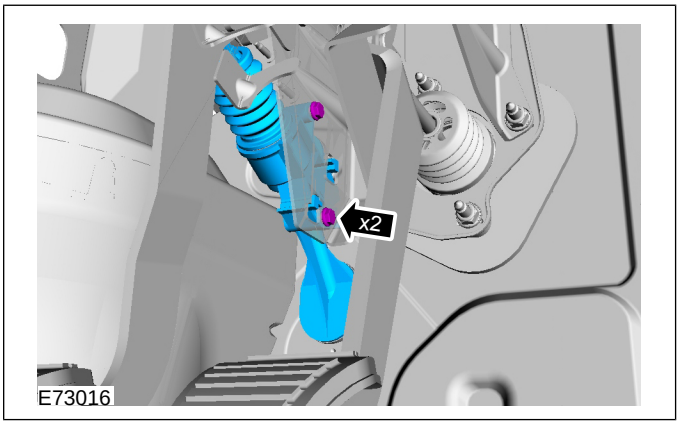
   Disconnect the clutch master cylinder supply line from the brake fluid reservoir and the high pressure clutch line from the clutch master cylinder.
   - Allow the fluid to drain into a suitable container.



3. **Detach the clutch master cylinder actuating rod from the clutch pedal.**
   - Remove the washer and the clip.

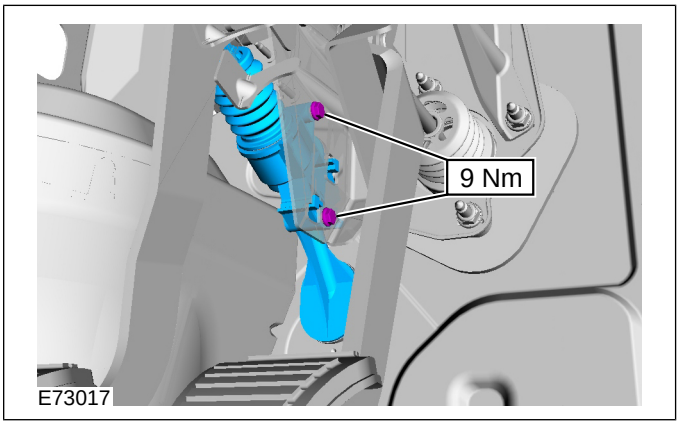


4. **Remove the clutch master cylinder.**
   - Remove the bolts.
   - Slide off the clutch master cylinder from the fixings at the clutch pedal box.



Installation

1. **To install, reverse the removal procedure.**



2. **Bleed the clutch system.**

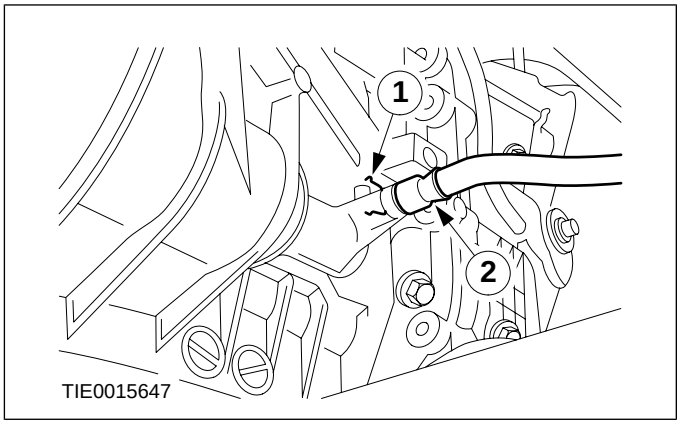
   For additional information, refer to:Clutch System Bleeding - Vehicles With: MT-75 (308-00 Manual Transmission/Transaxle and Clutch - General Information, General Procedures)
   / Clutch System Bleeding - Vehicles With: MT82 (308-00 Manual Transmission/Transaxle and Clutch - General Information, General Procedures).

REMOVAL AND INSTALLATION

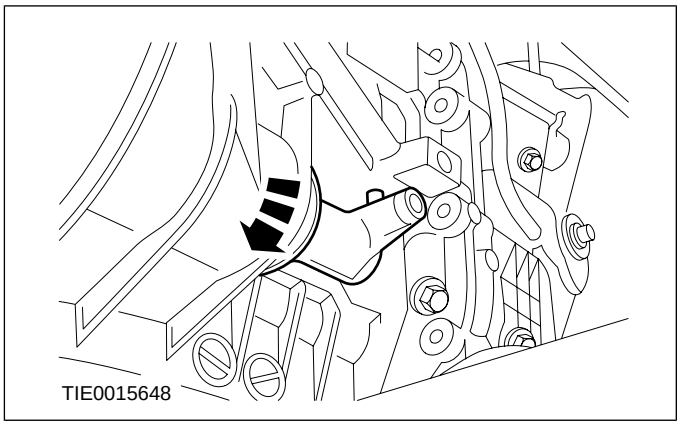
Clutch Slave Cylinder (16 862 4)

Removal

1. **Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].**
2. **Disconnect the supply hose from the clutch slave cylinder.**
   - Remove the clip.
   - Allow the fluid to drain into a suitable container.



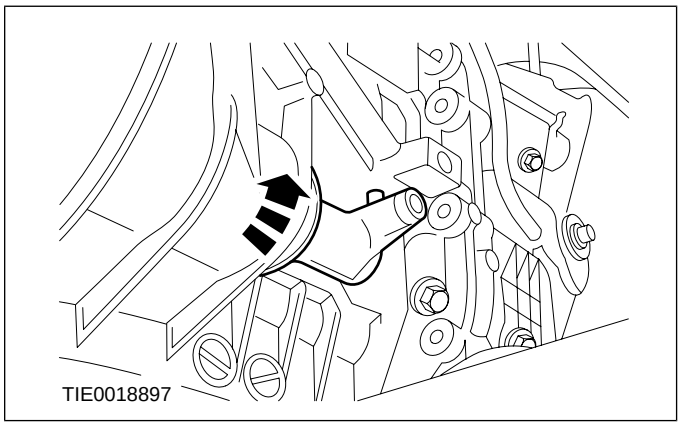
3. **Remove the clutch slave cylinder.**



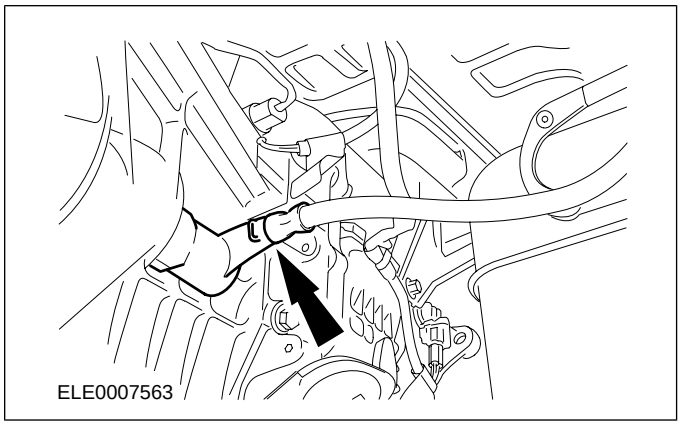
Installation

1. **NOTE:Make sure that the clutch slave cylinder actuating rod correctly engages with the clutch release lever.**

Install the clutch slave cylinder.



2. **Connect the supply hose to the clutch slave cylinder.**
   - Install the clip.



3. **Bleed the clutch system. For additional information, refer to Section 308-00 [Manual Transmission/Transaxle and Clutch - General Information].**

SECTION 308-03 Manual Transmission/Transaxle — Vehicles With: MT-75

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 308-03-2

DESCRIPTION AND OPERATION

Manual Transmission 308-03-4
Power Flow 308-03-11

DIAGNOSIS AND TESTING

Manual Transmission 308-03-17

GENERAL PROCEDURES

Transmission Draining and Filling 308-03-18

REMOVAL

Transmission — 2.4L Duratorq-Di (Puma) Diesel 308-03-19
Transmission — 2.3L Duratec-HE (MI4) 308-03-24

DISASSEMBLY

Transmission 308-03-29

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

Input Shaft 308-03-37
Output Shaft 308-03-38
Countershaft 308-03-42
Reverse Idler Gear 308-03-43
Synchronizers 308-03-44
Gearshift Control Shaft 308-03-45

ASSEMBLY

Transmission 308-03-46

INSTALLATION

Transmission — 2.4L Duratorq-Di (Puma) Diesel 308-03-56
Transmission — 2.3L Duratec-HE (MI4) 308-03-61

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Manual transmission fluid	WSD-M2C200-C
Super DOT 4 brake fluid	ESD-M6C57-A
Sealant	WSS-M2G348-A10
Grease	ESD-M1C220-A
Loctite 270 thread-locking compound	SDM-4G9107-A

Capacities

	Litres
MT75 transmission	1.3

Torque Specifications

Description	Nm	lb-ft	lb-in
Output shaft bearing bolts	24	18	-
Selector gate retaining bolts	10	-	89
Transmission retaining bolts	40	30	-
Reversing lamp switch retaining bolts	12	9	-
Locking plate retaining bolt	14	10	-
Reverse idler gear shaft to transmission housing retaining bolts	32	24	-
Selector interlock mechanism plug	24	18	-
Transmission output shaft flange retaining nut	200	148	-
Input shaft guide sleeve	250	184	-
Countershaft bearing retainer nuts	a)	-	-
Fixture of locking plate for bearing housing retaining bolt	25	18	-
Oil drain plug	35	26	-
Connecting sleeve	13	10	-
Gearshift lever bracket retaining bolts	25	18	-
Vehicle speed sensor (VSS)	6	-	53
Front axle crossmember retaining bolts	300	221	-
Front axle crossmember retaining nuts	175	129	-
Transmission support insulator to front axle cross-member bolt	40	30	-
Transmission support insulator to transmission bolts	55	41	-
Flexible coupling pinch bolt	25	18	-
Steering column pinch nut	30	22	-

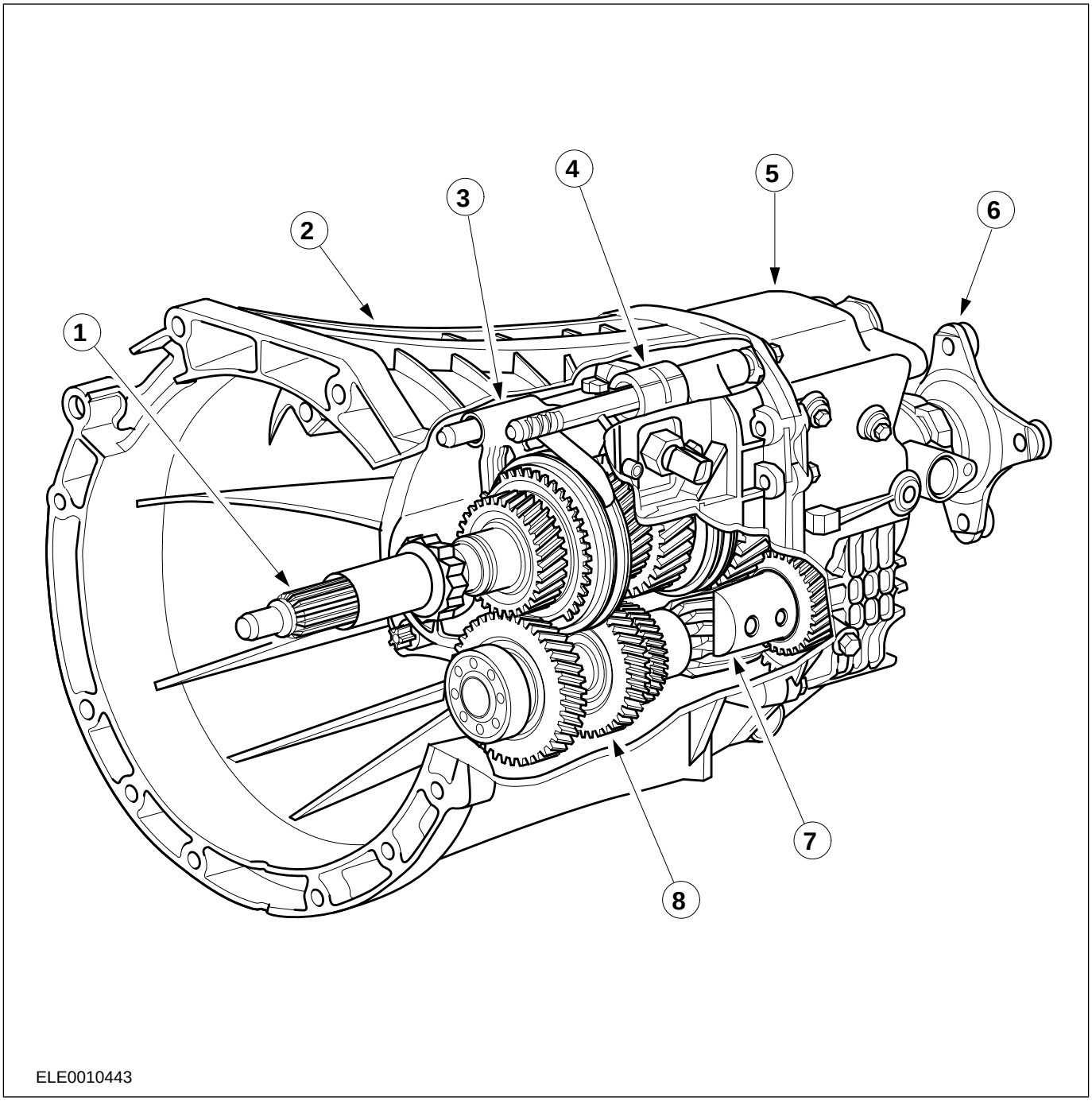
SPECIFICATIONS

Description	Nm	lb-ft	lb-in
Driveshaft to transmission output shaft flange retaining bolts	115	85	-
Driveshaft center bearing retaining bolts	22	15	-
a) Refer to procedure in this section.			

DESCRIPTION AND OPERATION

Manual Transmission

Transmission Overview



ELE0010443

Item	Part Number	Description
1		Mainshaft — Input shaft/Output shaft
2		Transmission front case
3		Shifter fork third/fourth gear
4		Selector shaft

Item	Part Number	Description
5		Transmission rear case
6		Output drive flange
7		Reverse gear idler
8		Counter shaft

DESCRIPTION AND OPERATION

The MT - 75 manual transmission is a ” three - shaft transmission".

MT - 75 means:

– M: Manual.
– T: Transmission
– 75: Distance between main shaft and counter shaft in mm.

The aluminum transmission housing consists of two closed sections. The reinforcing ribs on the transmission housing have been revised to reduce noise and vibration.

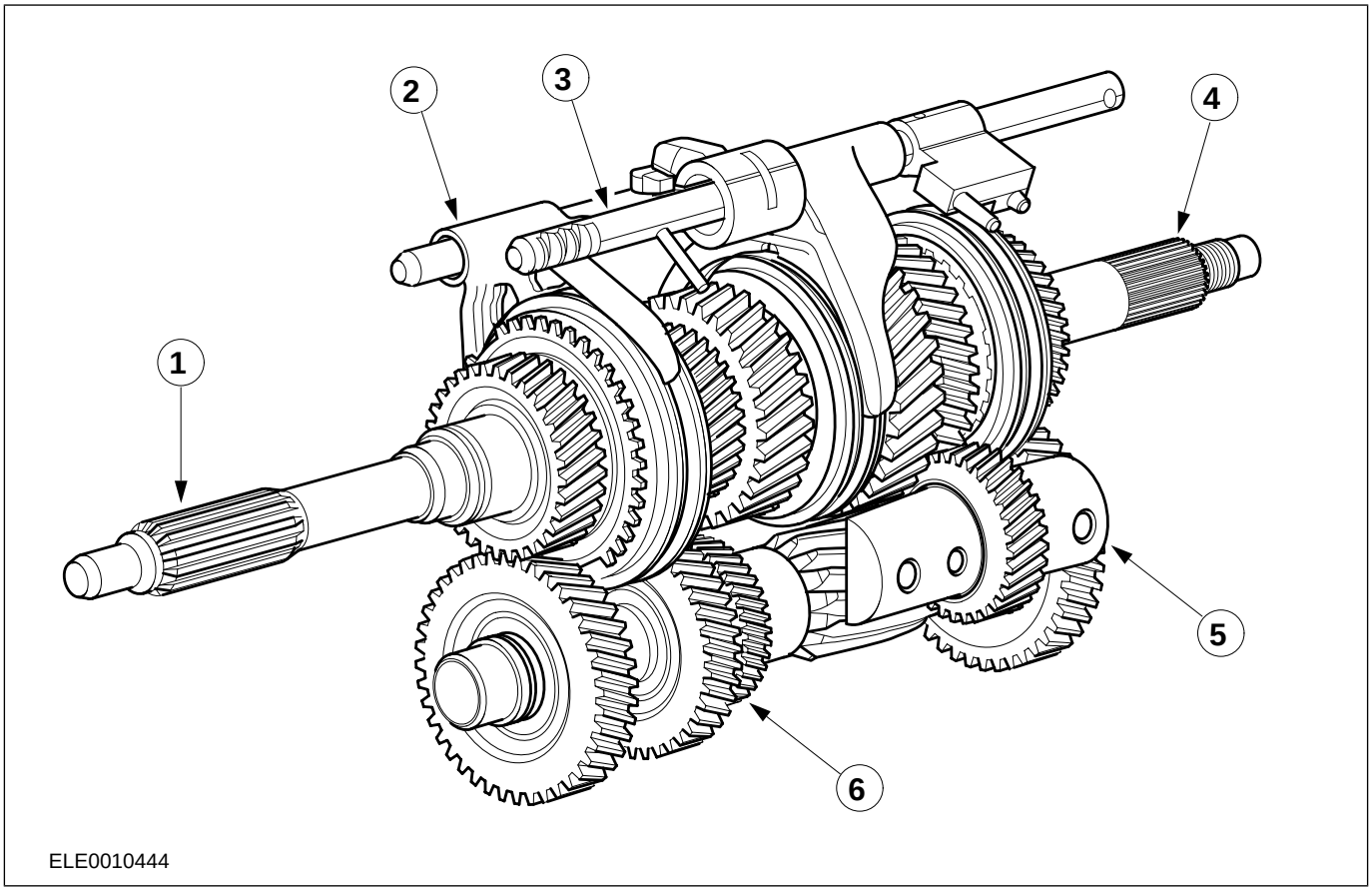
With the ” three - shaft transmission", all the gears are in permanent mesh. In each gear the required transmission ratio is achieved by means of a pair of gears.

When the reverse gear is selected, the direction of the output shaft is changed by an idler gear.

The input and output shafts turn on taper roller bearings.

All the gears, including reverse, are bevel - cut, synchronized and turn on needle roller bearings.

Mainshaft and Counter Shaft



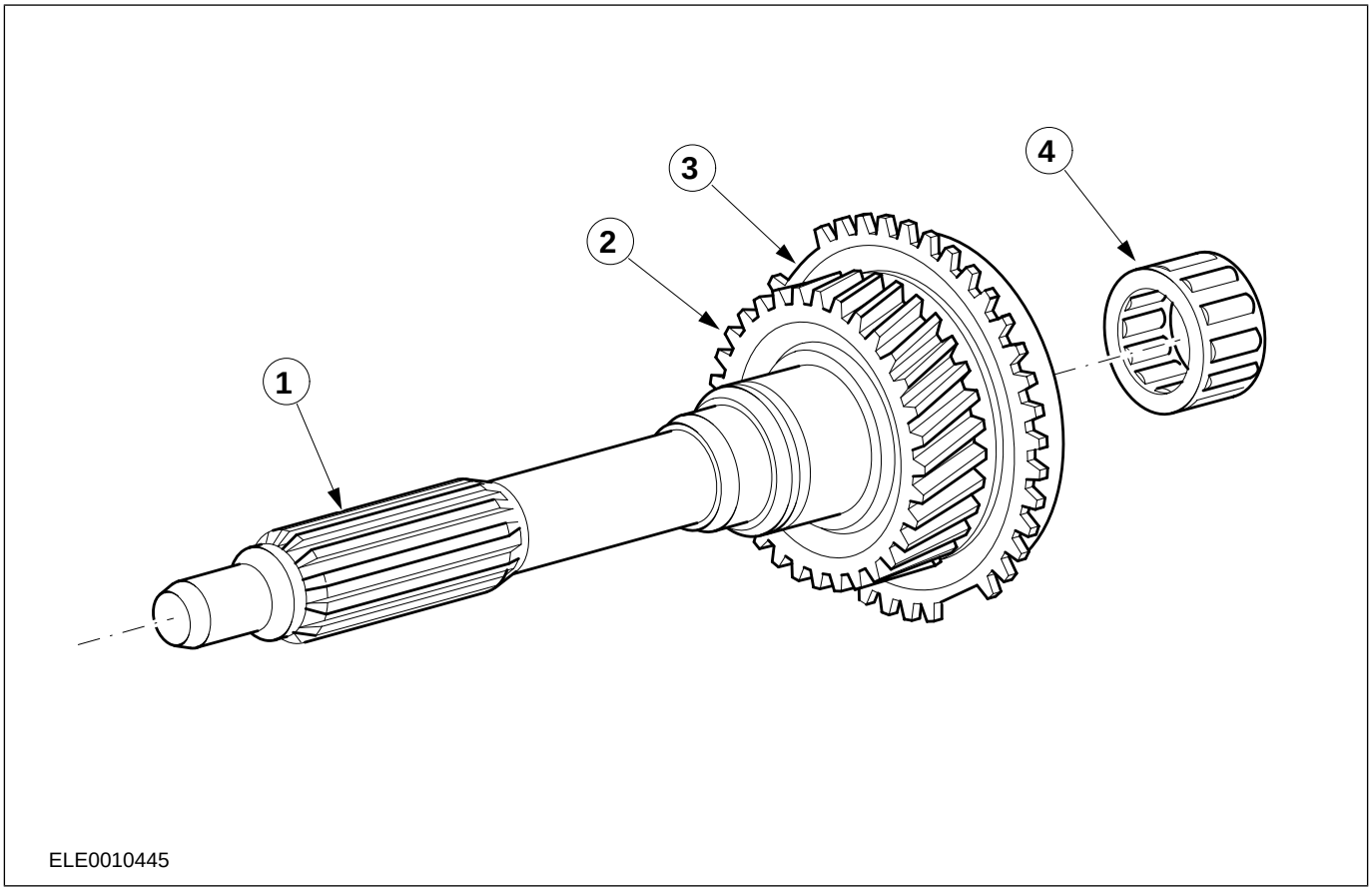
ELE0010444

Item	Part Number	Description
1		Input shaft
2		Selector fork third/fourth gear
3		Selector fork fifth/reverse gear

Item	Part Number	Description
4		Output shaft
5		Reverse gear idler
6		Counter shaft

DESCRIPTION AND OPERATION

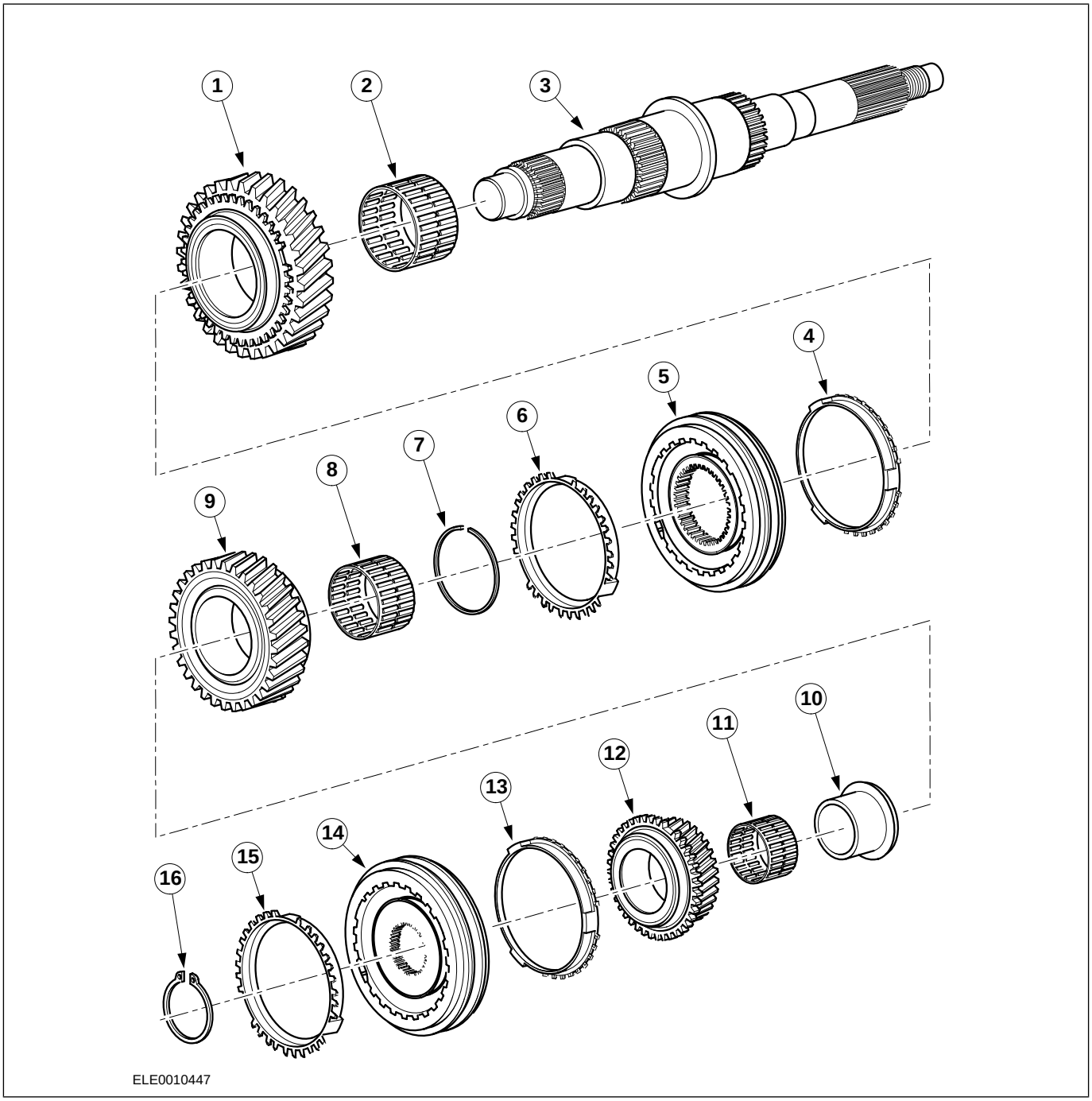
Input shaft



Item	Part Number	Description
1		Input shaft
2		Driving gear for counter shaft
3		Fourth gear synchronizer teeth
4		Output shaft locating bearing

DESCRIPTION AND OPERATION

Mainshaft (left - hand side shown)



Item	Part Number	Description
1		Output shaft
2		Needle roller bearing
3		Gear wheel first gear
4		Synchronizer ring first gear
5		Synchronizer clutch first/second gear
6		Synchronizer ring second gear

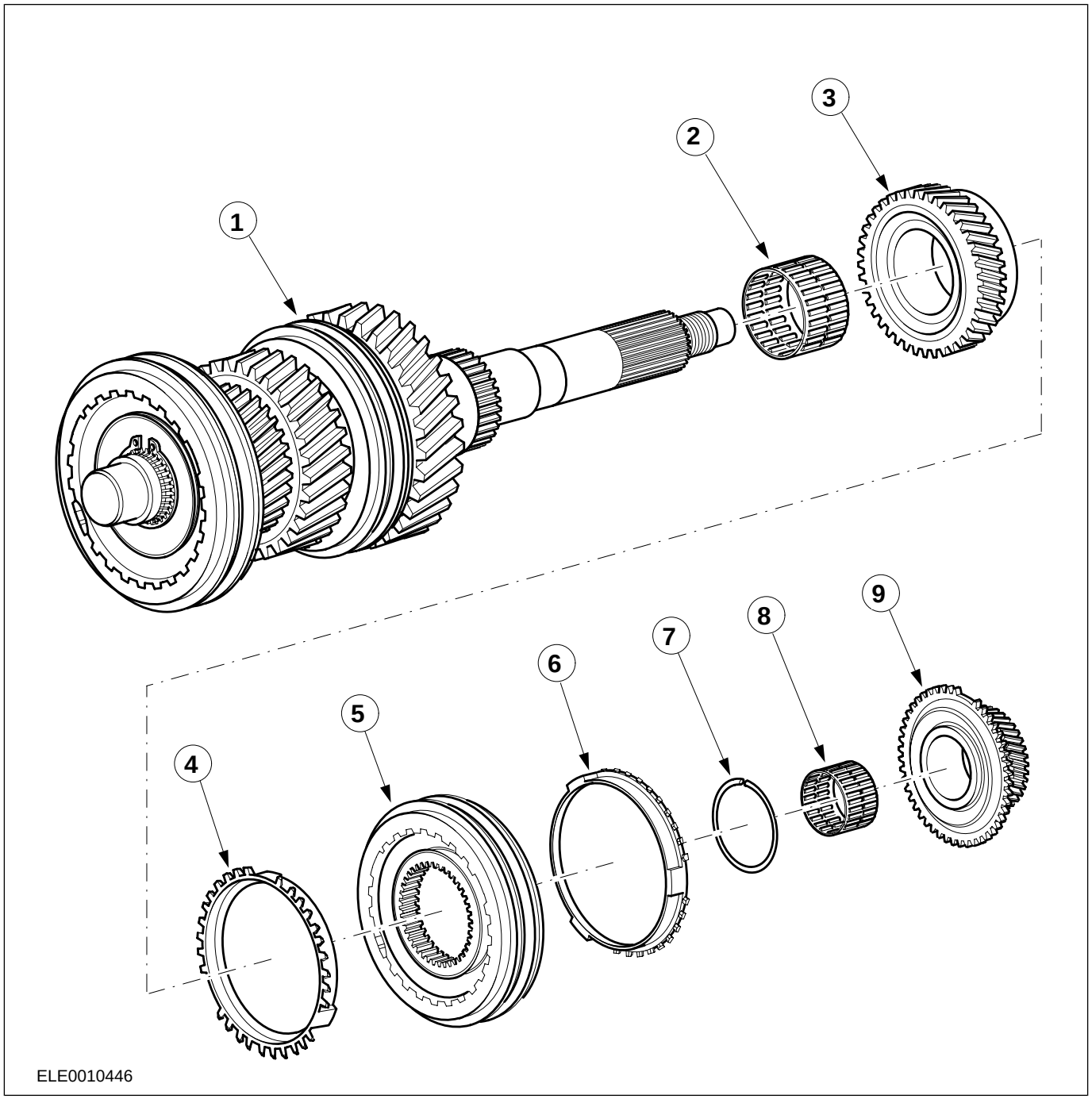
Item	Part Number	Description
7		Snap ring
8		Needle roller bearing
9		Gear wheel second gear
10		Inner race third gear needle roller bearing
11		Neeedle roller bearing
12		Gear wheel third gear

DESCRIPTION AND OPERATION

Item	Part Number	Description
13		Synchronizer ring third gear
14		Synchronizer clutch third/fourth gear

Item	Part Number	Description
15		Synchronizer ring fourth gear
16		Snap ring

Mainshaft (right - hand side shown)



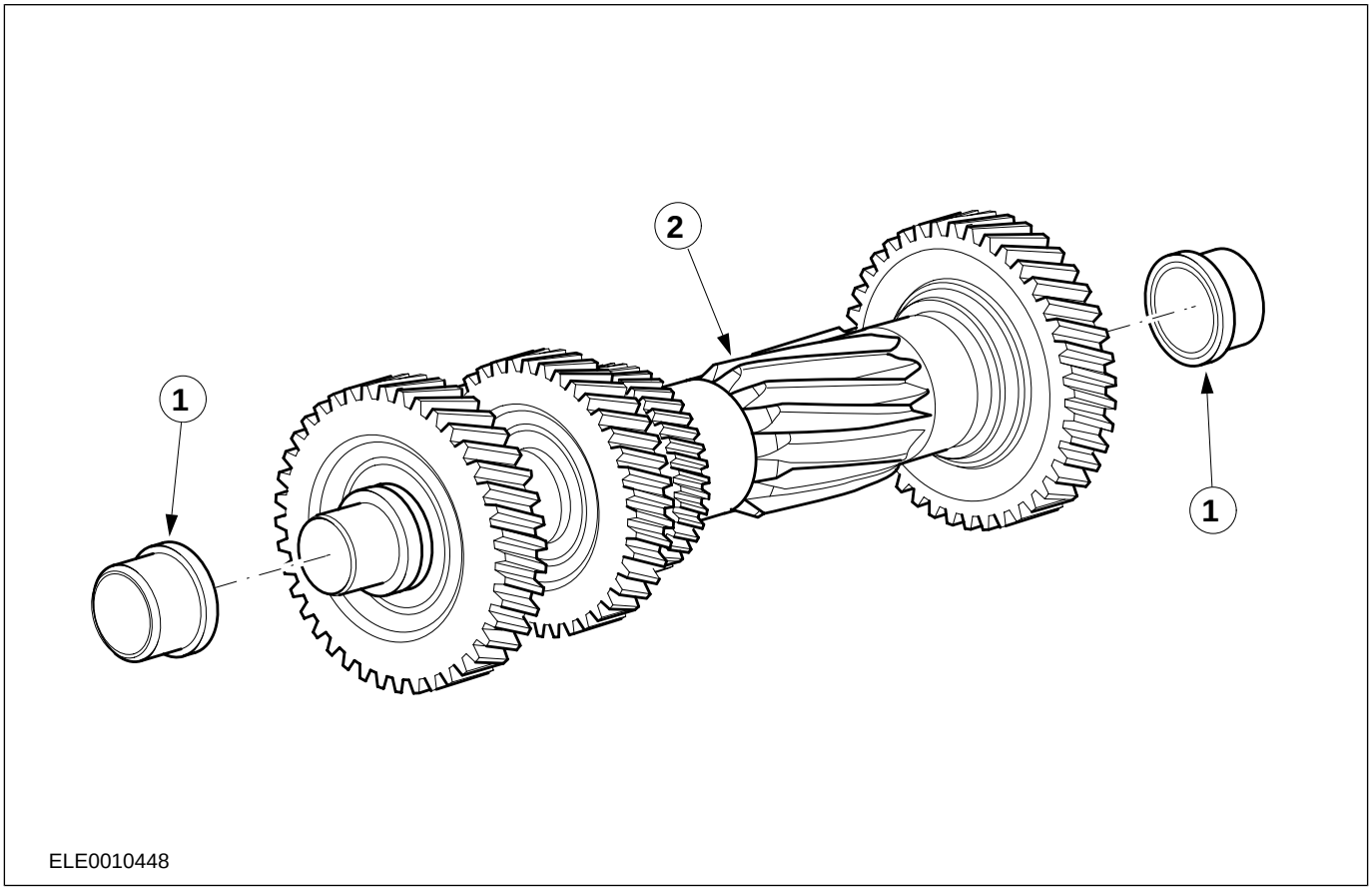
Item	Part Number	Description
1		Output shaft
2		Needle roller bearing
3		Reverse gear wheel

Item	Part Number	Description
4		Synchronizer ring reverse gear
5		Synchronizer clutch fifth/reverse gear

DESCRIPTION AND OPERATION

Item	Part Number	Description
6		Synchronizer ring fifth gear
7		Snap ring
8		Needle roller bearing
9		Gear wheel fifth gear
10		Taper roller bearing

Countershaft

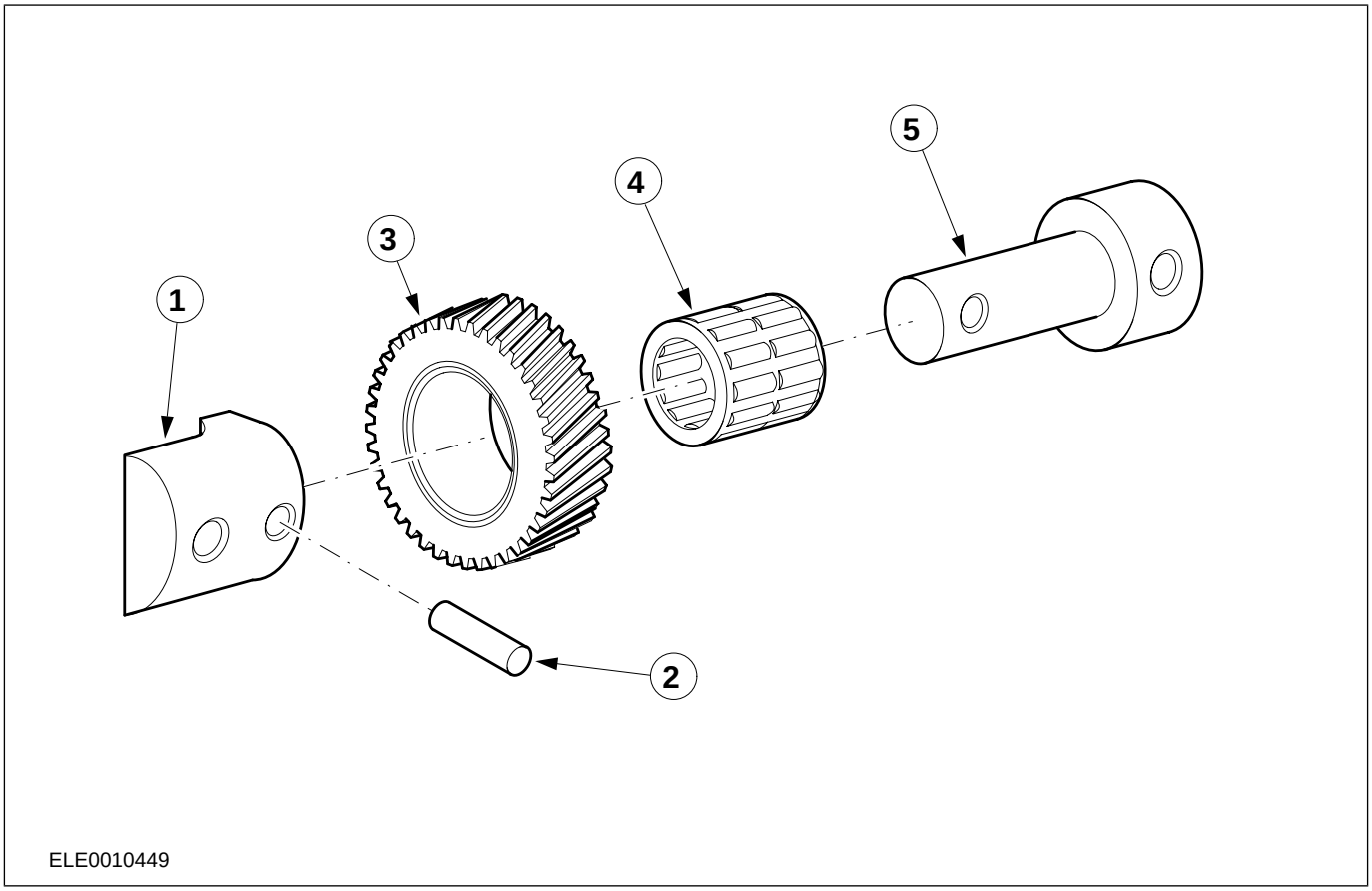


ELE0010448

Item	Part Number	Description
1		Inner race
2		Countershaft

DESCRIPTION AND OPERATION

Reverse gear idler



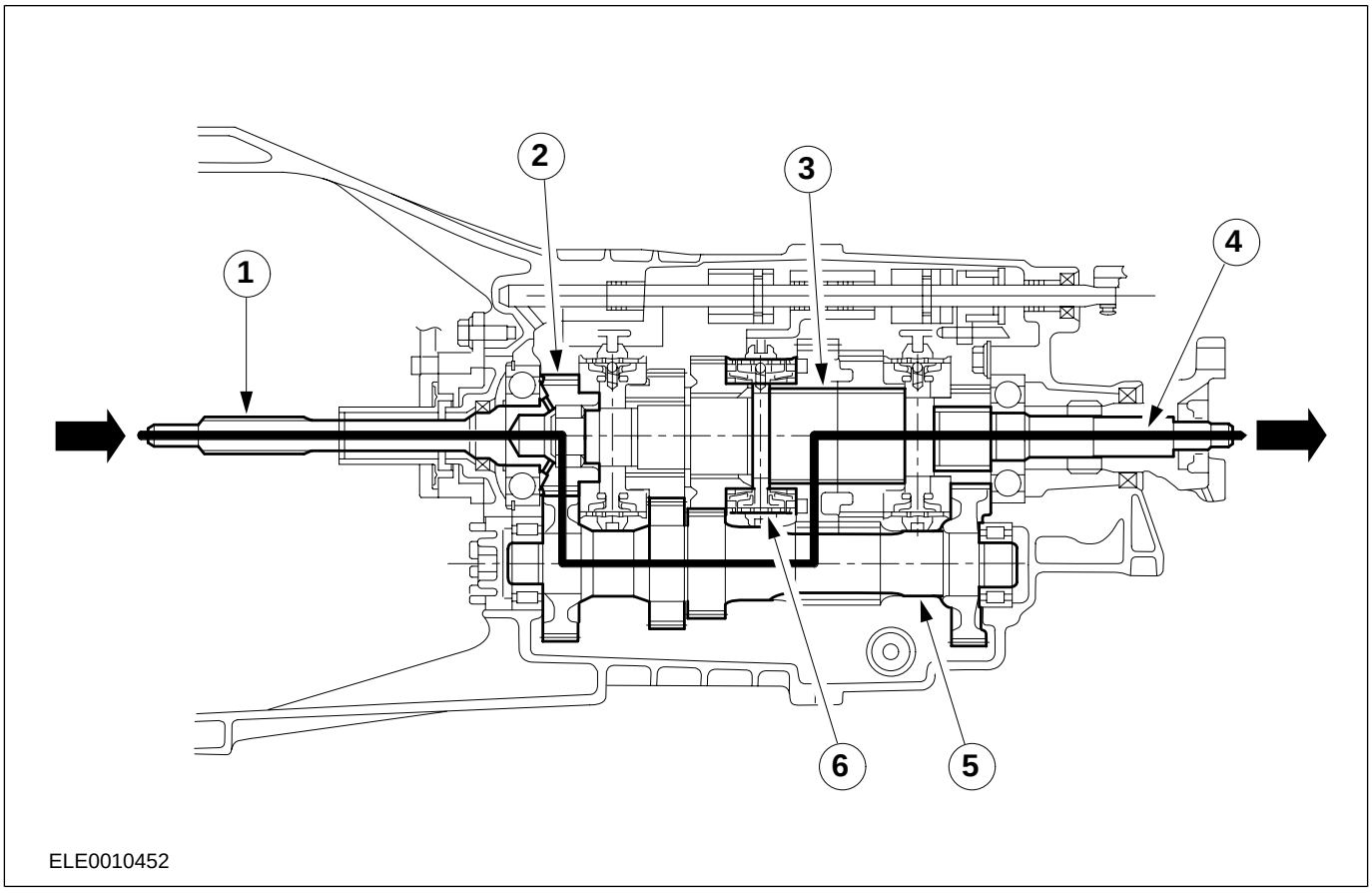
Item	Part Number	Description
1		Reverse gear idler shaft mounting
2		Roll pin

Item	Part Number	Description
3		Reverse gear idler
4		Needle roller bearing
5		Reverse gear idler shaft

DESCRIPTION AND OPERATION

Power Flow

First gear

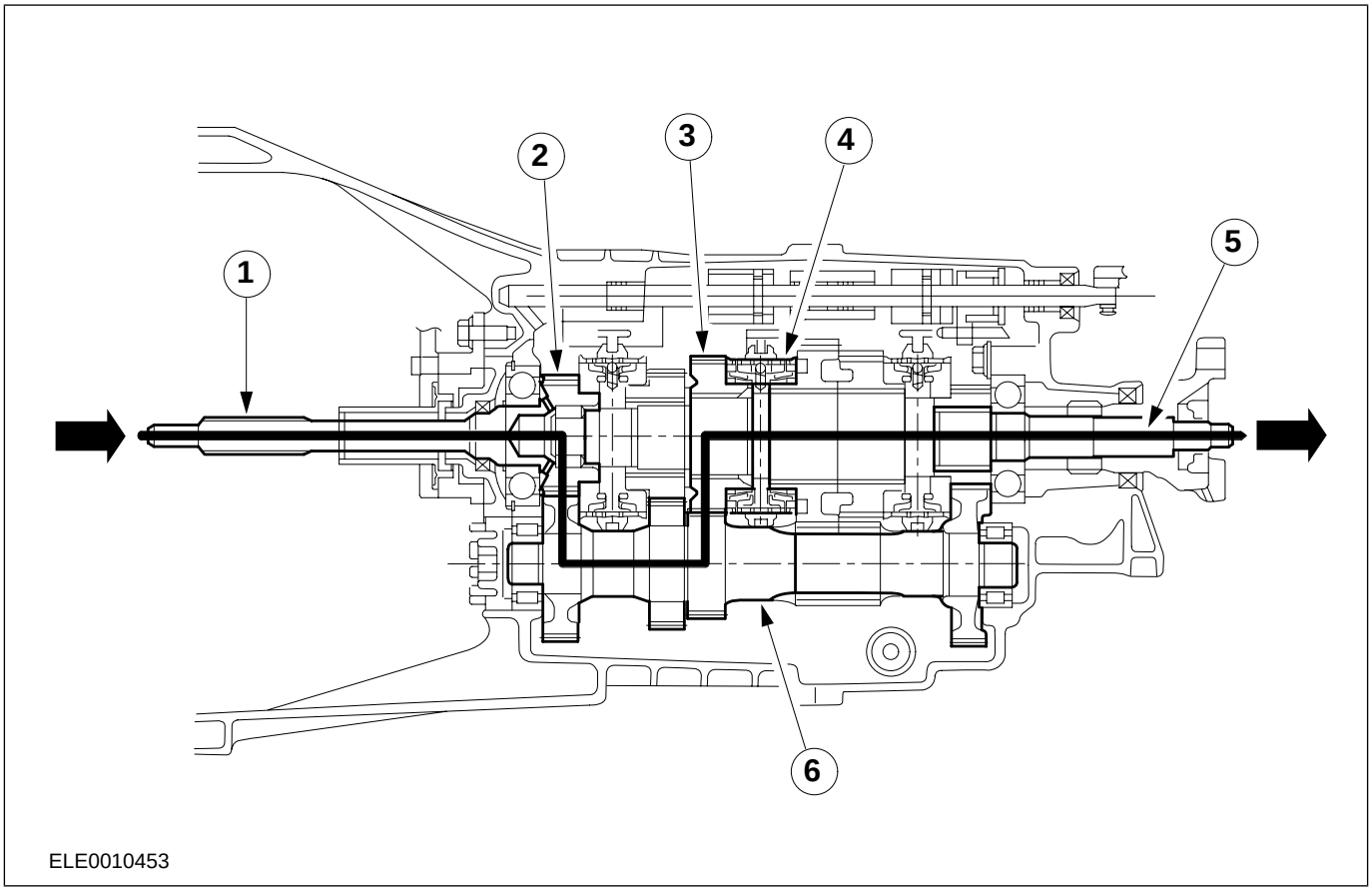


Item	Part Number	Description
1		Input shaft
2		Driving gear for countershaft
3		Gear wheel fist gear

Item	Part Number	Description
4		Output shaft
5		Counter shaft
6		Synchonizer clutch first/second gear

DESCRIPTION AND OPERATION

Second gear

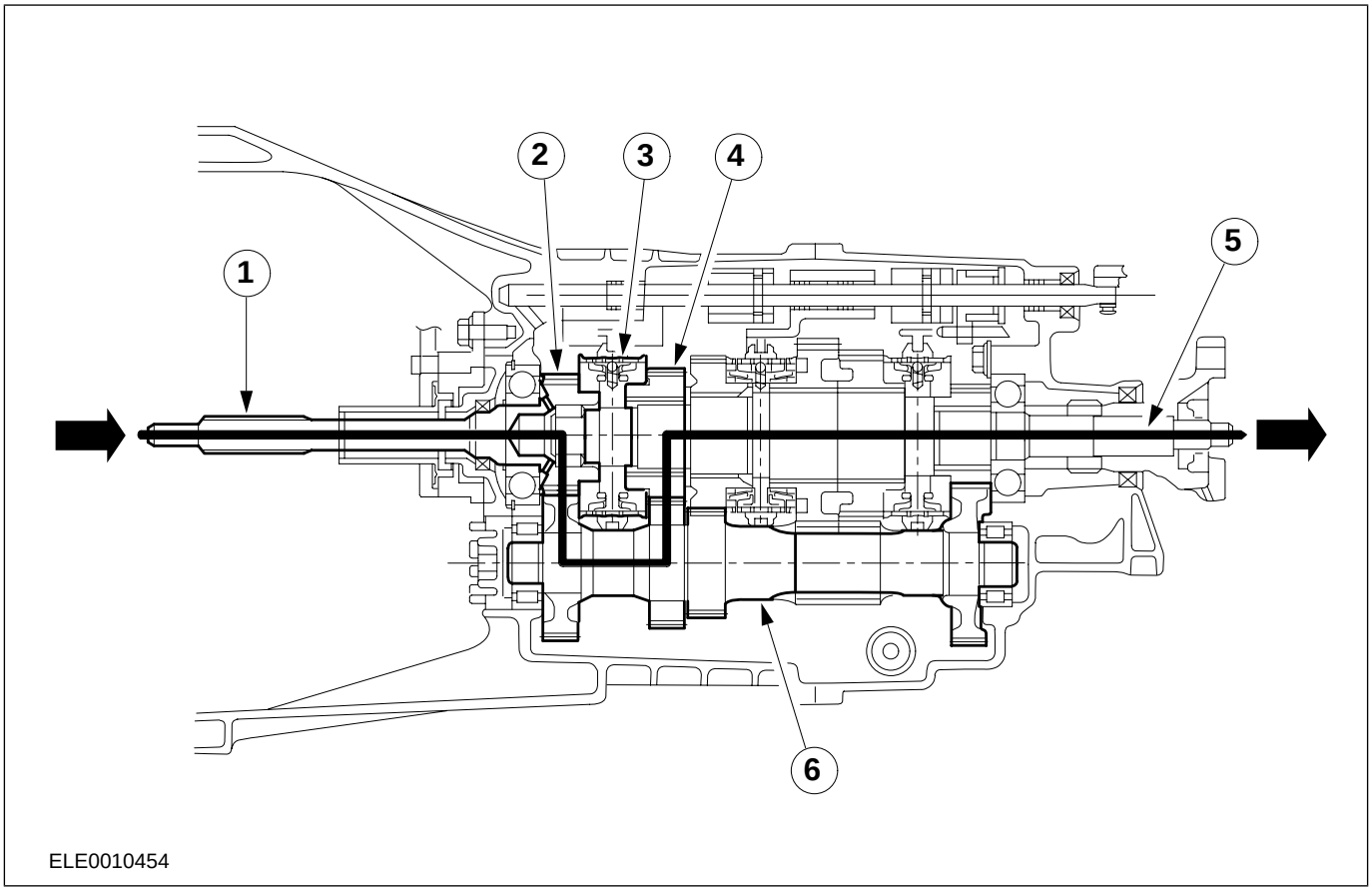


ELE0010453

Item	Part Number	Description
1		Input shaft
2		Driving gear for countershaft
3		Gear wheel second gear
4		Synchonizer clutch first/second gear
5		Output shaft
6		Counter shaft

DESCRIPTION AND OPERATION

Third gear



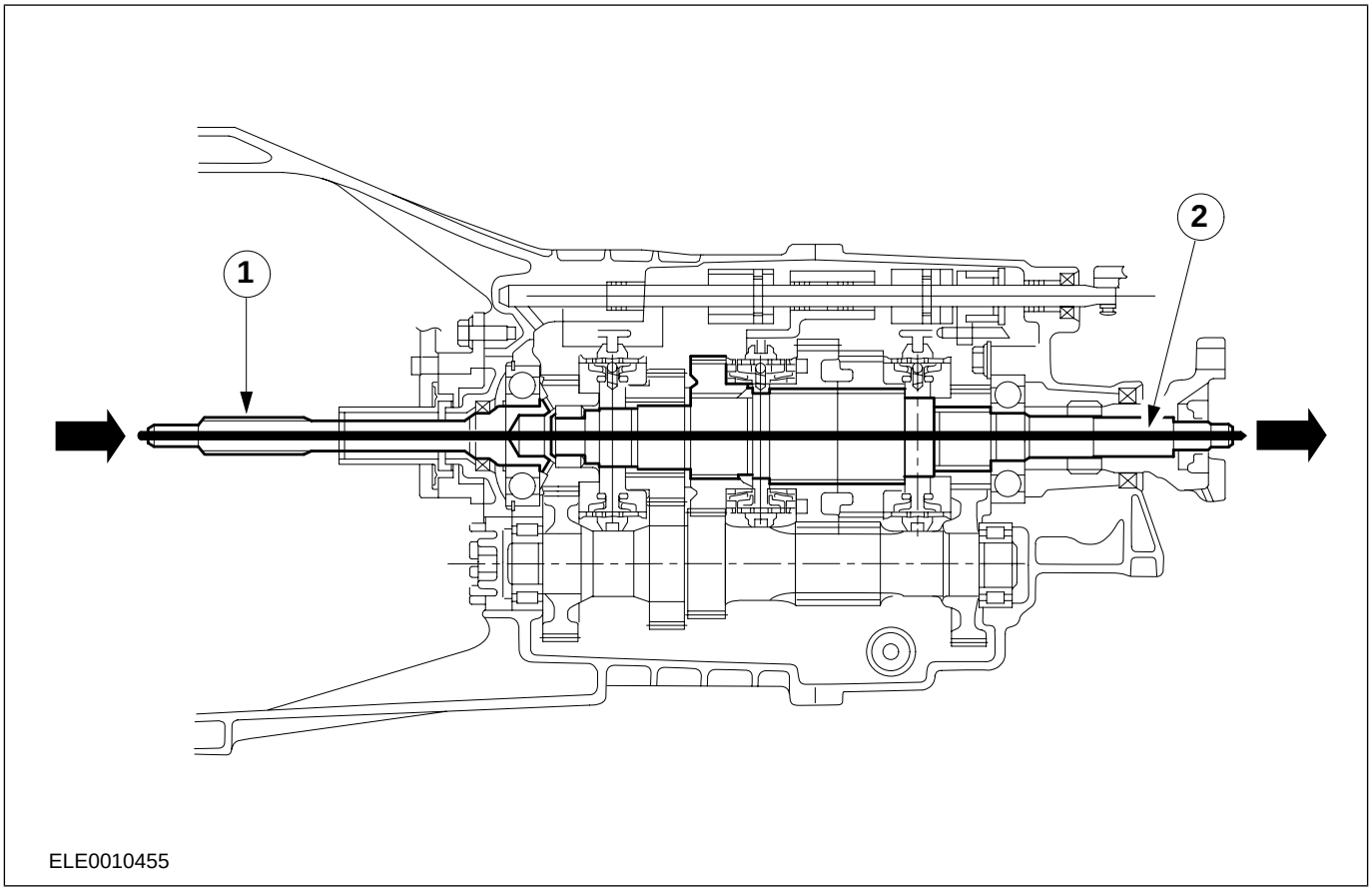
ELE0010454

Item	Part Number	Description
1		Input shaft
2		Driving gear for countershaft
3		Synchronizer clutch first/second gear

Item	Part Number	Description
4		Gear wheel second gear
5		Output shaft
6		Counter shaft

DESCRIPTION AND OPERATION

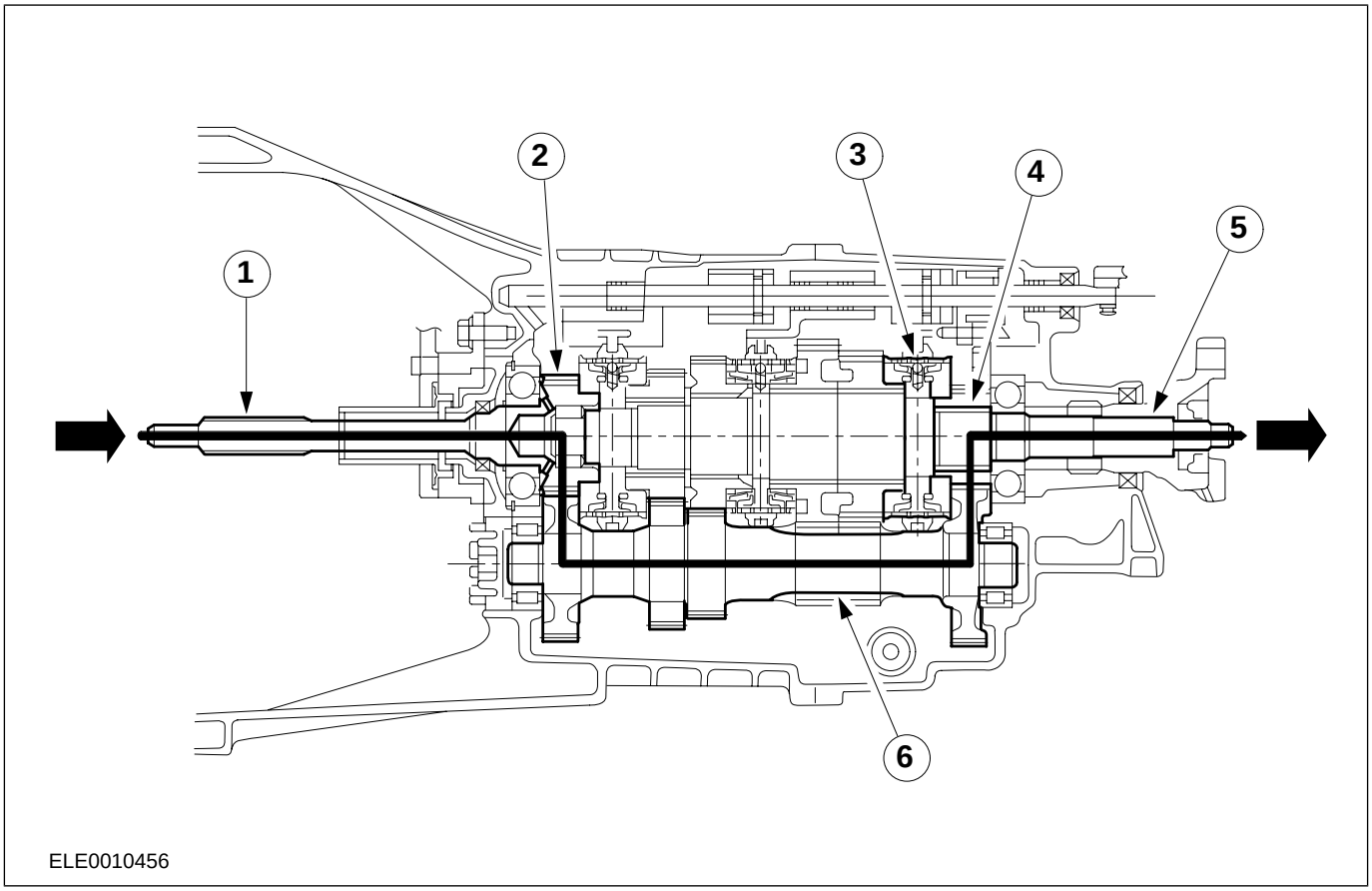
Fourth gear



Item	Part Number	Description
1		Input shaft
2		Output shaft

DESCRIPTION AND OPERATION

Fifth gear

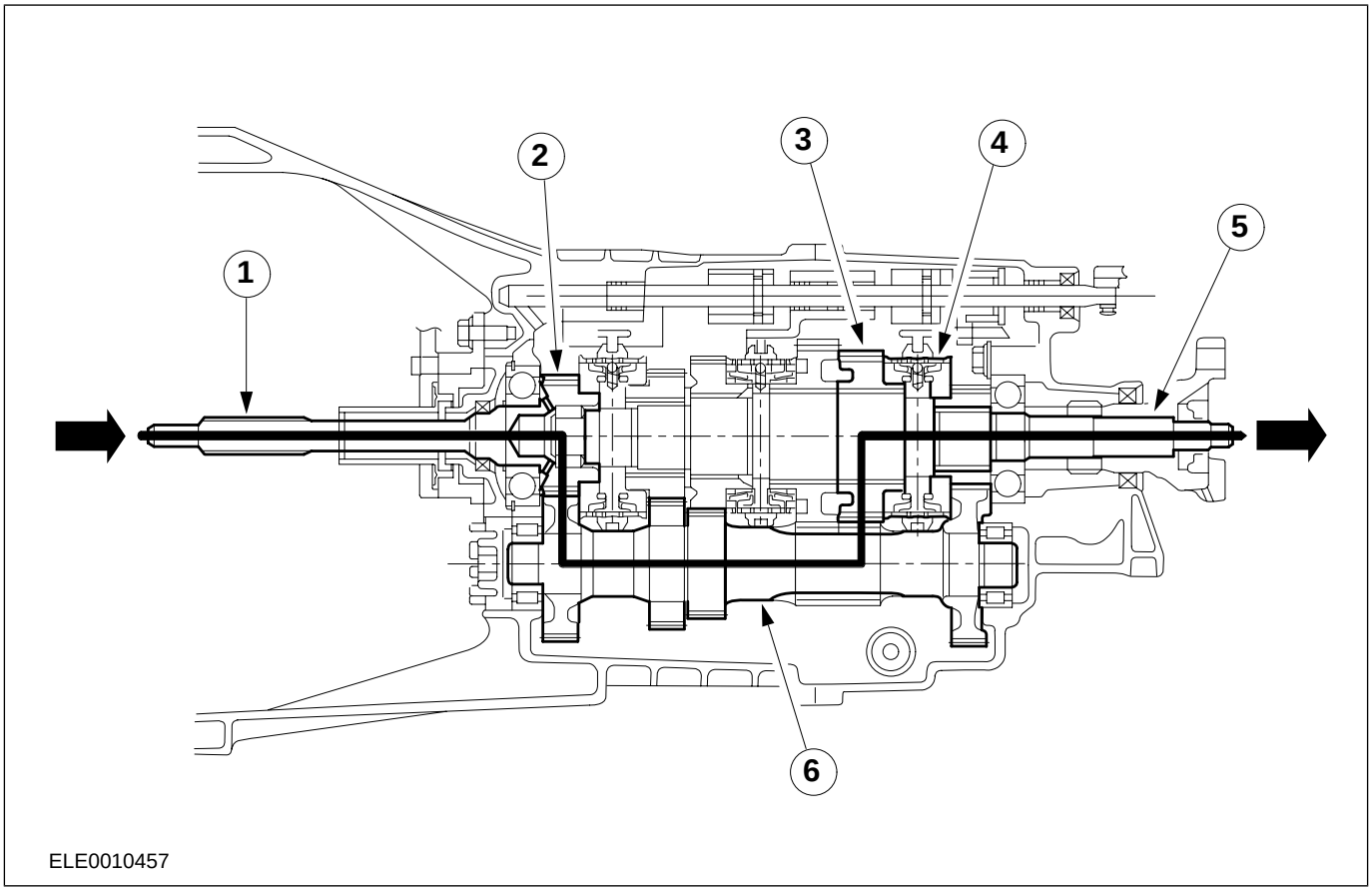


Item	Part Number	Description
1		Input shaft
2		Driving gear for countershaft
3		Synchronizer clutch fifth/reverse gear

Item	Part Number	Description
4		Gerar wheel fifth gear
5		Output shaft
6		Counter shaft

DESCRIPTION AND OPERATION

Reverse gear



Item	Part Number	Description
1		Input shaft
2		Driving gear for countershaft
3		Gear wheel reverse gear
4		Synchronizer clutch fifth/reverse gear
5		Output shaft
6		Input shaft

DIAGNOSIS AND TESTING

Manual Transmission

REFER to Section 308-00 [Manual Transmission/Transaxle and Clutch - General Information].

GENERAL PROCEDURES

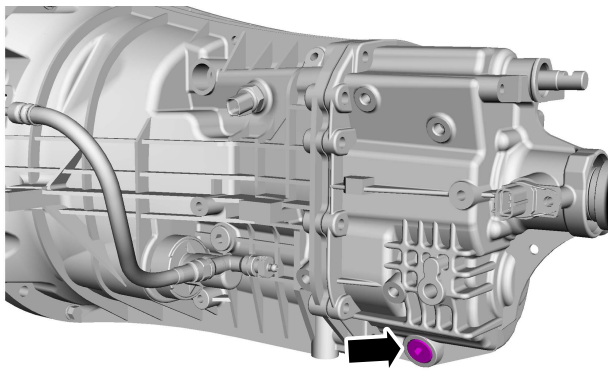
Transmission Draining and Filling

Materials	
Name	**Specification**
Transmission Fluid	WSD-M2C200-C

1. Raise the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

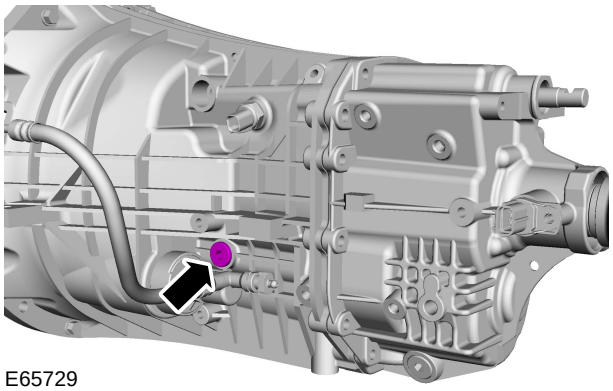
2. Torque: 35 Nm



E65728

3. • Fill up with transmission fluid to 0-5 mm below the lower edge of the filler hole.

   Material: Transmission Fluid
   Torque: 35 Nm

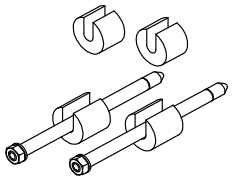


E65729

REMOVAL

Transmission — 2.4L Duratorq-Di (Puma) Diesel

Special Tool(s)

 E62036	Spacer, Subframe 204-606

General Equipment

Two transmission jacks
Two M10 x 60 mm locating studs

Removal

All vehicles

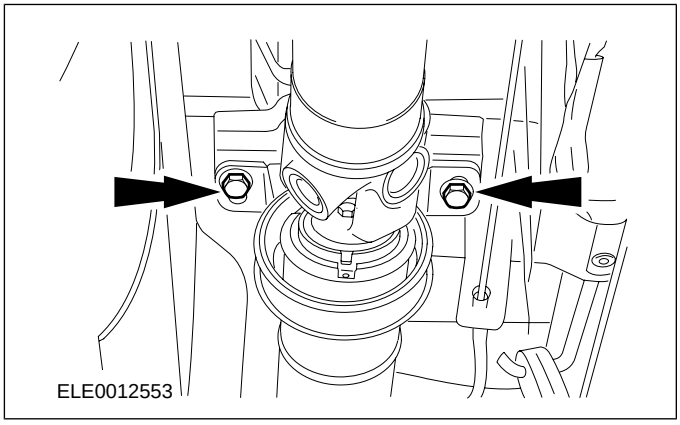
1. **Disconnect the battery ground cable.**

   For additional information, refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

2. **Shift the transmission into third gear.**
3. **Raise and support the vehicle.**

   For additional information, refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

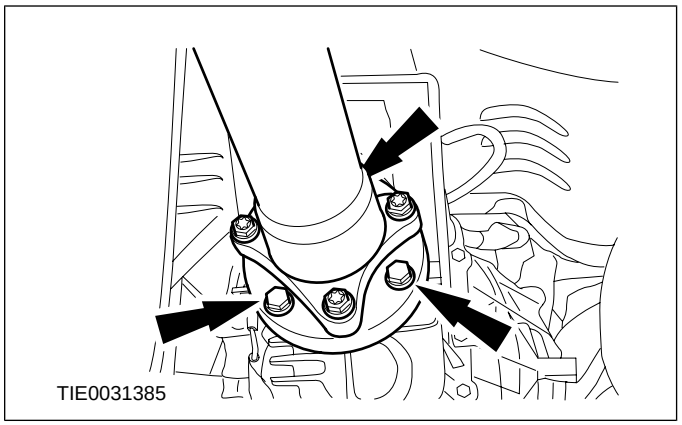
4. **Loosen the driveshaft front center bearing retaining bolts.**



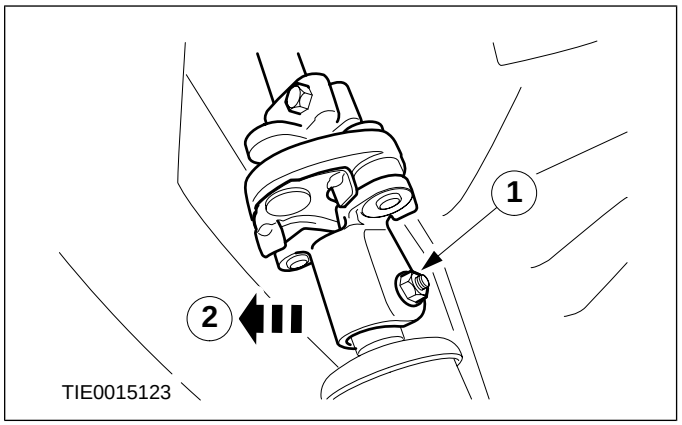
5. **NOTE:Mark the position of the driveshaft flange in relation to the transmission output shaft flange.**

   Detach the driveshaft from the transmission output shaft flange and position it to one side.

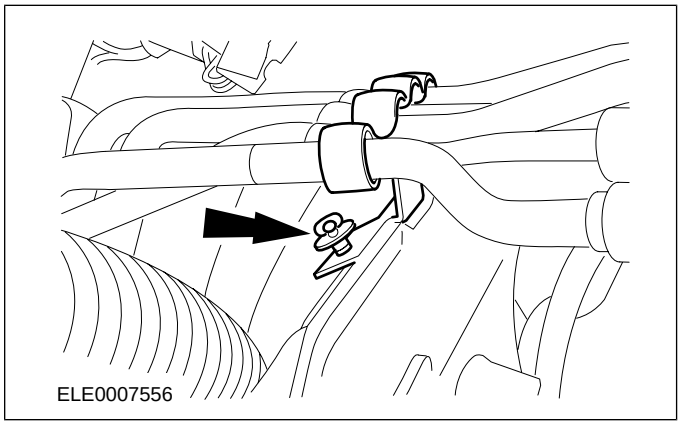
   - Discard the bolts.



6. **Disconnect the steering column flexible coupling from the steering gear pinion.**
   1. Remove the lower pinch bolt.
   2. Detach the steering column shaft and position to one side.
   - Discard the nut.

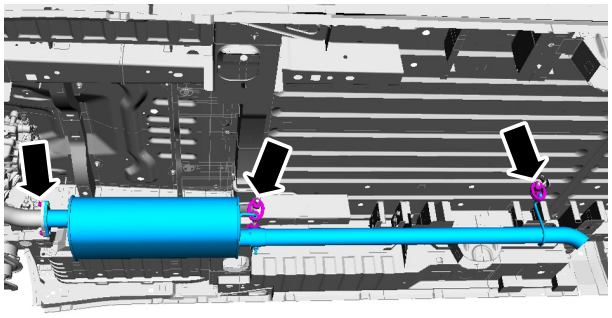


7. **Detach the power steering lines from the front axle crossmember.**

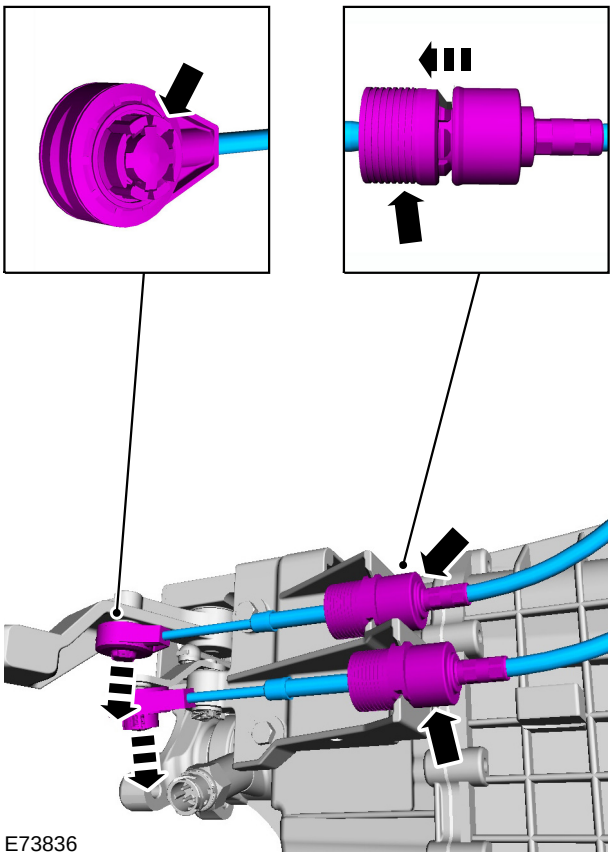


REMOVAL

8. Remove the exhaust muffler.

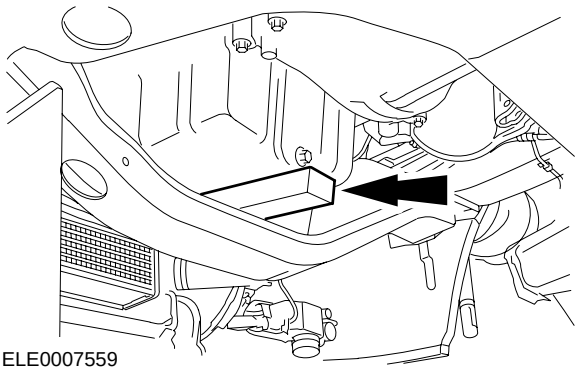

E73592

9. Remove the gearshift cables.


E73836

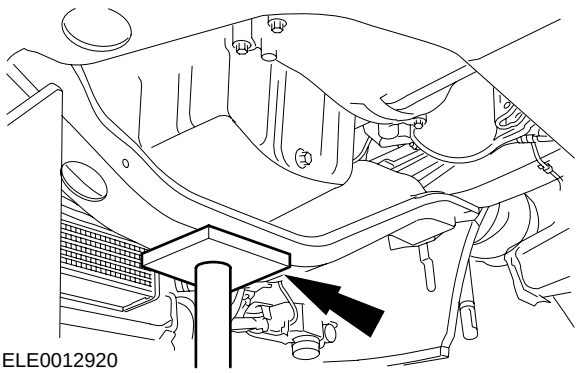
10. NOTE:When using a two post lift.

Support the engine with a wooden block.


ELE0007559

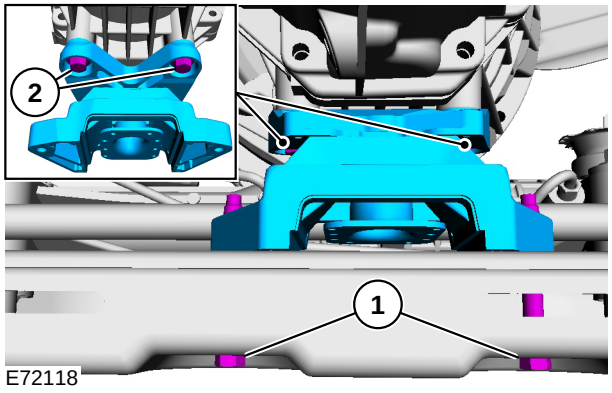
11. NOTE:When using a four post lift.

Using a suitable transmission jack, support the vehicle under the engine crossmember.


ELE0012920

12. Remove the transmission support insulator.

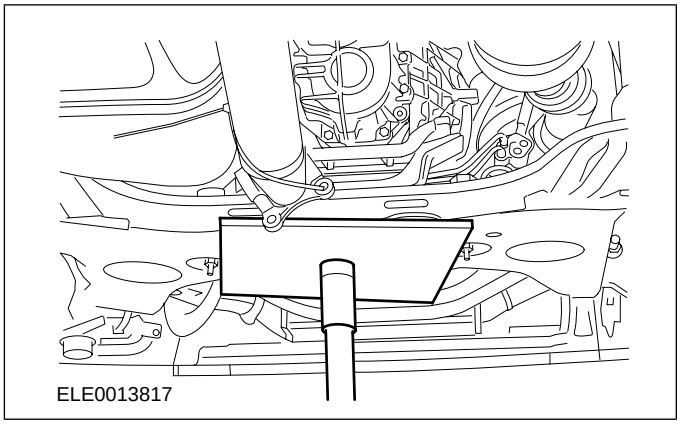
1. Remove the front axle to bracket retaining bolts.
2. Remove the bracket to transmission retaining bolts.



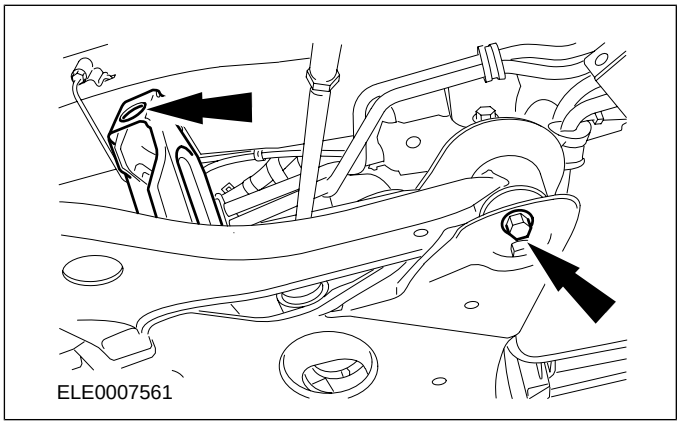
E72118

REMOVAL

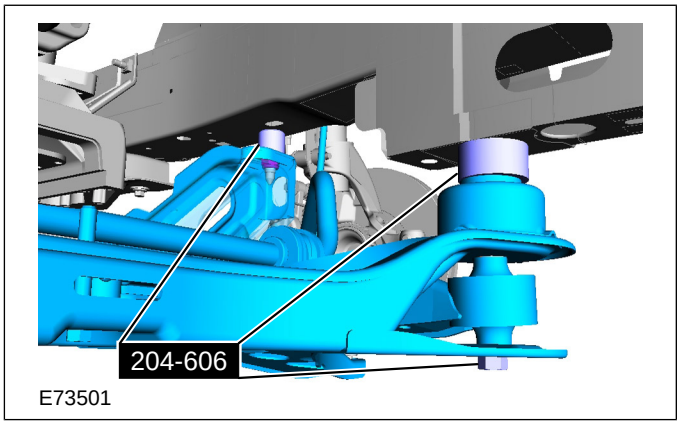
13. Using a suitable transmission jack, support the front axle crossmember.



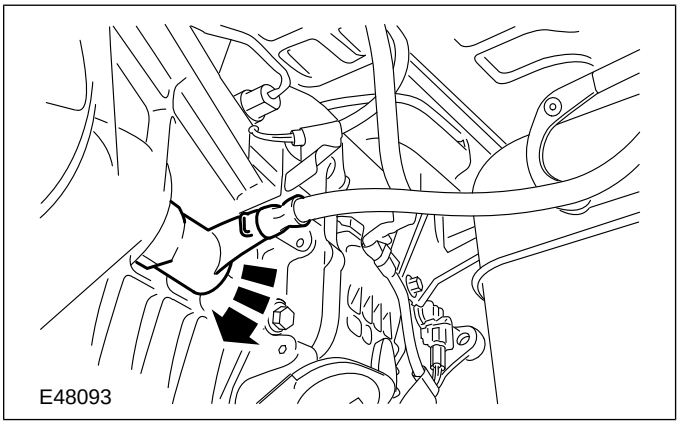
14. Lower the front axle crossmember 150 mm (left-hand side shown).
    - Loosen the four bolts ten turns.



15. Using the special tool, lower the front axle.

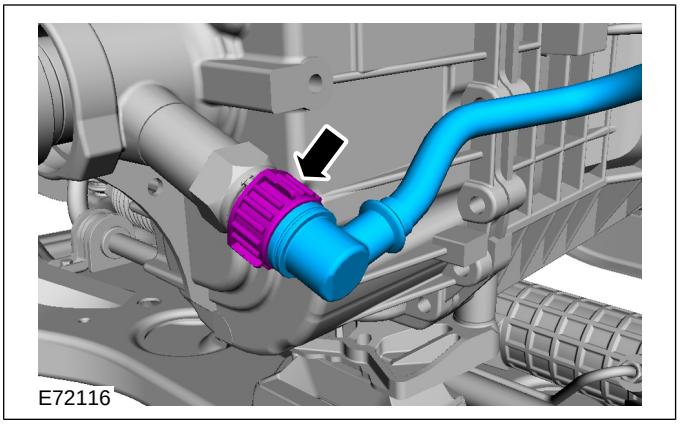


16. Turning the clutch slave cylinder counterclockwise, detach the clutch slave cylinder from the transmission.



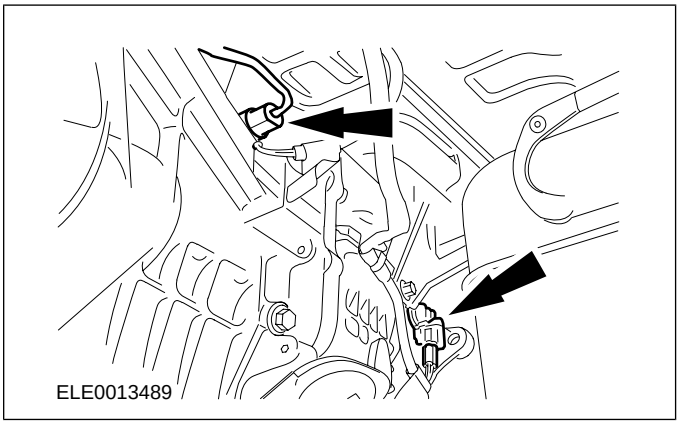
Vehicles with tachograph

17. Disconnect the tachograph sensor electrical connector.



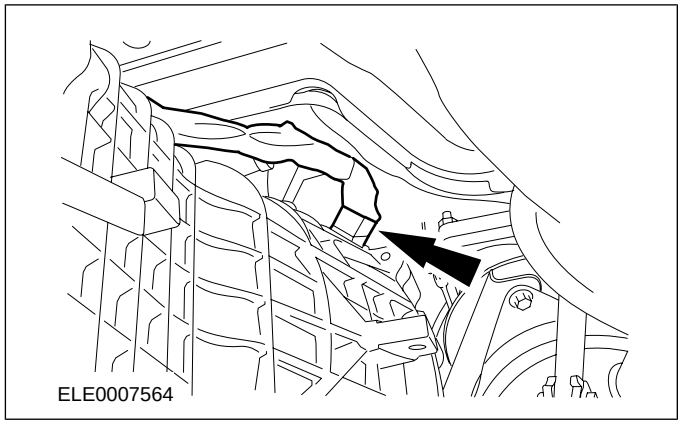
All vehicles

18. Disconnect the reversing lamp switch and the vehicle speed sensor (VSS) electrical connectors.

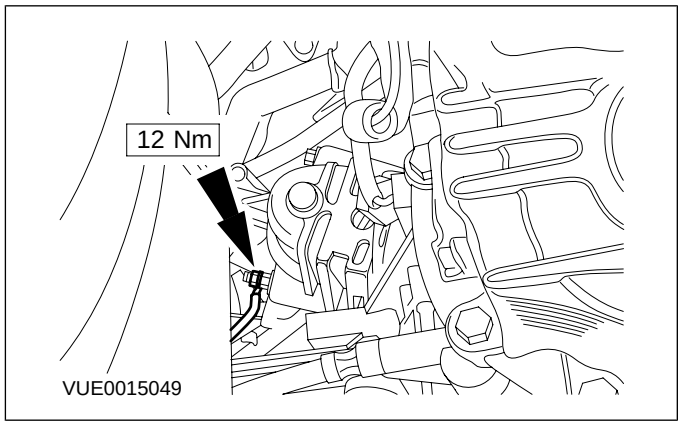


REMOVAL

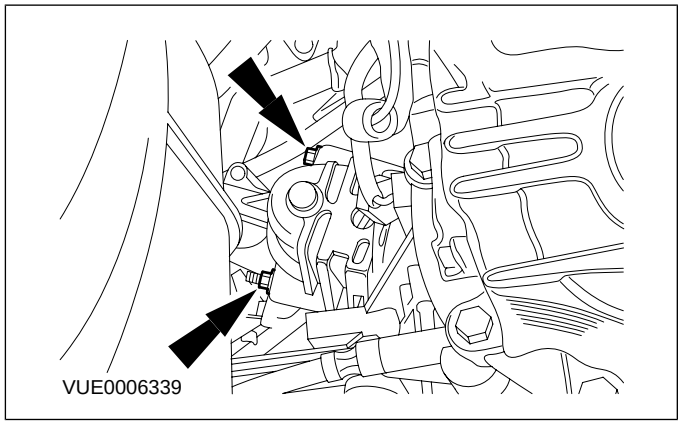
19. Detach the heat shield and disconnect the crankshaft position (CKP) sensor.



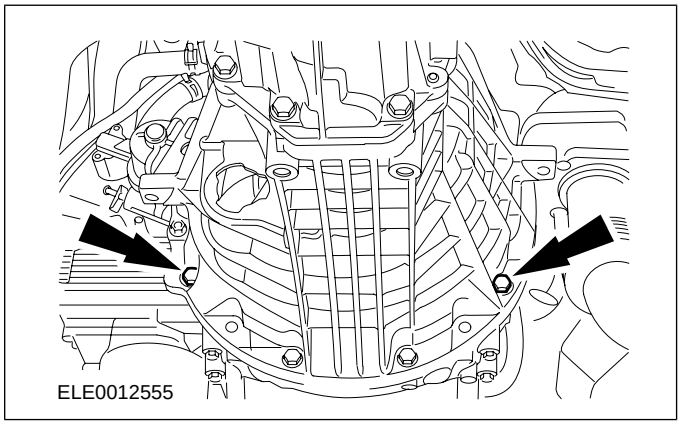
20. Remove the starter motor ground cable.



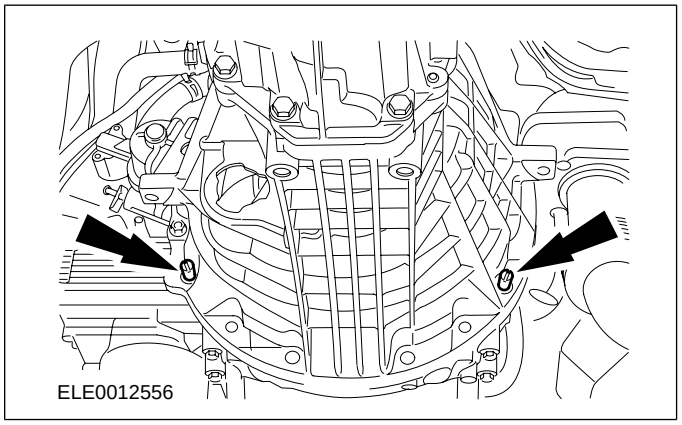
21. Detach the starter motor from the transmission.



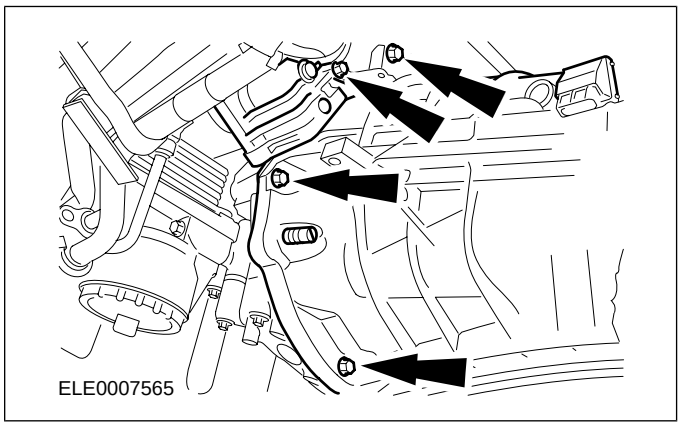
22. Remove one transmission retaining bolt from the right-hand side and one from the left-hand side.



23. Install the M10 x 60 mm locating studs.

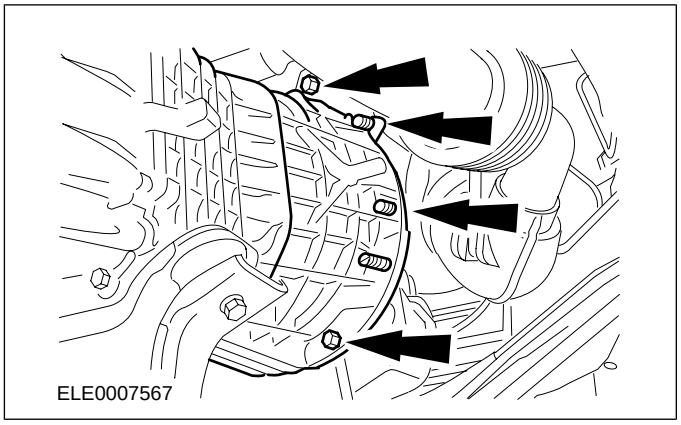


24. Remove the remaining transmission retaining bolts from the left-hand side.



REMOVAL

25. Remove the remaining transmission retaining bolts from the right-hand side.



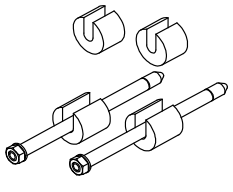
26. CAUTION:Do not tilt the transmission during removal. This may cause damage to the pilot bearing.

Remove the transmission.

REMOVAL

Transmission — 2.3L Duratec-HE (MI4)

Special Tool(s)

 E62036	Spacer, Subframe 204-606

General Equipment

Two M10 x 60 mm locating studs
Transmission jack

Removal

All vehicles

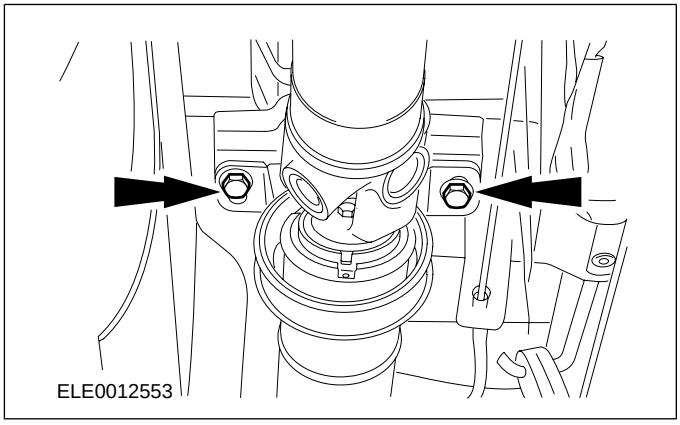
1. **Disconnect the battery ground cable.**

   For additional information, refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

2. **Shift the transmission into third gear.**
3. **Raise and support the vehicle.**

   For additional information, refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

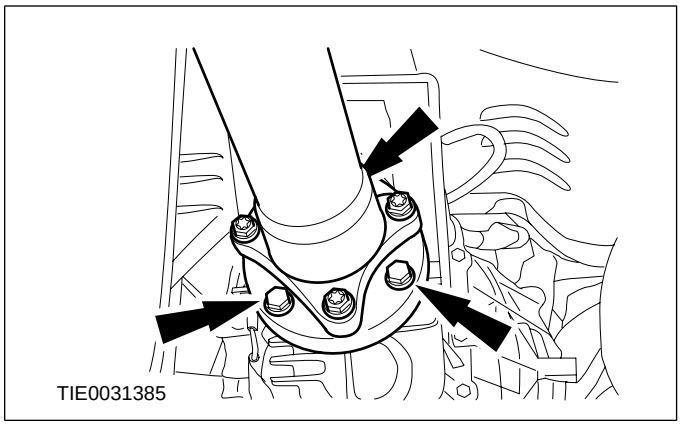
4. **Loosen the driveshaft front center bearing retaining bolts.**



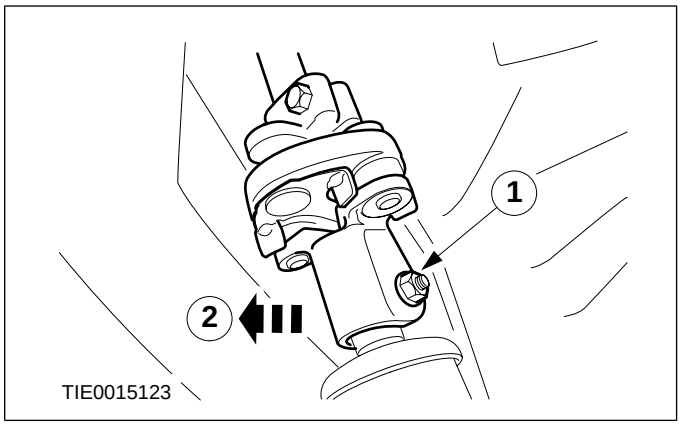
5. **NOTE:Mark the position of the driveshaft flange in relation to the transmission output shaft flange.**

   Detach the driveshaft from the transmission output shaft flange and position it to one side.

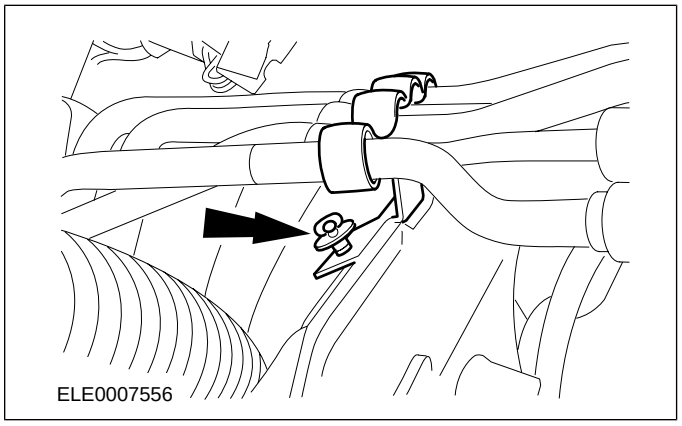
   - Discard the bolts.



6. **Disconnect the steering column flexible coupling from the steering gear pinion.**
   1. Remove the lower pinch bolt.
   2. Detach the steering column shaft and position to one side.
   - Discard the nut.

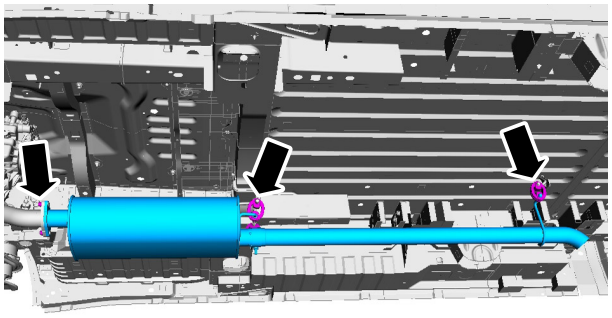


7. **Detach the power steering lines from the front axle crossmember.**



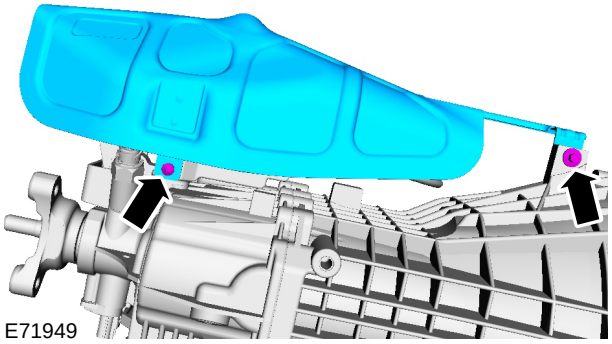
REMOVAL

8. Remove the exhaust muffler.



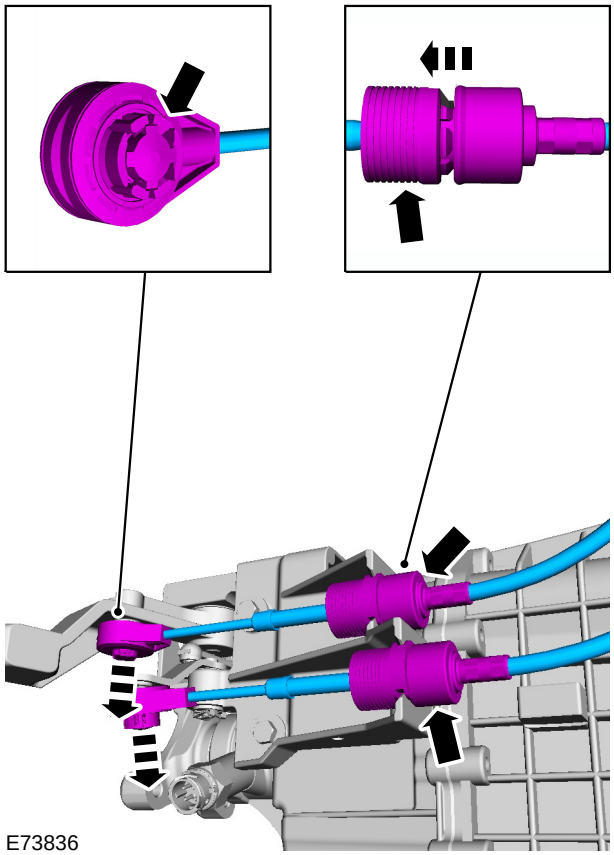
E73592

9. Remove the heat shield.



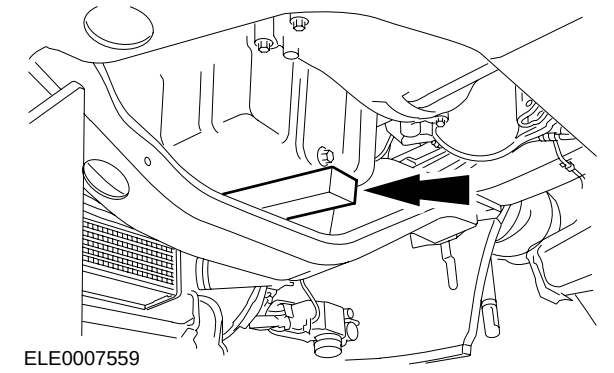
E71949

10. Detach the gearshift cables.



E73836

11. NOTE:When using a two post lift.
Support the engine with a wooden block.

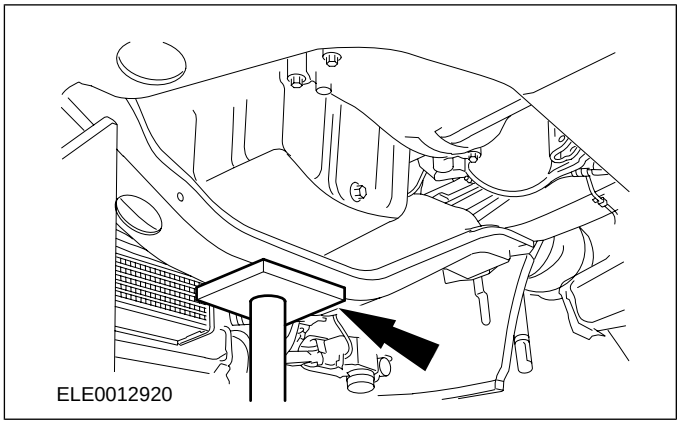


ELE0007559

12. NOTE:When using a four post lift.

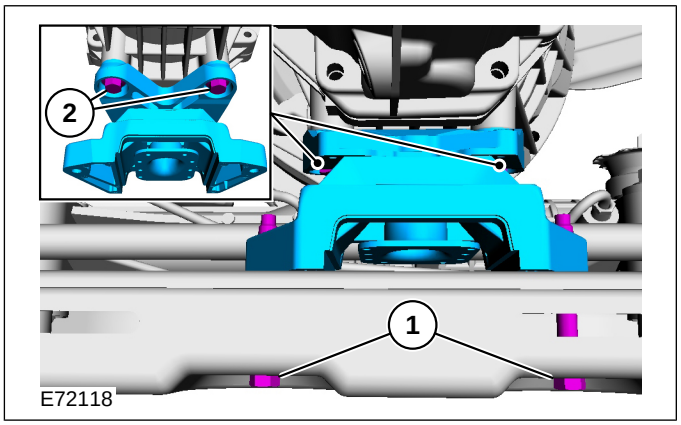
REMOVAL

Using a suitable transmission jack, support the vehicle under the engine crossmember.

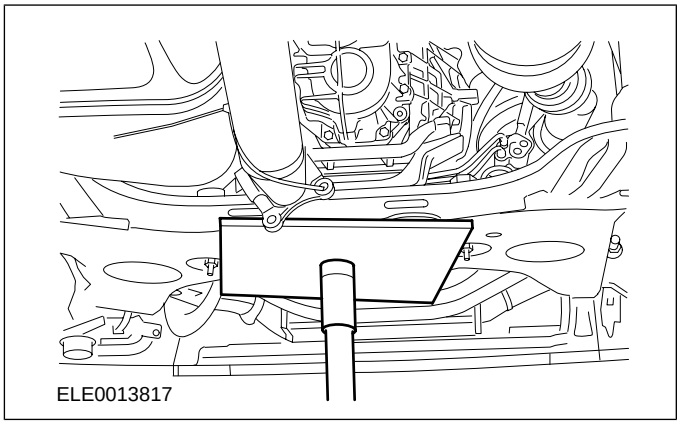


13. Remove the transmission support insulator.

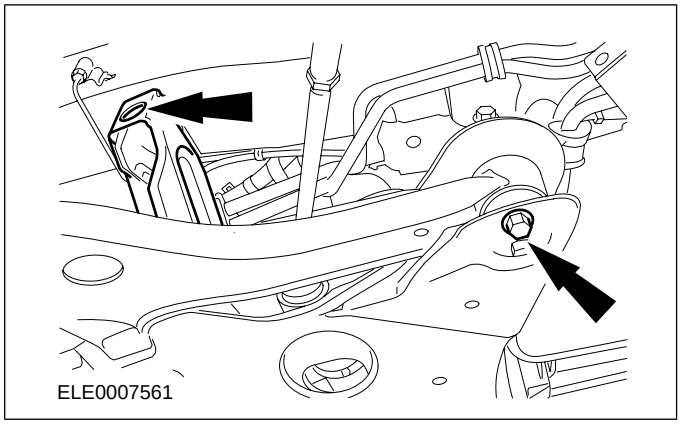
1. Remove the front axle to bracket retaining bolts.
2. Remove the bracket to transmission retaining bolts.



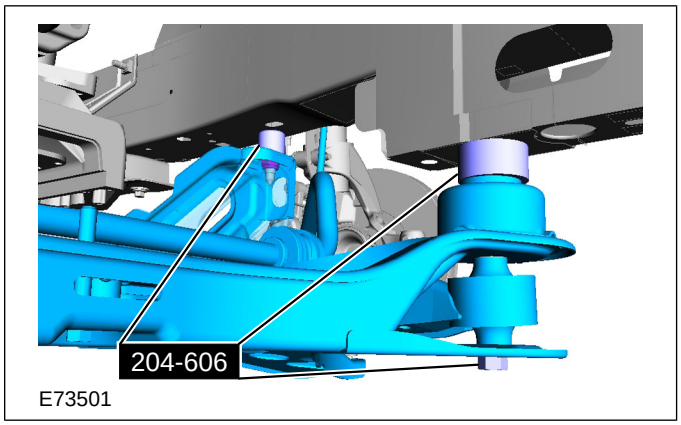
14. Using a suitable transmission jack, support the front axle crossmember.



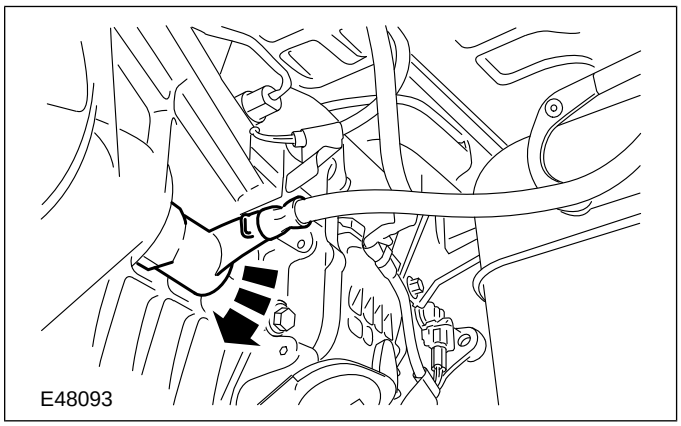
15. Lower the front axle crossmember 150 mm (left-hand side shown).



16. Using the special tool, lower the front axle.



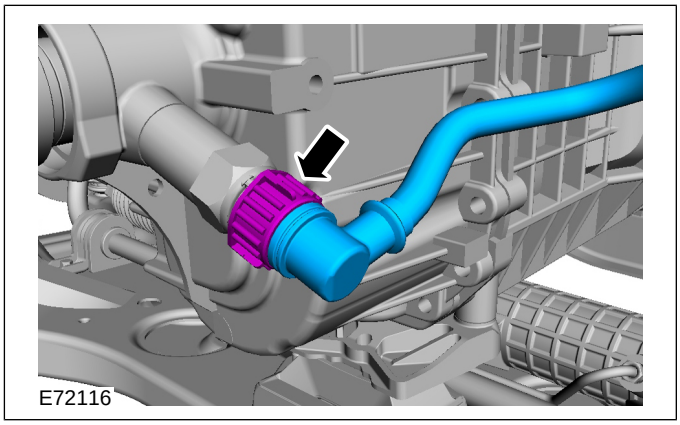
17. Turning the clutch slave cylinder counterclockwise, detach the clutch slave cylinder from the transmission.



REMOVAL

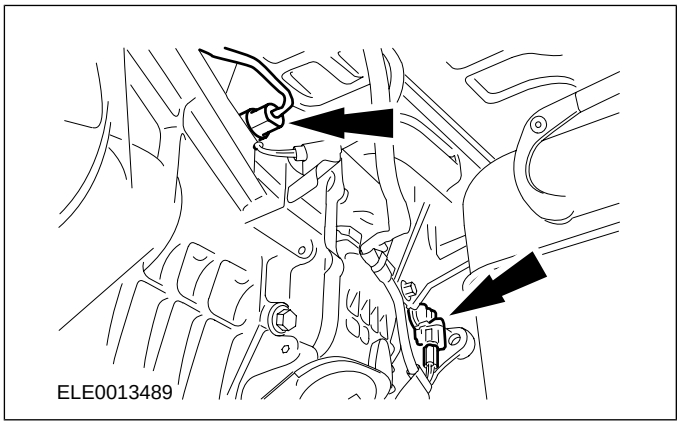
Vehicles with tachograph

18. **Disconnect the tachograph sensor electrical connector.**

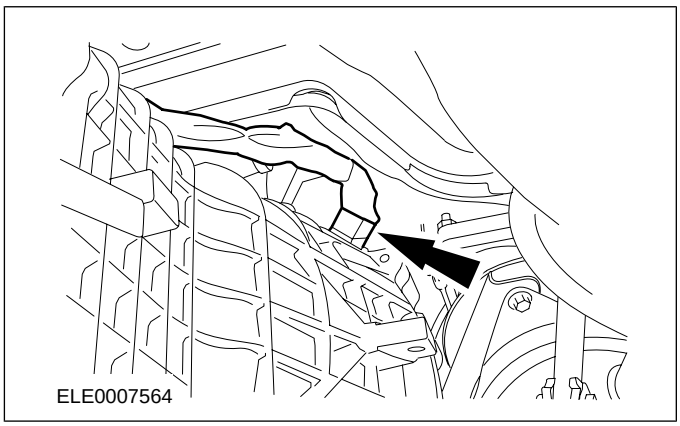


All vehicles

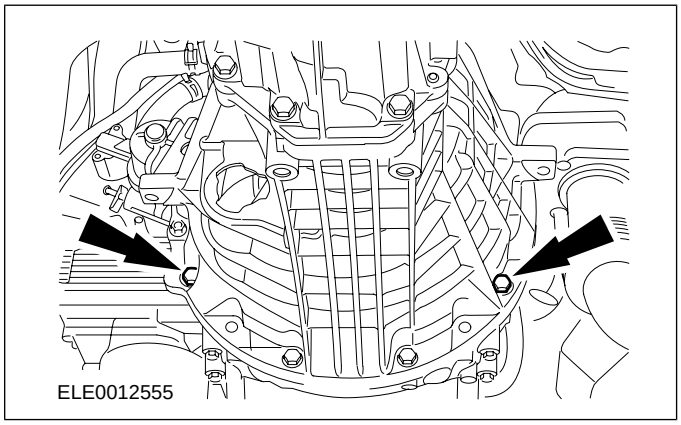
19. **Disconnect the reversing lamp switch and the vehicle speed sensor (VSS) electrical connectors.**



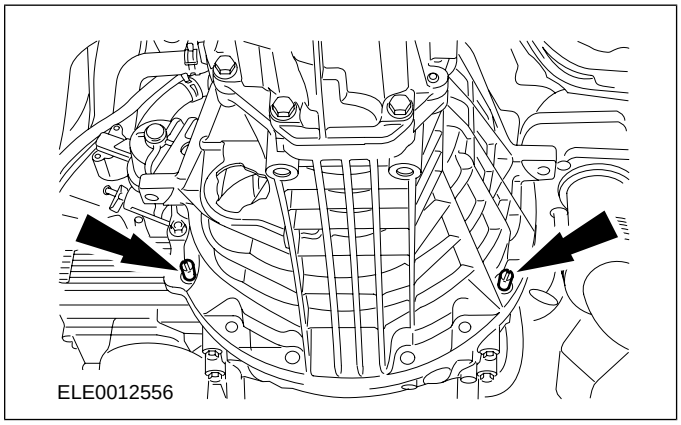
20. **Detach the heat shield and disconnect the crankshaft position (CKP) sensor.**



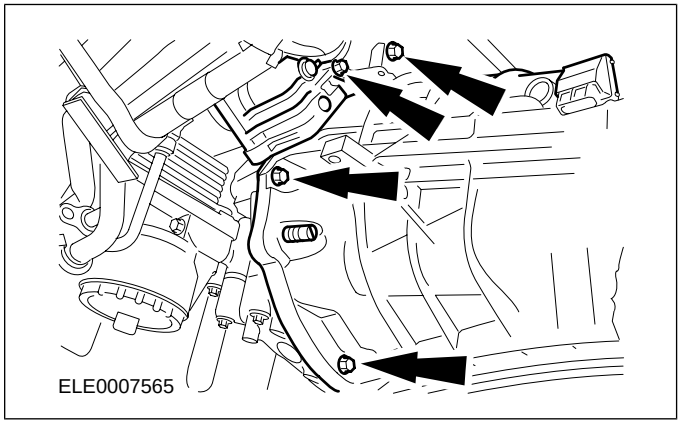
21. **Remove one transmission retaining bolt from the right-hand side and one from the left-hand side.**



22. **Install the M10 x 60 mm locating studs.**

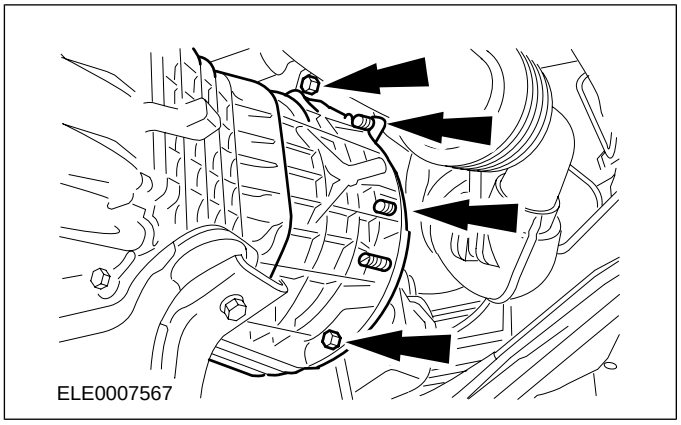


23. **Remove the remaining transmission retaining bolts from the left-hand side.**



REMOVAL

24. Remove the remaining transmission retaining bolts from the right-hand side.



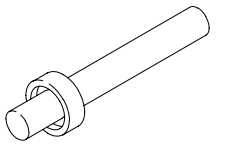
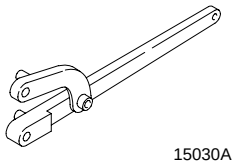
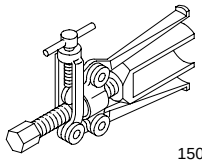
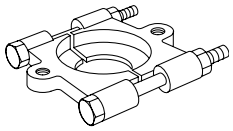
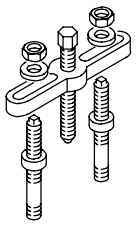
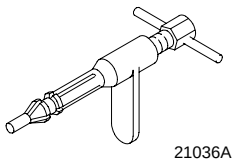
25. CAUTION:Do not tilt the transmission during removal. This may cause damage to the pilot bearing.

Remove the transmission.

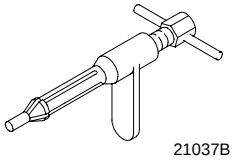
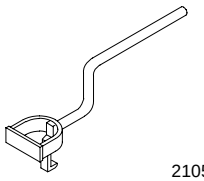
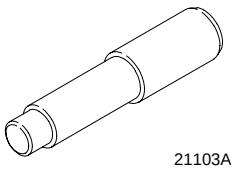
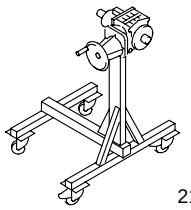
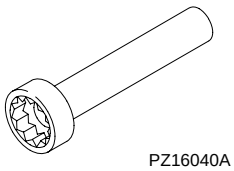
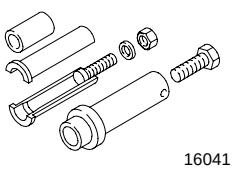
DISASSEMBLY

Transmission

Special Tool(s)

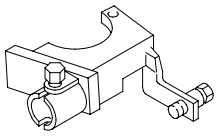
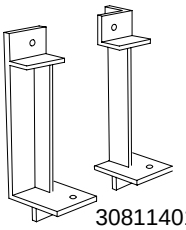
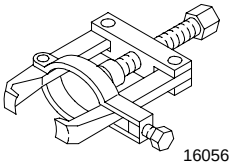
 15025A	Installer, Differential Bearing 205-062 (15-025A)
 15030A	Flange Holding Wrench, Universal 205-072 (15-030A)
 15048	Remover, Drive Pinion Oil Seal 205-078 (15-048)
 TI15091	Remover, Bearing/Gear 205-310 (15-091)
 15092	Remover, Bearing/Gear 205-311 (15-092)
 21036A	Remover, Crankshaft Pilot Bearing 303-078 (21-036A)

Special Tool(s)

 21037B	Remover, Crankshaft Pilot Bearing 303-079 (21-037B)
 21051	Remover, Oil Seal 303-112 (21-051)
 21103A	Aligner, Clutch Plate 303-173 (21-103A)
 21187	Mounting Stand 303-435 (21-187)
 PZ16040A	Socket, Guide Sleeve 308-109 (16-040A)
 16041	Remover/Installer, Front Housing 308-110 (16-041)

DISASSEMBLY

Special Tool(s)

 16045	Mounting Bracket for 303-435 308-114 (16-045)
 30811401	Mounting Brackets for 308-114 308-114-01 (16-045-01)
 16056	Remover, Mainshaft Needle Bearing Sleeve 308-191 (16-056)

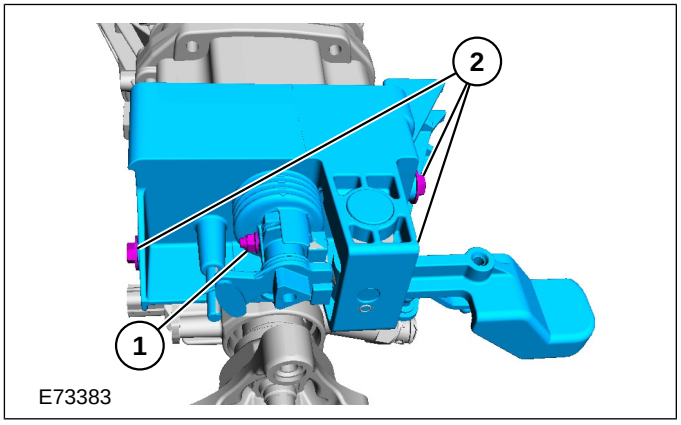
Disassembly

All vehicles

NOTE: All the bearings are paired and must not be mixed.

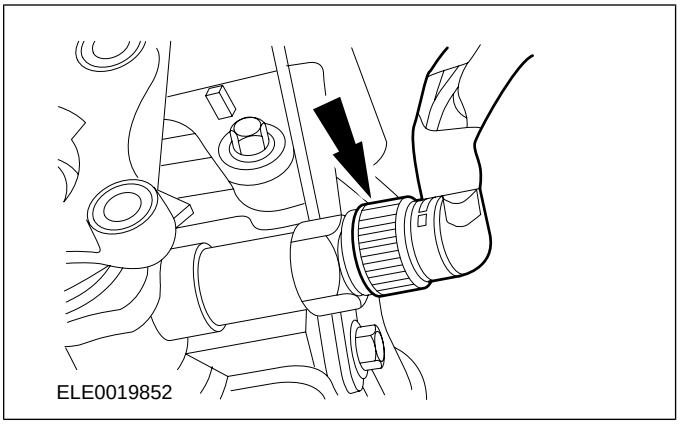
1. Remove the external gearshift control bracket.

1. Detach the selector shaft.
2. Remove the bolts.



Vehicles with tachograph

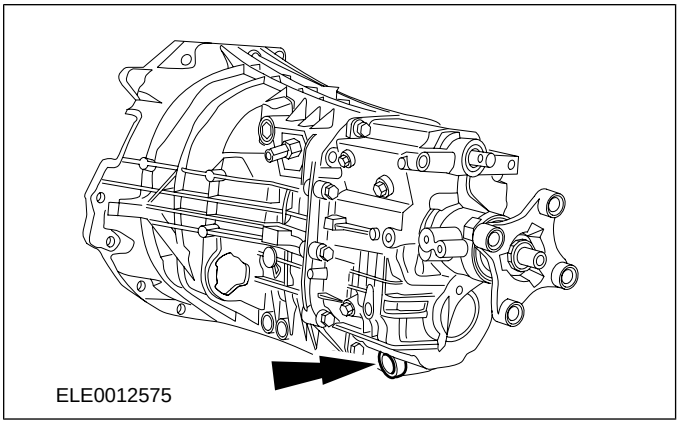
2. Remove the tachograph sensor.



All vehicles

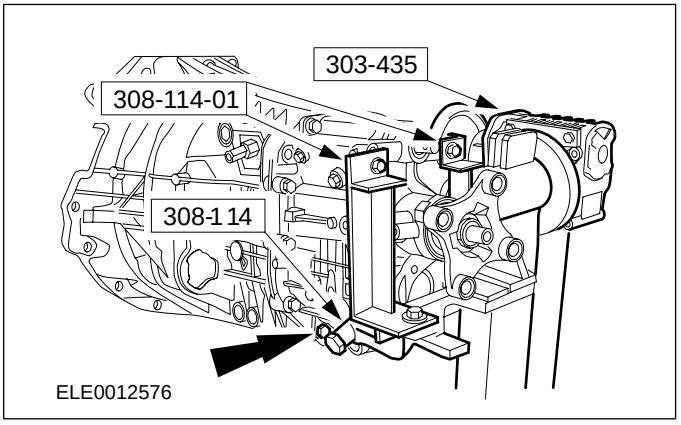
3. Drain the transmission.

- Remove the drain plug.
- Allow the oil to drain into a suitable container.



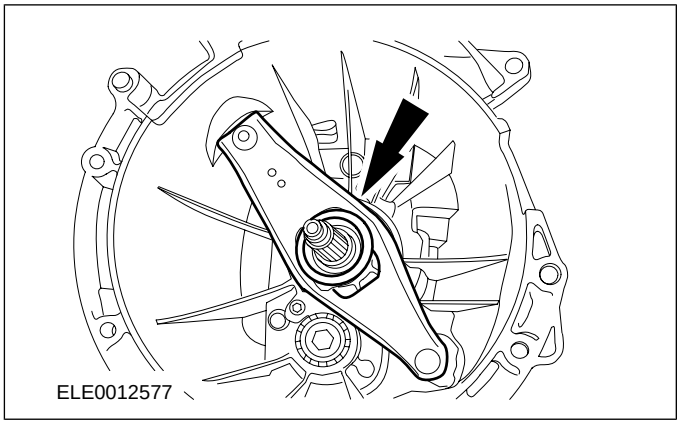
4. Mount the transmission on the mounting stand.

- Remove the transmission housing retaining bolt.



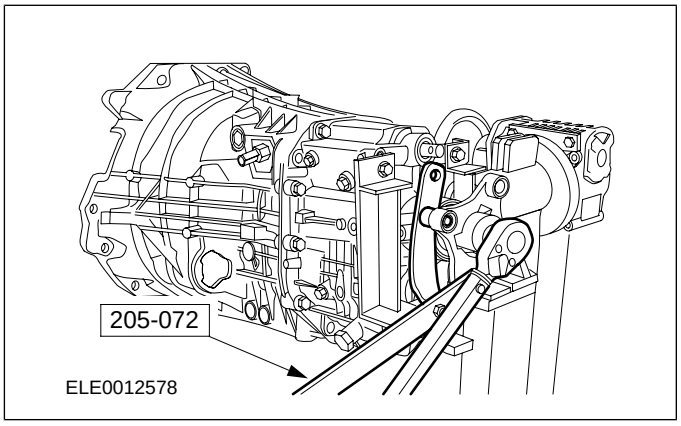
DISASSEMBLY

5. Remove the clutch release bearing and the clutch release lever.



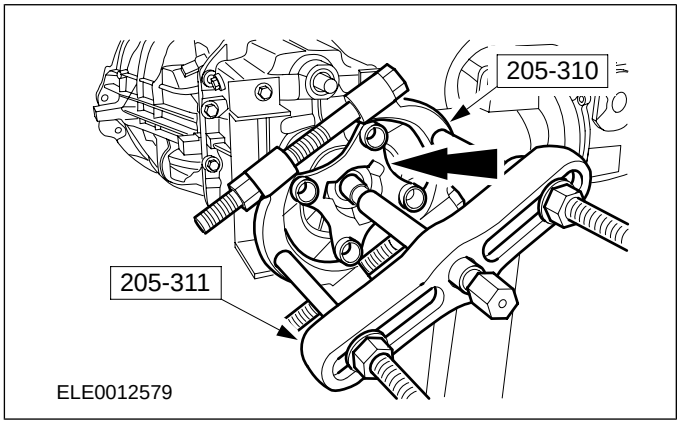
6. Using the special tool, remove the output shaft flange retaining nut.

- Discard the nut.

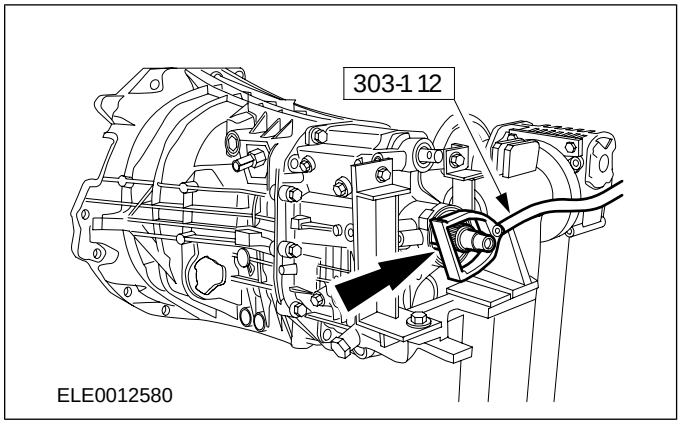


7. Using the special tools, remove the output shaft flange.

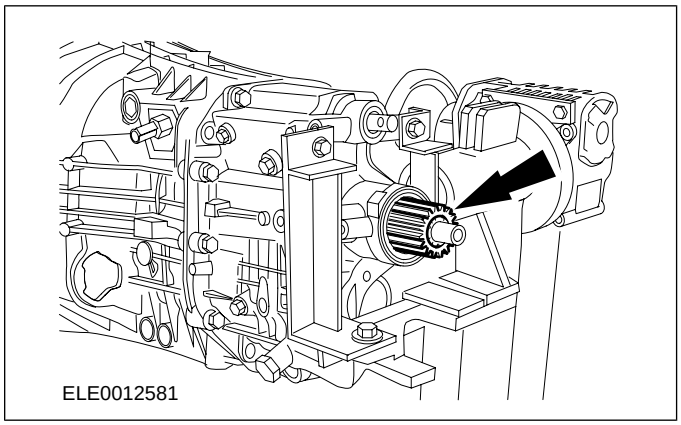
- Remove the splash shield.



8. Using the special tool, remove the output shaft oil seal.

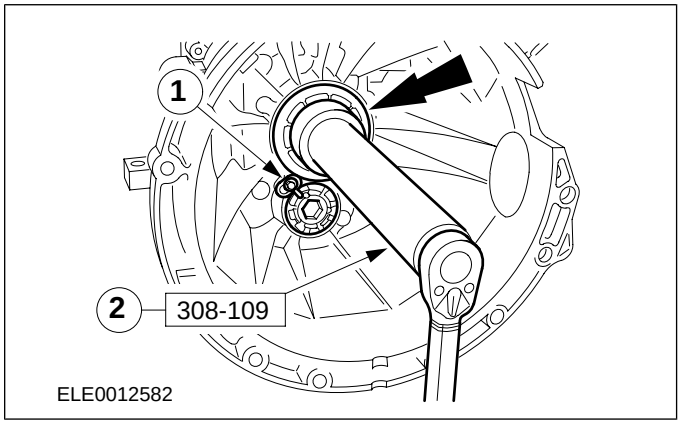


9. Remove the VSS ring.



10. Using the special tool, remove the input shaft guide sleeve.

1. Remove the bearing retainer locking plate.
2. Install the special tool and remove the guide sleeve.

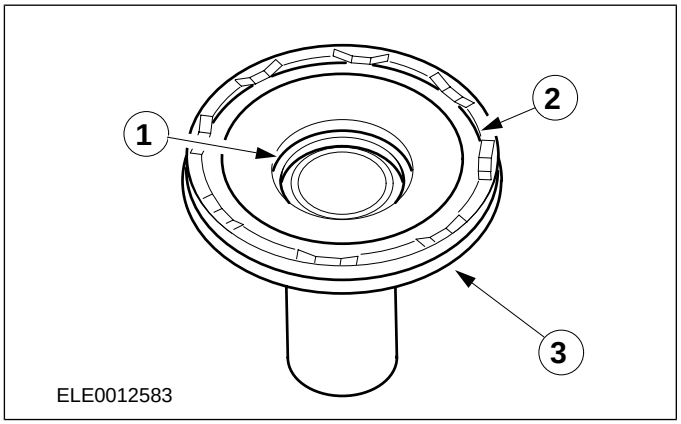


11. Disassemble the input shaft guide sleeve.

1. Remove the oil seal.
2. Remove the thrust washer.

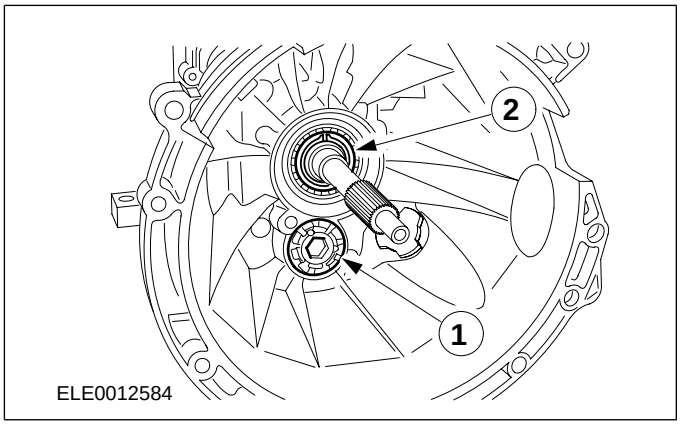
DISASSEMBLY

3. Remove the O-ring seal.

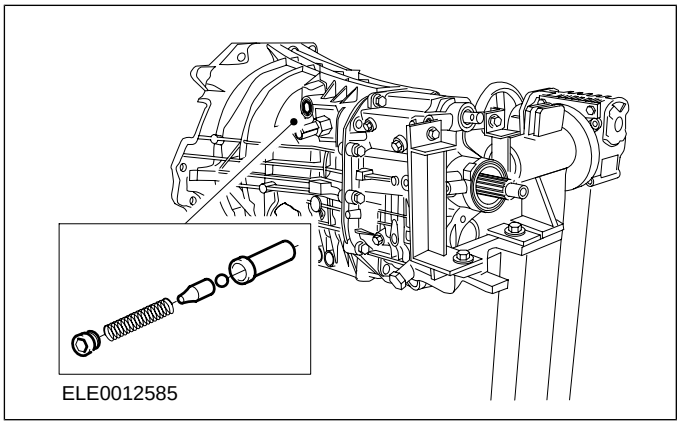


12. Remove the countershaft bearing.

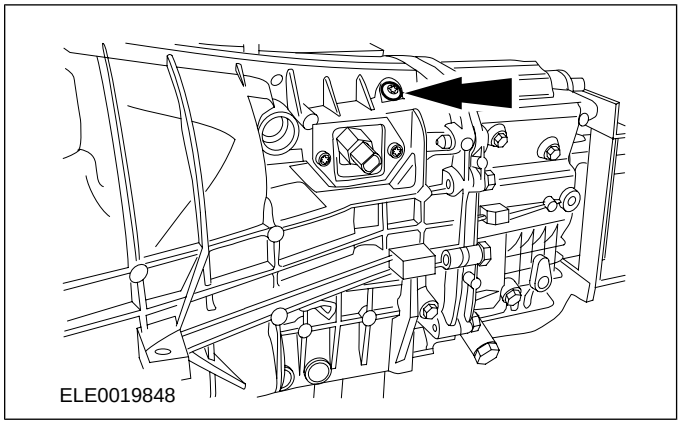
1. Remove the bearing retainer.
2. Remove the circlip.



13. Remove the selector interlock mechanism.

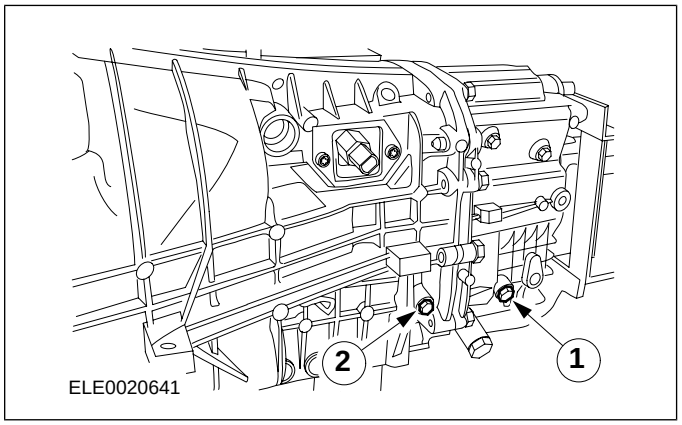


14. Remove the selector shaft locking plate bolt.

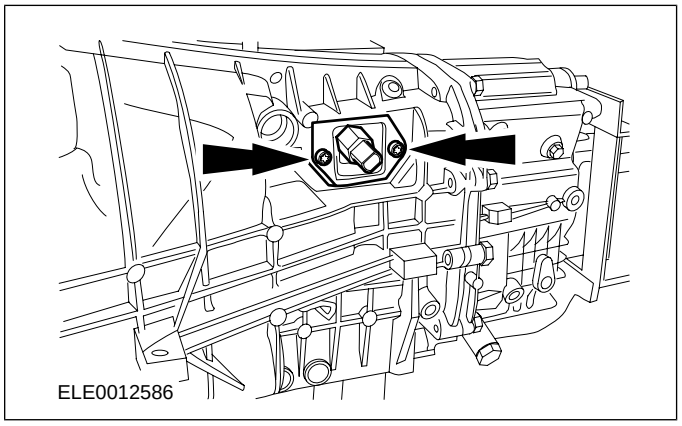


15. Loosen and remove the reverse gear idler shaft retaining bolts.

1. Loosen the retaining bolt.
2. Remove the retaining bolt.

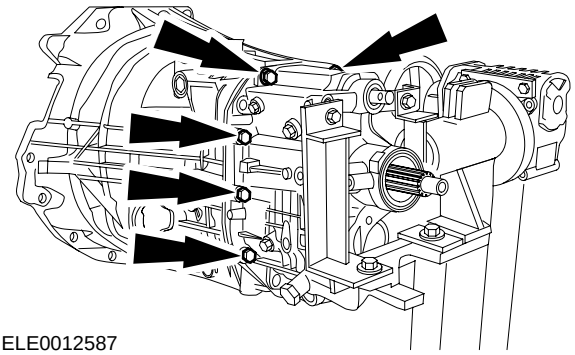


16. Remove the reversing lamp switch.

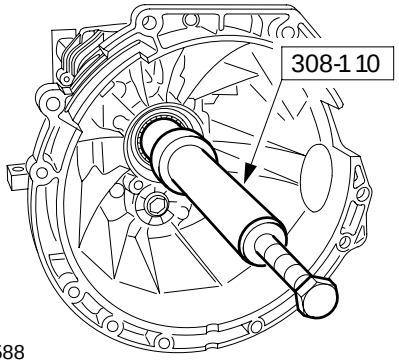


DISASSEMBLY

17. **Remove the transmission housing retaining bolts (nine bolts).**


ELE0012587

Using the special tool, remove the transmission front housing.



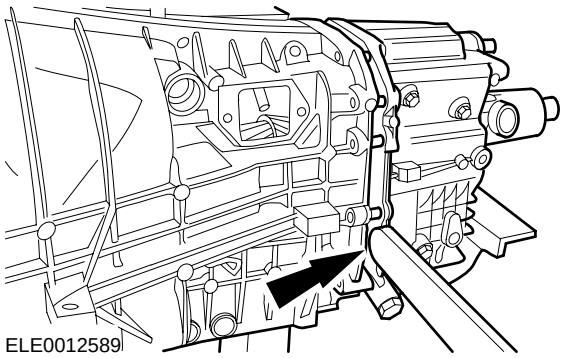
ELE0012588

18. **CAUTIONS:**

⚠Do not remove the housing locating dowels.

⚠Only apply leverage to the reinforcement ribs.

Using a suitable lever, separate the two halves of the transmission housing.

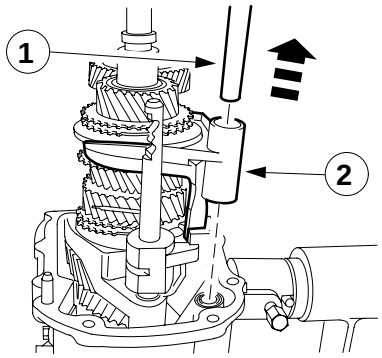

ELE0012589

19. **⚠CAUTION:Do not apply excessive pressure to the input shaft. This may cause damage to the fourth gear synchronizer ring.**

NOTE: Hold the special tool with a drift.

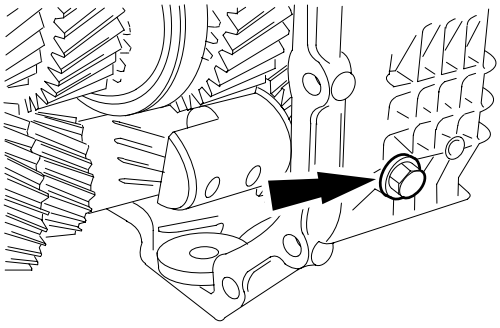
20. **Remove the third and fourth gear selector fork.**

1. Remove the auxiliary selector shaft.
2. Remove the selector fork.



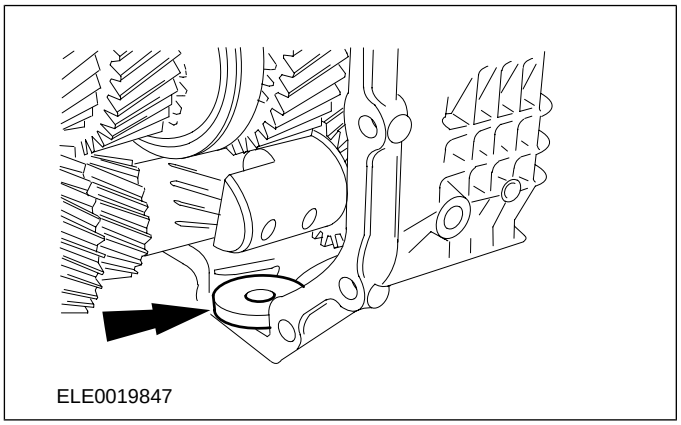
D1601161

21. **Remove the reverse gear idler shaft rear retaining bolt.**


ELE0019846

DISASSEMBLY

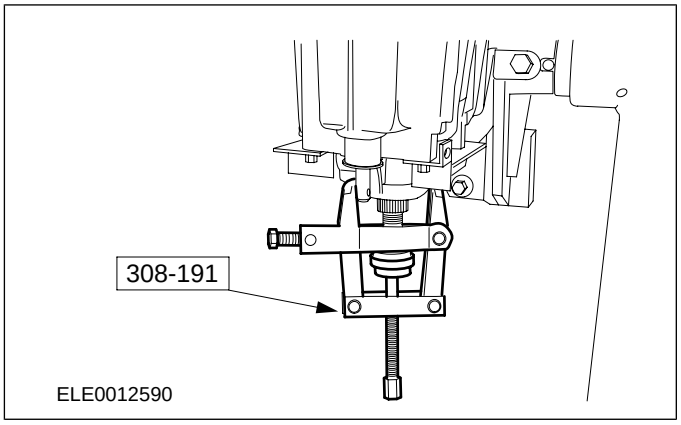
22. **Remove the magnetic disc.**



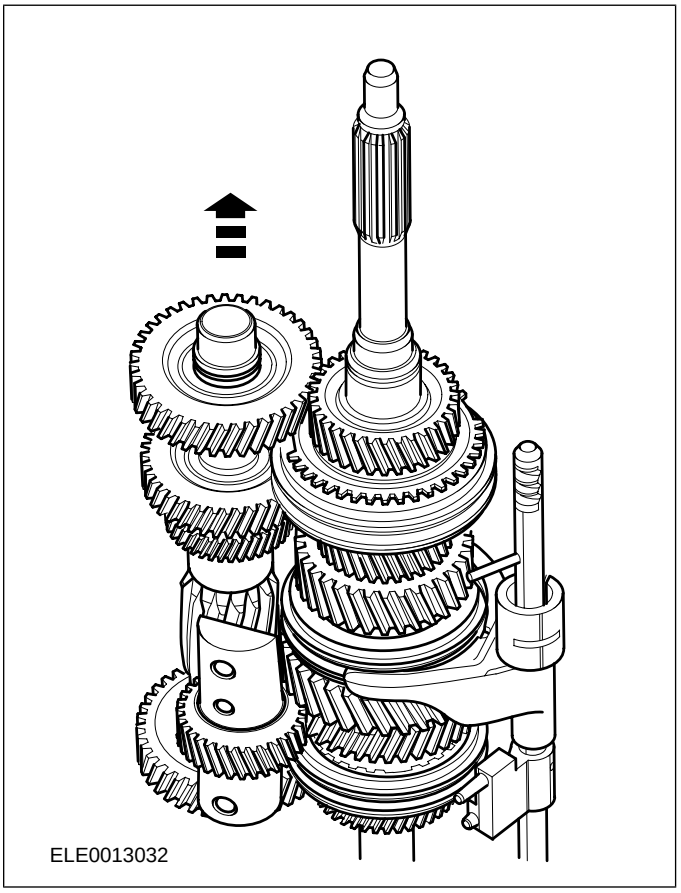
23. **⚠CAUTION:Move the main selector shaft to the NEUTRAL position. Failure to follow this instruction may result in damage to the shift finger.**

NOTE: Locate the special tool on the housing bosses.

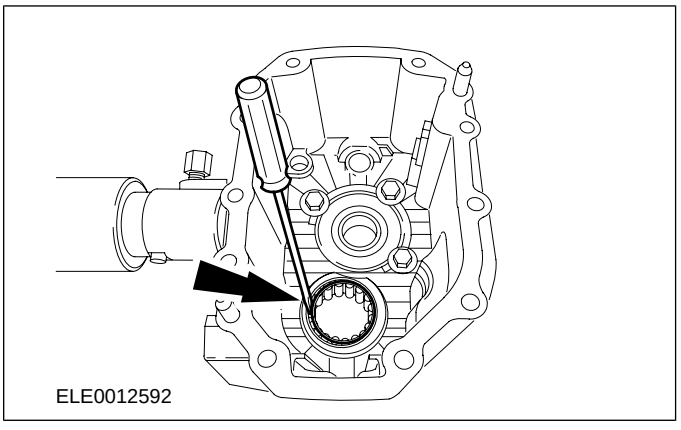
Using the special tool, remove the output shaft.



24. **Remove the mainshaft and countershaft assembly, the main selector shaft and the selector fork.**

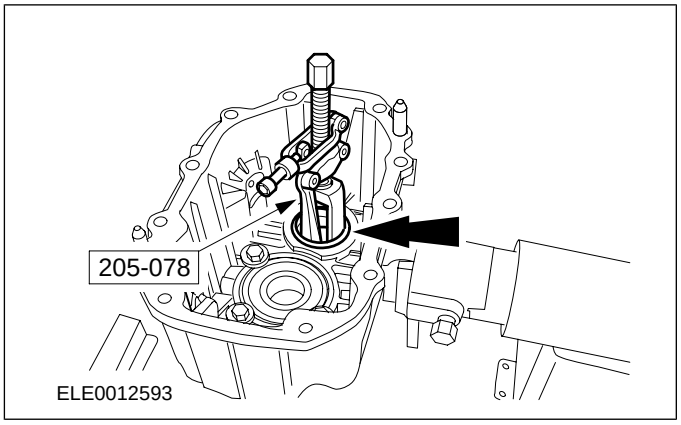


25. **Remove the countershaft rear bearing rollers.**



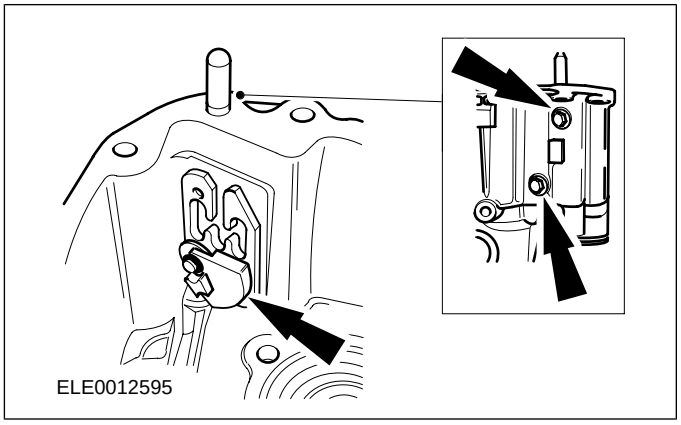
DISASSEMBLY

26. Using the special tool, remove the countershaft rear bearing.

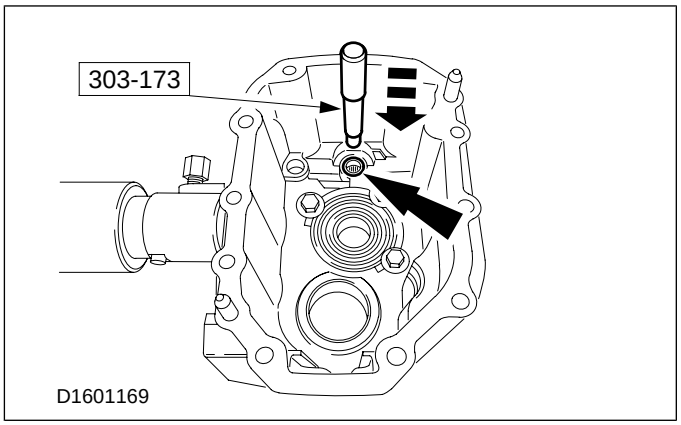


27. NOTE:Only remove the selector gate if it is damaged.

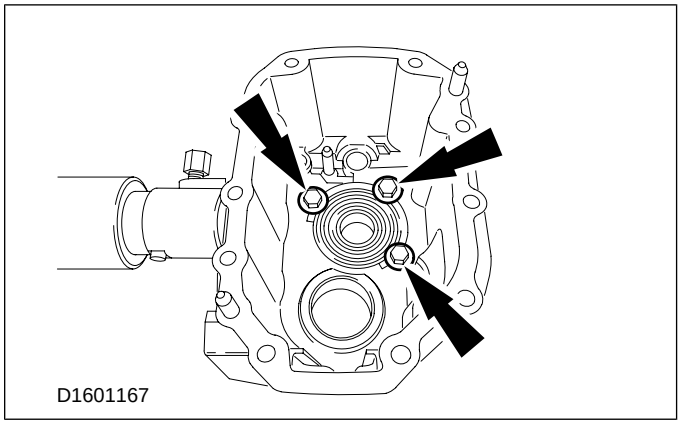
    Remove the selector gate.



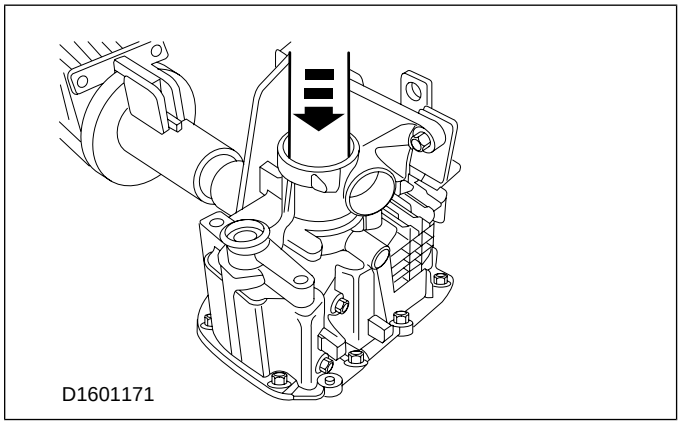
28. Using the special tool, remove the main selector shaft bearing and oil seal.



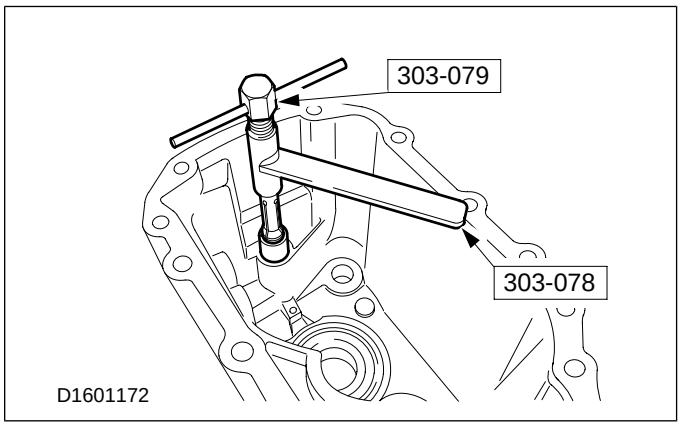
29. Remove the output shaft bearing retaining bolts.



30. Using a length of suitable tube, remove the output shaft bearing.

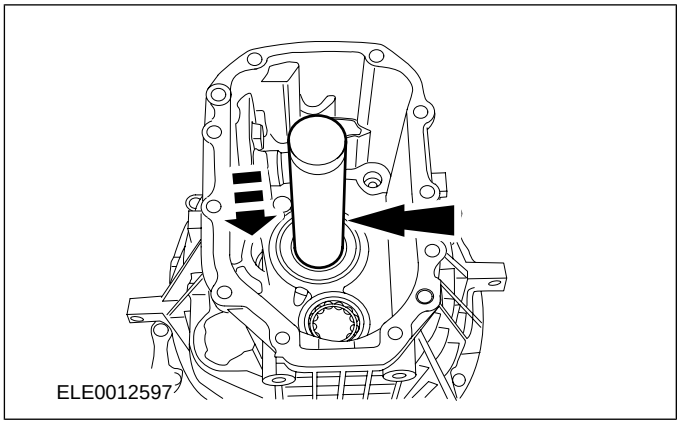


31. Using the special tools and a 63 mm spacer, remove the main selector shaft bearing.



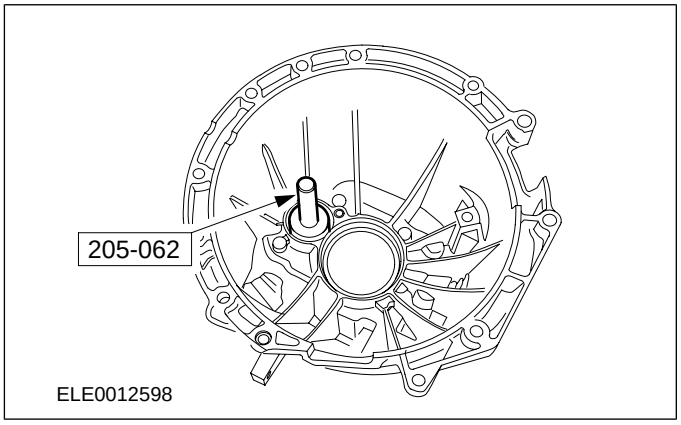
DISASSEMBLY

32. Using a length of suitable tube, remove the input shaft bearing.



33. CAUTION:Do not damage the thread in the transmission housing.

Using the special tool, remove the countershaft front bearing.



DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

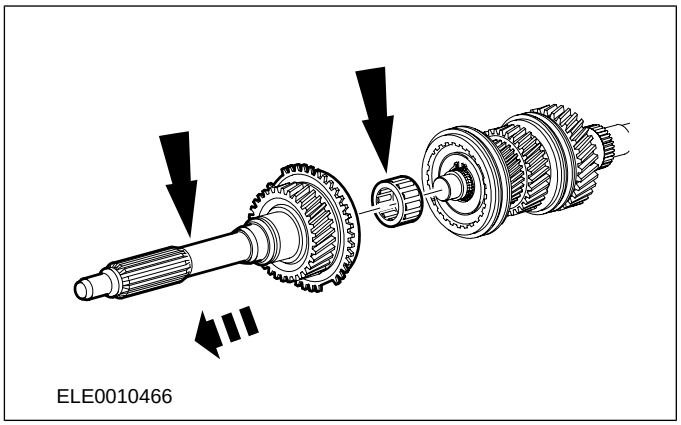
Input Shaft

Disassembly

1. **⚠CAUTION:Handle the synchronizer ring and synchronizer cone with care.**

   Remove the input shaft with the fourth gear synchronizer ring from the output shaft.

   - Remove the output shaft locating bearing.



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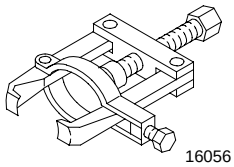
Assembly

1. **Carefully clean and check all parts and assemble the parts in reverse order.**

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

Output Shaft

Special Tool(s)

 16056	Remover, Mainshaft Needle Bearing Sleeve 308 - 191 (16 - 056)

General Equipment

Hot air gun

Materials

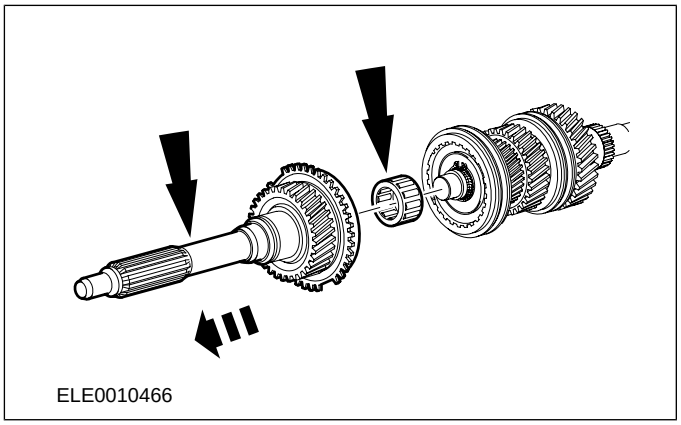
Name	Specification
Manual transmission fluid	WSD - M2C200 - C

Disassembly

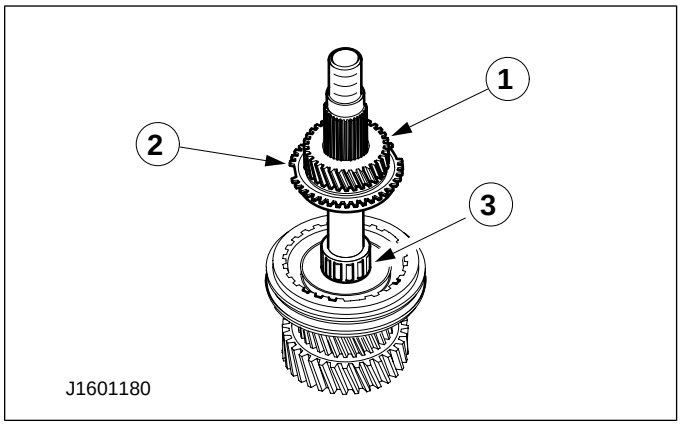
1. **CAUTION:Mark the position of the synchronizer rings in relation to the synchronizer units to aid installation.**

   Remove the input shaft and fourth gear synchronizer ring from the output shaft.

   - Remove the output shaft locating bearing.



2. **Remove the fifth gear wheel and synchronizer ring from the output shaft.**
   1. Remove the gear wheel.
   2. Remove the gear synchronizer ring.
   3. Remove the needle roller bearing.

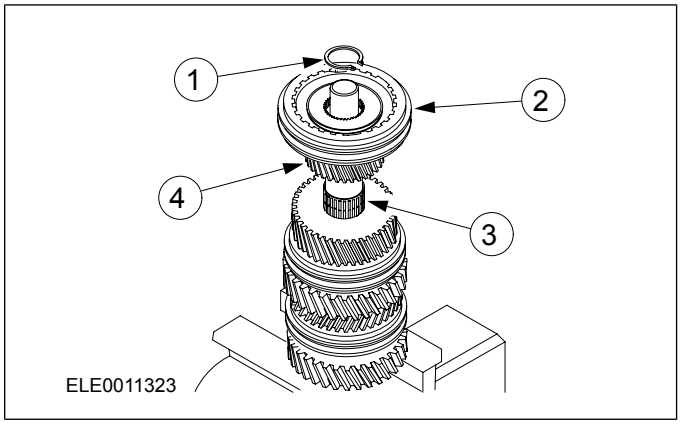


3. **WARNING:Do not allow the synchronizers to fall apart. Failure to follow these instructions may result in personal injury.**

   CAUTION:Use soft jaws for all operations in a vise.

   NOTE: Clamp the output shaft in a vise with the output end.

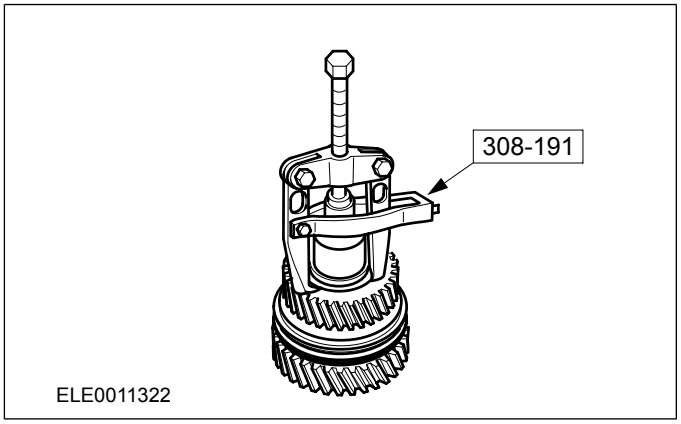
   Remove the third/fourth gear synchronizer unit together with the third gear wheel.
   1. Remove the circlip.
   2. Third/fourth gear synchronizer.
   3. Needle roller bearing.
   4. Third gear wheel.



4. **Using the special tool, remove the third gear bearing ring.**

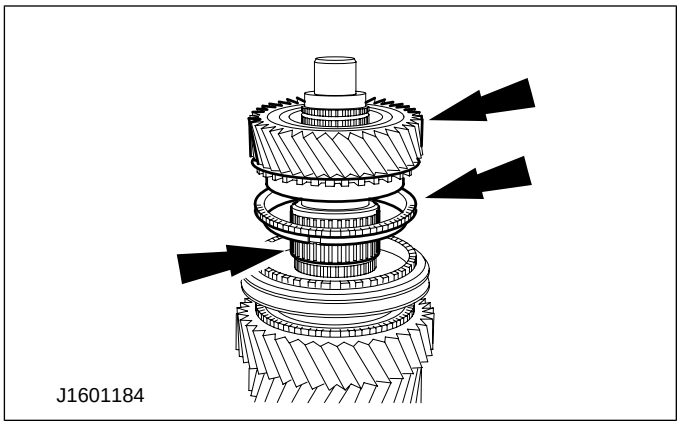
DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

- Locate the special tool in the recesses off the bearing ring.



5. **NOTE:Mark the position of the second gear wheel in relation to the synchronizer ring to aid installation.**

   Remove the second gear wheel, the needle roller bearing and synchronizer ring.

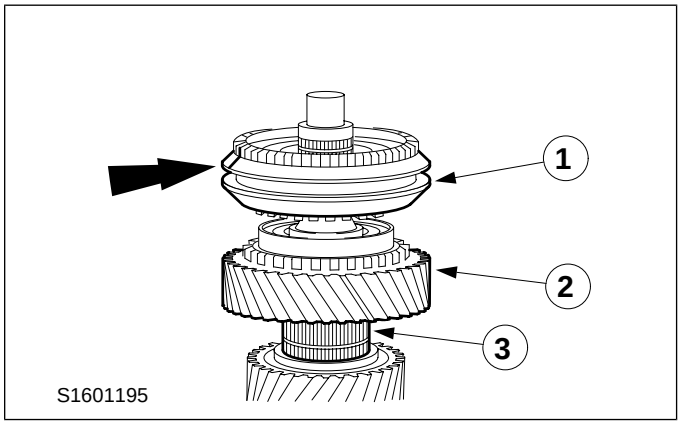


6. **NOTE:Mark the position of the shift ring in relation to the first gear wheel to aid installation.. Components are paired.**

NOTE: Remove the circlip.

Remove the first/second gear synchronizer and the first gear wheel.

1. First/second gear synchronizer.
2. First gear wheel.
3. Needle roller bearing.



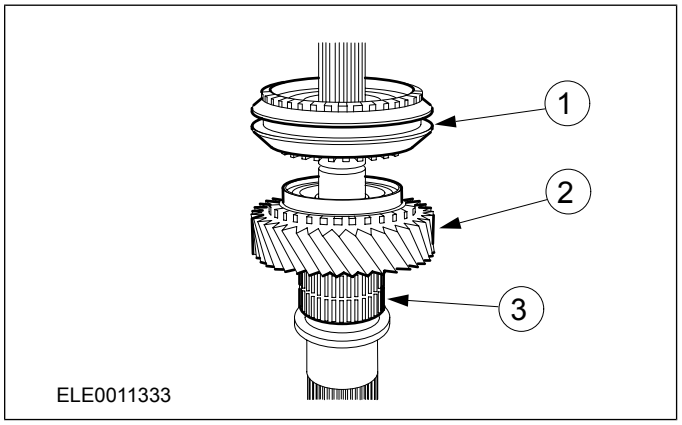
7. **NOTE:Mark the position of the shift ring in relation to the reverse gear wheel to aid installation. Components are paired.**

NOTE: Clamp the output shaft the other way round in the vise.

NOTE: Remove the circlip.

Remove the fifth/reverse gear synchronizer, the reverse gear wheel and needle roller bearing.

1. Fifth/reverse gear synchronizer.
2. Reverse gear wheel.
3. Needle roller bearing.

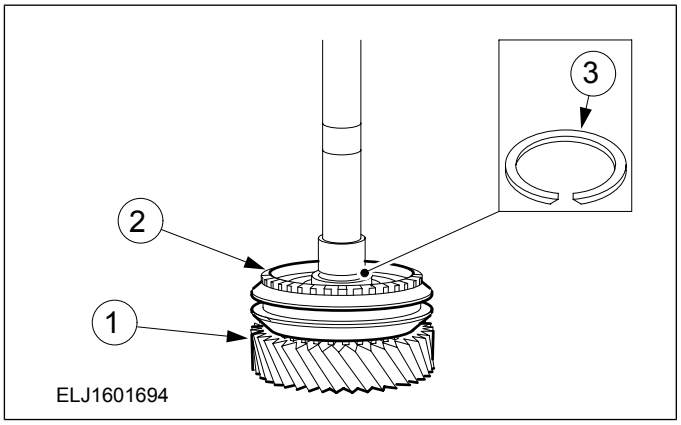


Assembly

1. **Carefully clean and check all sliding parts and lubricate the synchronizer rings with Manual transmission fluid before assembly.**
2. **Install the needle roller bearing, reverse gear wheel and synchronizer unit.**
   1. Install the reverse gear wheel.
   2. Install the synchronizer.

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

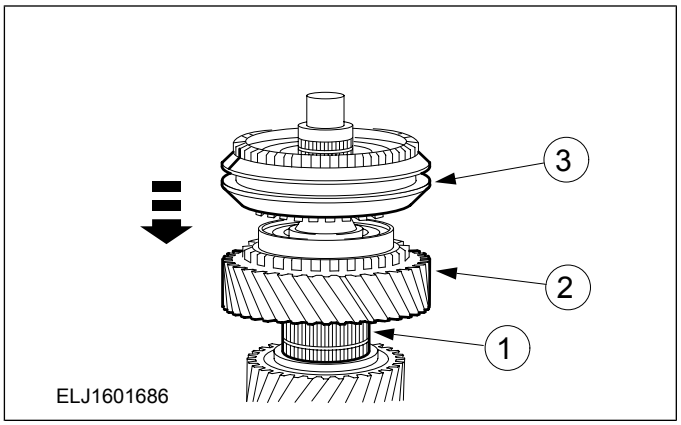
3. Install the snap ring.



3. Install the first/second gear synchronizer unit.

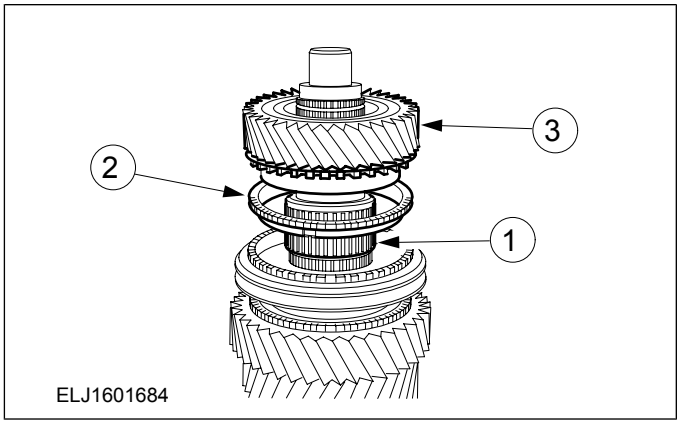
1. Install the needle roller bearing.
2. Install the gear wheel.
3. Install the synchronizer unit.

- Install the circlip.



4. Install the synchronizer ring, needle roller bearing and second gear wheel.

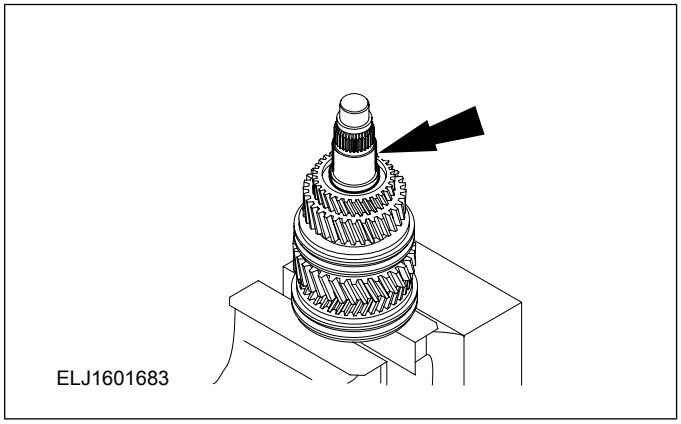
1. Install the needle roller bearing.
2. Install the synchronizer ring.
3. Install the gear wheel.



5. NOTE:Slide the inner bearing ring onto the output shaft as far as the shoulder.

NOTE: Install a new inner bearing ring and needle bearing.

Using a hot air gun heat the inner bearing ring to approximately 100 ° C and install it.

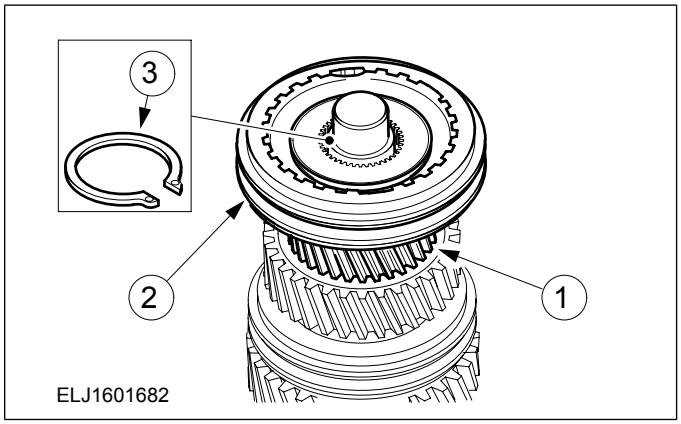


6. NOTE:Install the synchronizer with the small collar upwards.

NOTE: Install the needle roller bearing.

Install the third/fourth gear synchronizer.

1. Install the gear wheel.
2. Install the synchronizer.
3. Install the circlip.

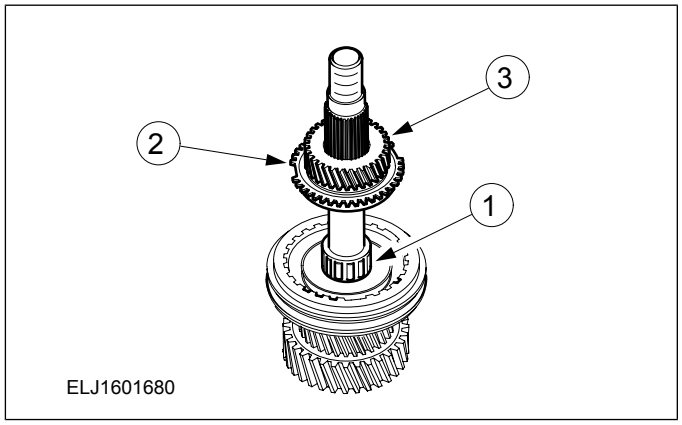


7. Install the fifth gear wheel.

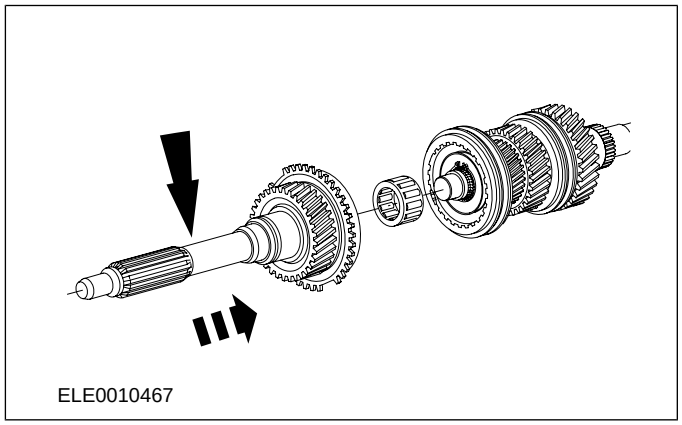
1. Install the needle roller bearing.
2. Install the synchronizer ring.

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

3. Install the gear wheel.



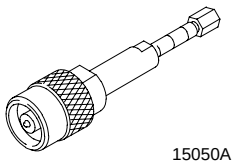
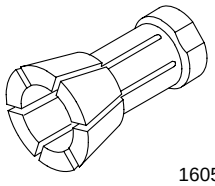
8. Install the output shaft locating bearing, synchronizer ring and the input shaft.



DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

Countershaft

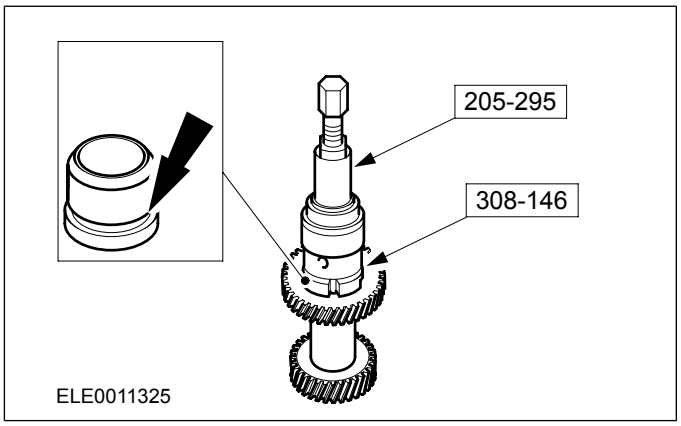
Special Tool(s)

 15050A	Remover, Bearing (Main Tool) 205-295 (15-050A)
 16050	Collet for 205-295 308-146 (16-050)

Disassembly

1. **NOTE:Insert the special tool in the annular groove provided in the ring.**

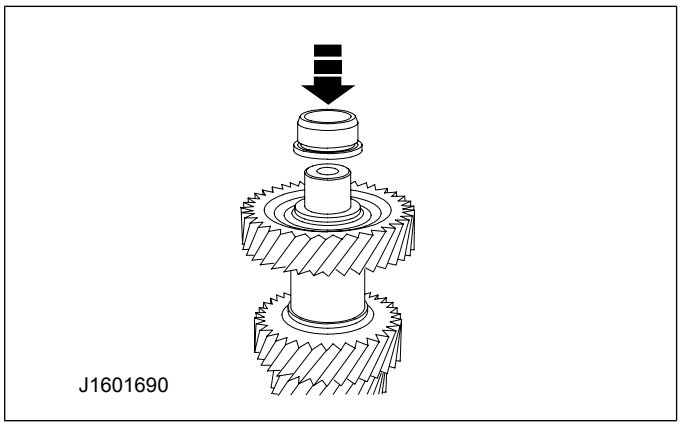
   Using the special tools, pull the bearing rings off the countershaft.



Assembly

1. **Install the bearing rings.**

- Heat the bearing rings to approximately 100°C and slide on.



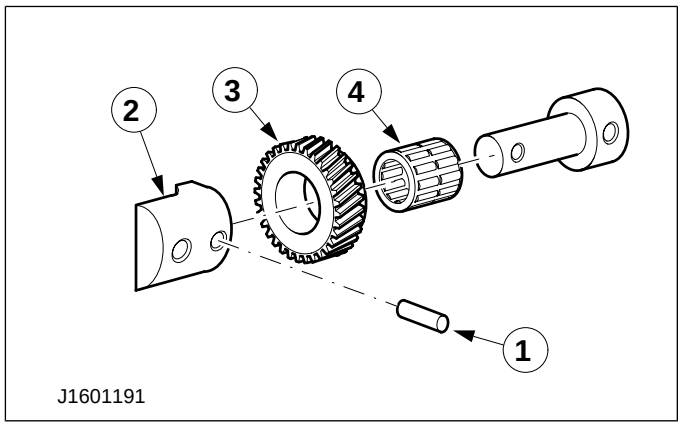
DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

Reverse Idler Gear

Disassembly

1. Disassemble the reverse gear idler shaft.

1. Drive out the roll pin.
2. Remove the bearing housing.
3. Remove the reverse idler gear.
4. Remove the needle roller bearing.



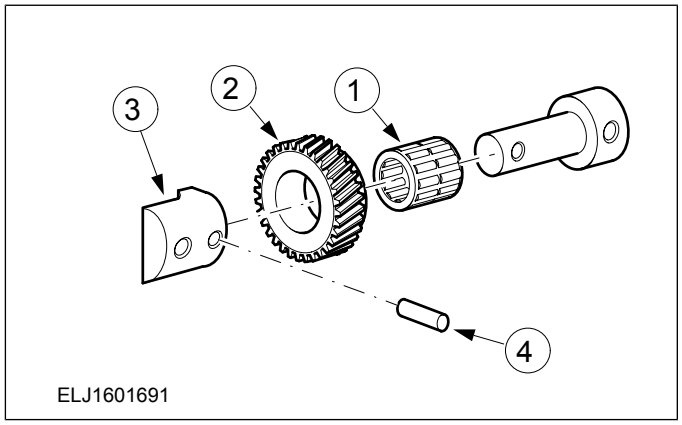
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Assembly

1. NOTE:Do not install the bearing housing twisted. The threaded holes must line up with one another.

Assemble the reverse gear idler shaft.

1. Install the needle roller bearing.
2. Install the reverse idler gear.
3. Install the bearing housing.
4. Drive in the roll pin.



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DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

Synchronizers

Materials	
Name	**Specification**
Manual transmission fluid	WSD-M2C200-C

Disassembly

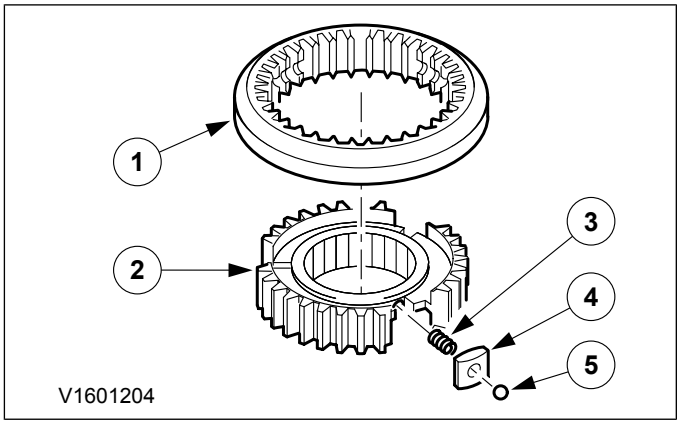
1. CAUTIONS:

⚠ Take care when pulling the selector ring off the synchronizer hub. The detent balls are spring-loaded.

⚠ Mark the synchronizers to the synchronizer hubs in relation to the selector rings.

Disassemble the synchronizer.

1. Selector ring.
2. Synchronizer hub.
3. Compression spring.
4. Blocker bar.
5. Detent ball.

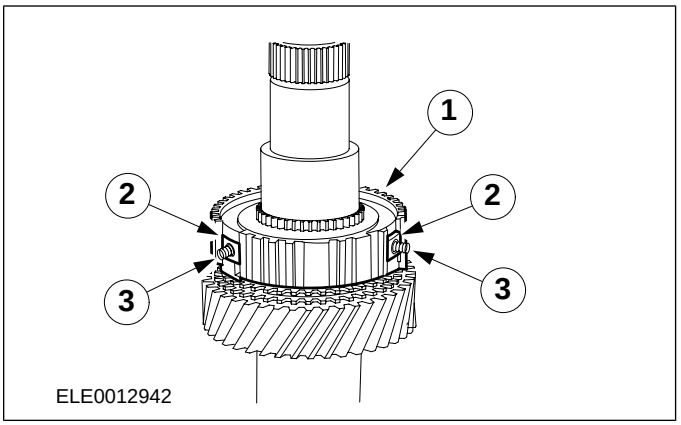


Assembly

1. NOTE:Carefully clean and check all sliding parts and lubricate them with Manuel transmission fluid before assembly.

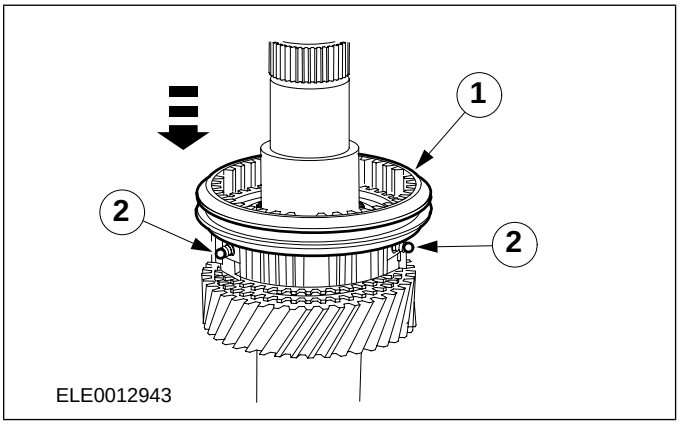
Assemble the inner synchronizer.

1. Synchronizer inner ring.
2. Blocker bars.
3. Compression springs.



2. Assemble the outer synchronizer.

1. Synchronizer outer ring.
2. Detent balls.



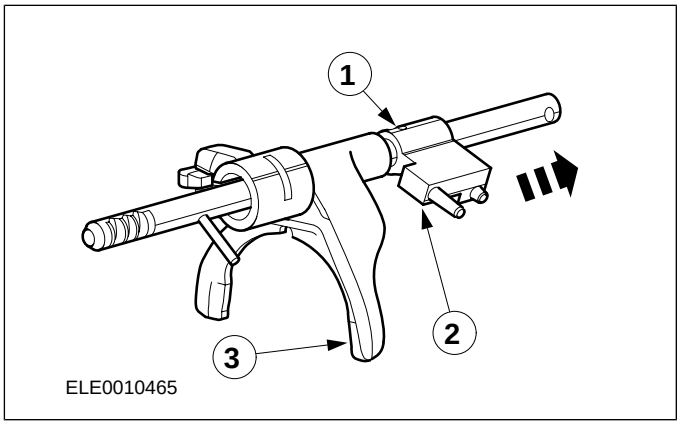
DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

Gearshift Control Shaft

Disassembly

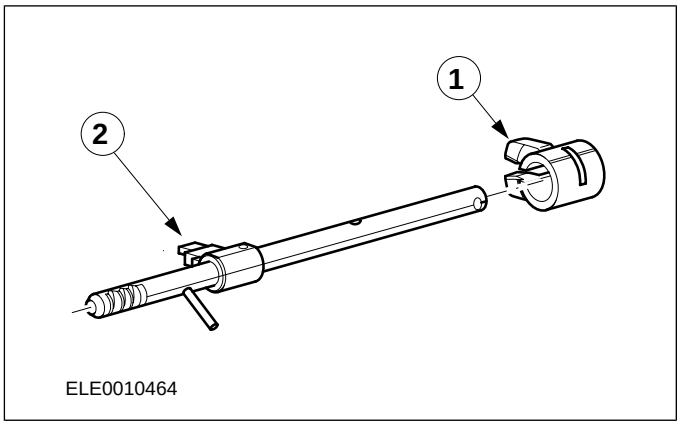
1. Disassemble the gearshift control shaft.

1. Remove the roll pin.
2. Remove the shift finger.
3. Remove the selector fork.



2. Disassemble the gearshift control shaft (continued)

1. Remove the locking sleeve.
2. Remove the roll pin and the selector finger.



Assembly

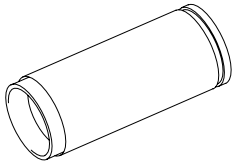
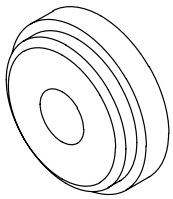
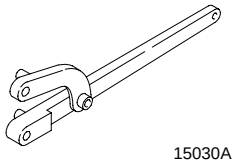
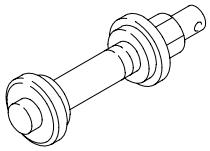
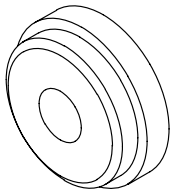
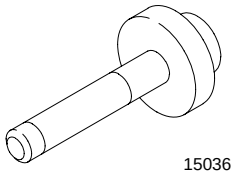
1. NOTE:Make sure that the roll pins do not protrude.

To assemble, reverse the disassembly procedure.

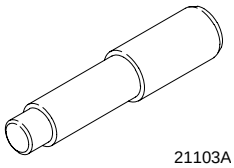
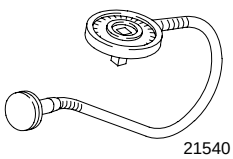
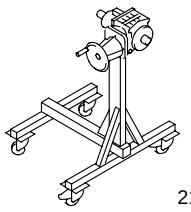
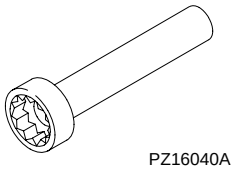
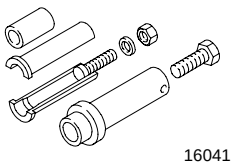
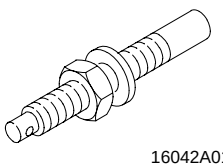
ASSEMBLY

Transmission

Special Tool(s)

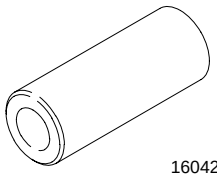
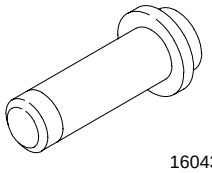
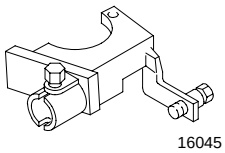
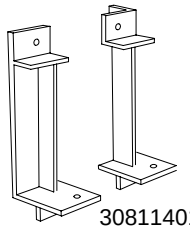
 204276	Installer, Wear Sleeve Stub Axle 204-276 (14-055)
 15068	Adapter for 205-066 205-066-04 (15-068)
 15030A	Flange Holding Wrench, Universal 205-072 (15-030A)
 15035	Installer, Differential Bearing Cone 205-074 (15-035)
 15064	Adapter for 205-074 205-074-01 (15-064)
 15036	Installer, Rear Hub Oil Seal 205-075 (15-036)

Special Tool(s)

 21103A	Aligner, Clutch Plate 303-173 (21-103A)
 21540	Angle Gauge, Bolt Tightening 303-174 (21-540)
 21187	Mounting Stand 303-435 (21-187)
 PZ16040A	Socket, Guide Sleeve 308-109 (16-040A)
 16041	Remover/Installer, Front Housing 308-110 (16-041)
 16042A01	Threaded Spindle 308-111 (16-042A-01)

ASSEMBLY

Special Tool(s)

 16042A	Adapter for 308-111 308-111-01 (16-042A)
 16043A	Installer, Output Drive Flange Oil Seal 308-112 (16-043A)
 16045	Mounting Bracket for 303-435 308-114 (16-045)
 30811401	Mounting Brackets for 308-114 308-114-01 (16-045-01)

General Equipment

17 mm socket

Materials

Name	Specification
Manual transmission fluid	WSD-M2C200-C
Sealant	WSS-M2G348-A10
Sealant	ESK-M4G242-A
Grease	ESD-M2C220-A

Assembly

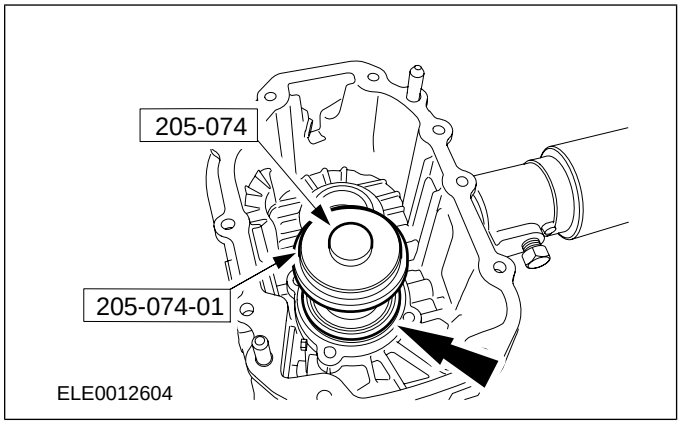
All vehicles

1. **NOTE:Lubricate all moving parts with manual transmission fluid during assembly.**

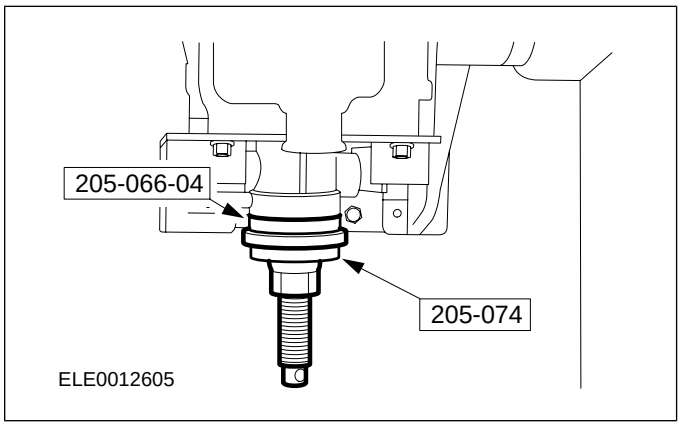
NOTE: Clean and check all parts for wear and damage. Install new parts as necessary.

NOTE: When installing a new transmission rear housing, install the locating studs with a 24 ± 0.5 mm protrusion.

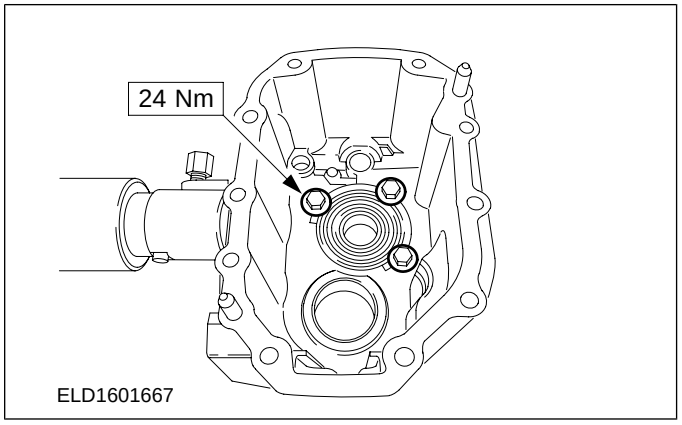
Using the special tools, install the output shaft bearing.



2. **Using the special tools, install the output shaft bearing.**

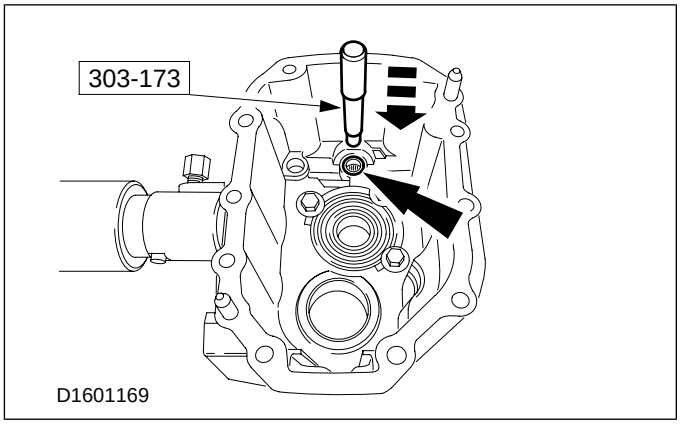


3. **Install the output shaft bearing retaining bolts.**

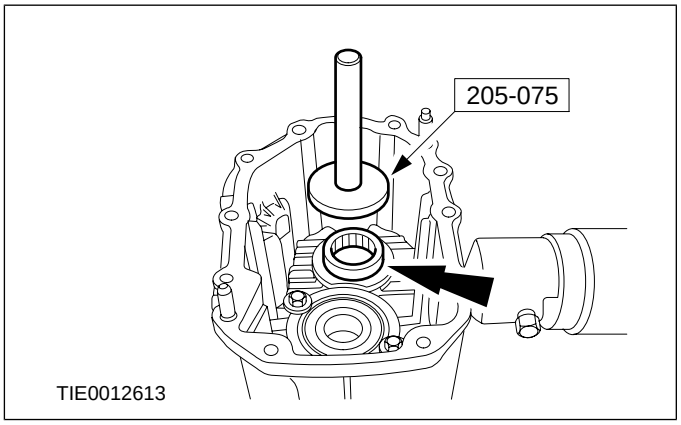


ASSEMBLY

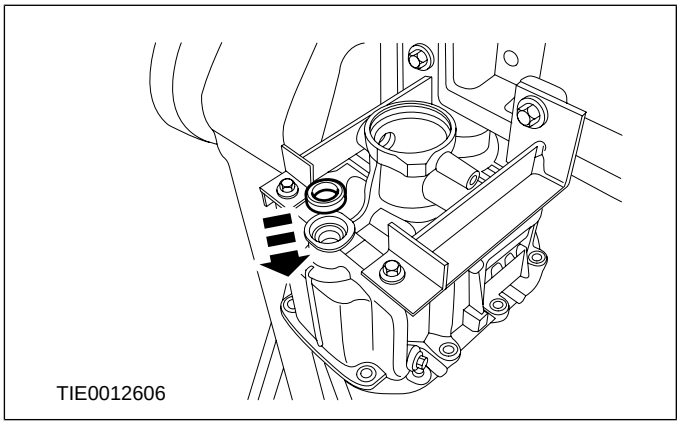
4. **Using the special tool, install the main selector shaft bearing.**



5. **Using the special tool, install the countershaft rear bearing.**

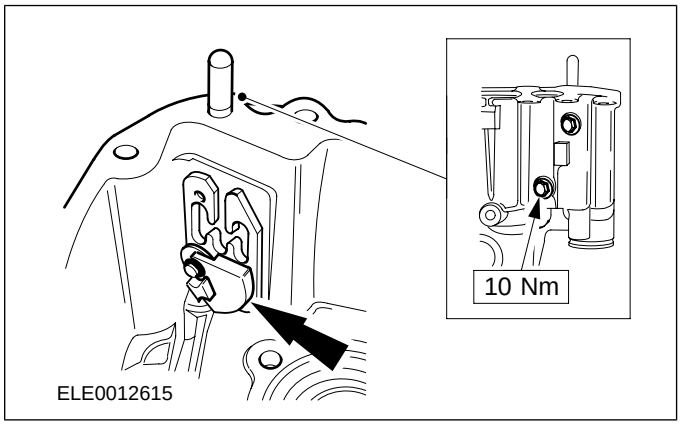


6. **Coat the lip of the main selector shaft oil seal with grease.**
7. **Using a 17 mm socket, install the main selector shaft oil seal.**



8. **NOTE:Install new selector gate retaining bolts.**

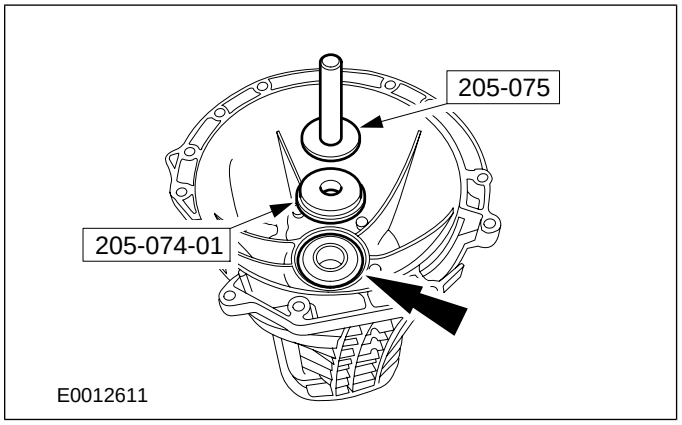
   Install the selector gate.



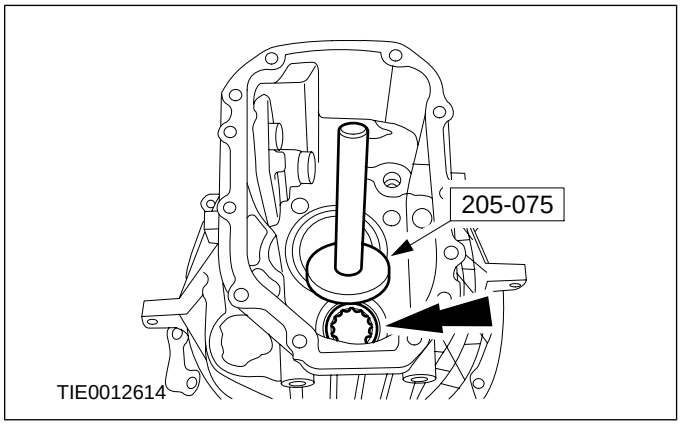
9. **NOTE:Install a new input shaft bearing snap ring.**

   Using the special tools, install the input shaft bearing.

   - Install the snap ring in the annular groove of the bearing.

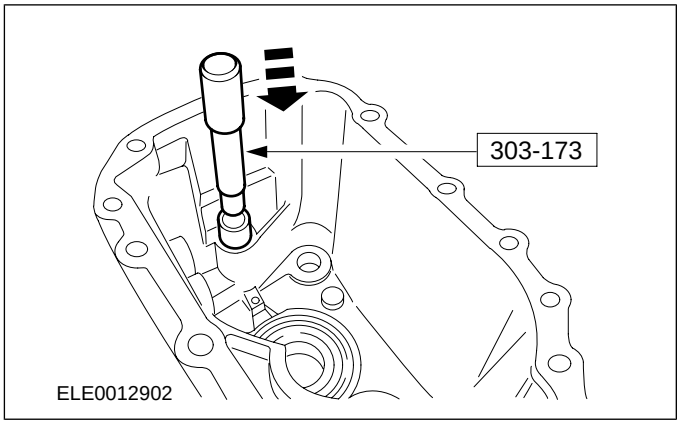


10. **Using the special tool, install the countershaft front bearing.**

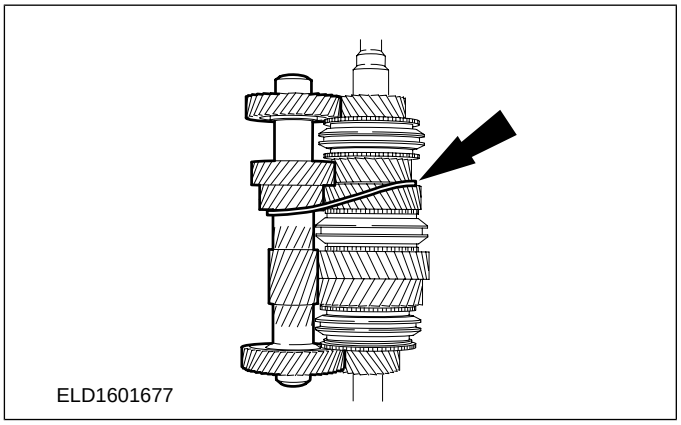


ASSEMBLY

11. **Using the special tool, install the main selector shaft bearing.**

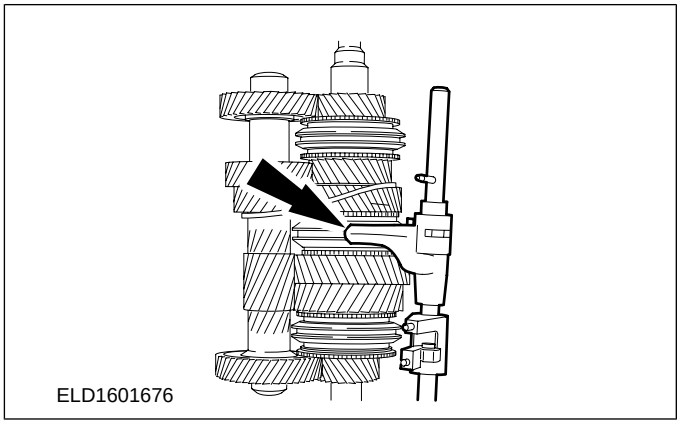


12. **Assemble the countershaft to the output shaft and secure it with a cable tie.**



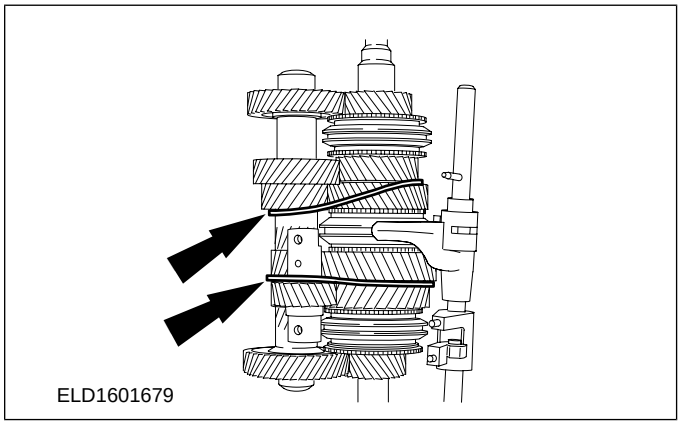
13. **NOTE:The first and second gear selector fork must engage in the middle of the first and second gear synchronizer unit.**

Assemble the main selector shaft to the countershaft and output shaft assembly.



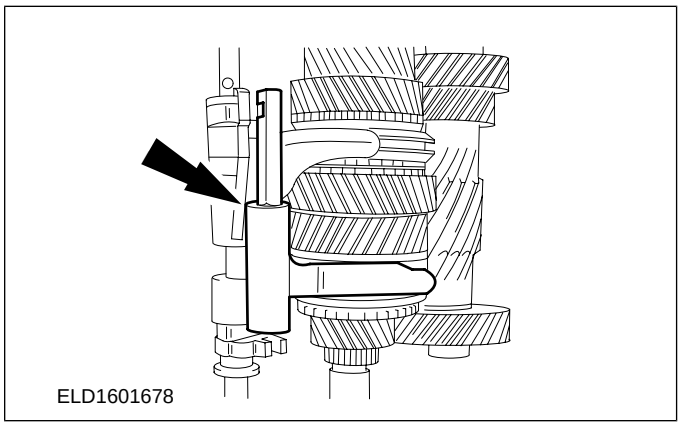
14. **NOTE:Make sure that the flat end of the reverse gear idler shaft is facing upwards.**

Assemble the reverse gear idler to the countershaft and output shaft assembly and secure it with cable ties.



15. **NOTE:Make sure that the outtrigger of the selector fork is facing upwards.**

Attach the fifth and reverse gear selector fork to the lower synchronizer unit.



16. **NOTE:During installation, guide the main selector shaft into the bearing and selector gate correctly.**

NOTE: Make sure that there is no touch condition between the countershaft and the synchronizer ring.

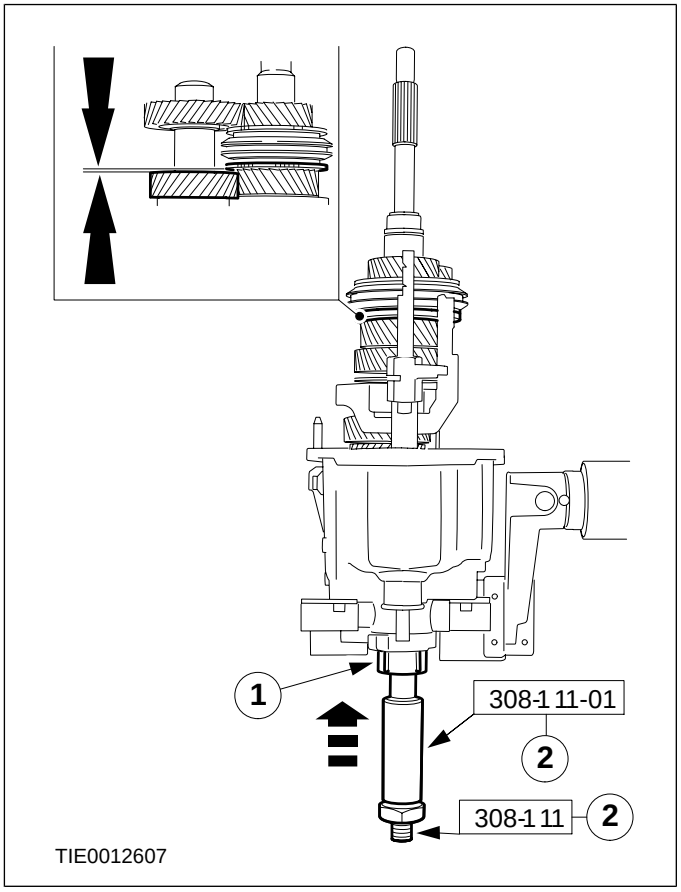
NOTE: Make sure that the inside splines of the sensor ring are facing to the output shaft flange.

Using the special tools, install the countershaft and output shaft assembly.

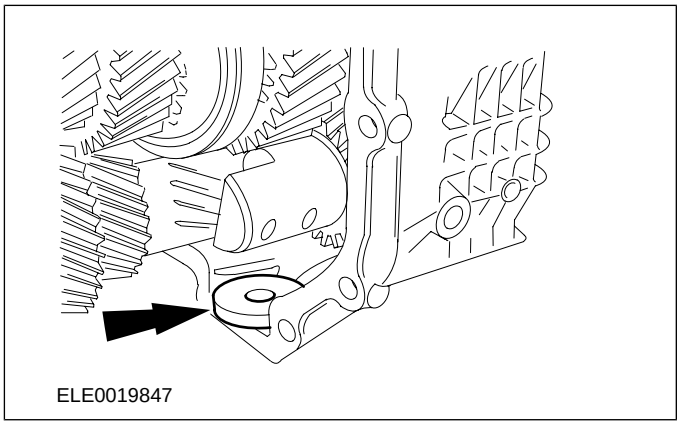
1. Install the vehicle speed sensor (VSS) ring.

ASSEMBLY

2. Use the special tools to guide the countershaft into the rear bearing.

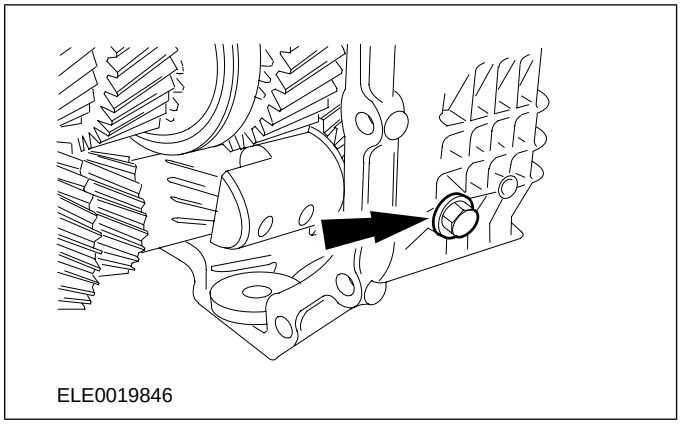


17. **Remove the VSS ring.**
18. **Install the magnetic disc.**



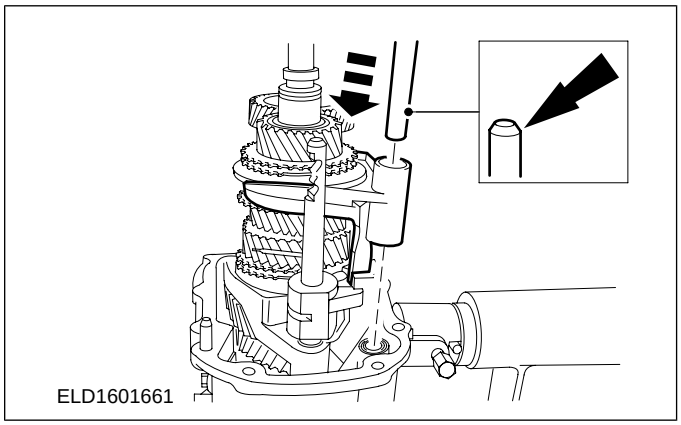
19. **NOTE:Do not fully tighten the reverse gear idler shaft rear retaining bolt at this stage.**

Install the reverse gear idler shaft rear retaining bolt.



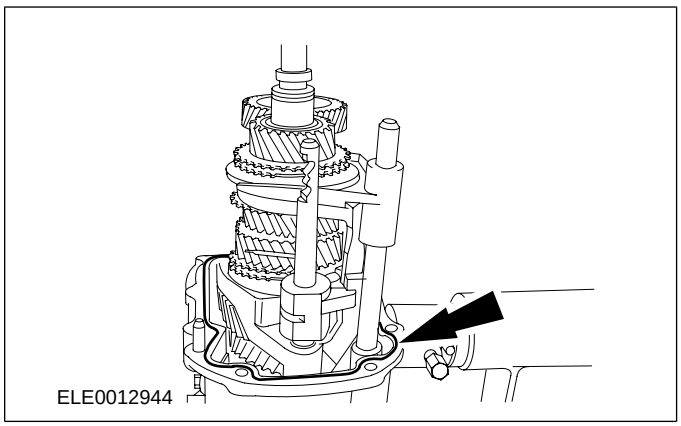
20. **Remove the cable ties from the countershaft and output shaft assembly.**
21. **NOTE:Make sure that the chamfered end of the selector shaft is facing upwards.**

Install the third and fourth gear selector fork and the auxiliary selector shaft.



22. **CAUTION:Install the transmission front housing within 15 minutes of applying the sealant.**

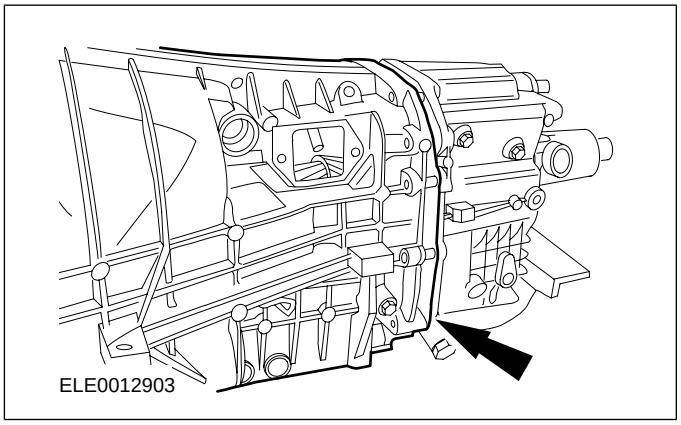
Apply sealant to the mating surface of the transmission rear housing.



ASSEMBLY

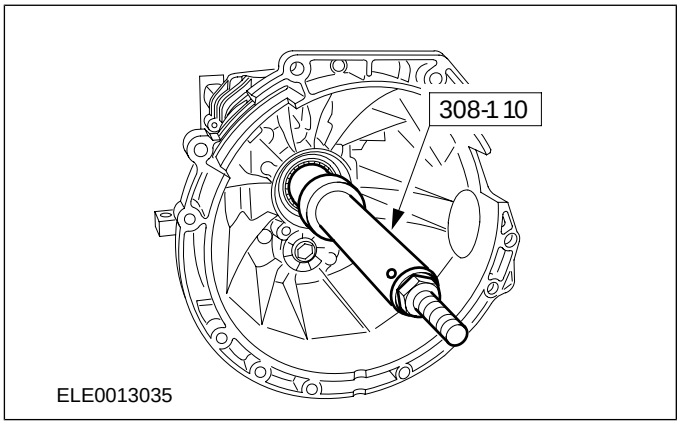
23. **⚠CAUTION:Install the transmission front housing carefully. Failure to follow this instruction may result in damage to the fourth gear synchronizer ring.**

Assemble the transmission front housing to the transmission rear housing.



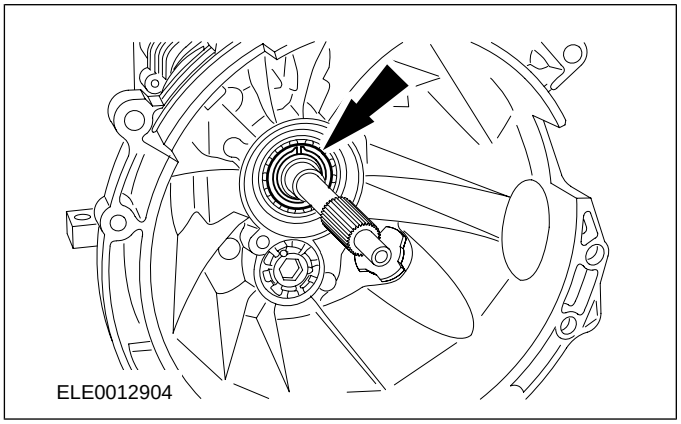
24. **NOTE:During installation, guide the countershaft carefully into the bearing.**

Using the special tool, install the transmission front housing.

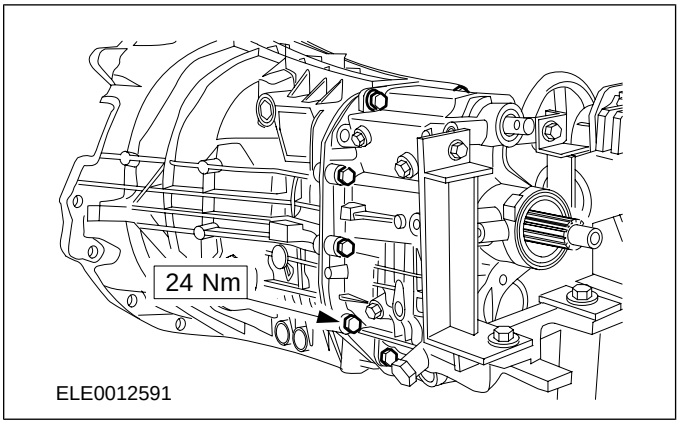


25. **NOTE:Install a new input shaft circlip.**

Install the input shaft circlip.



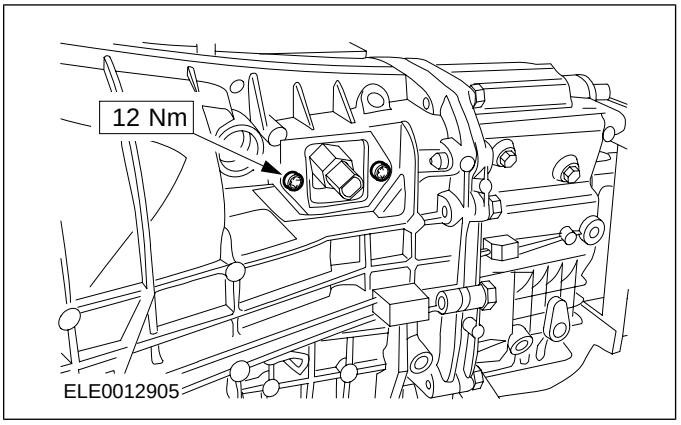
26. **Install the transmission housing retaining bolts.**



27. **⚠CAUTION:Check the reversing lamp switch gasket. If the gasket is loose or damaged, discard the reversing lamp switch.**

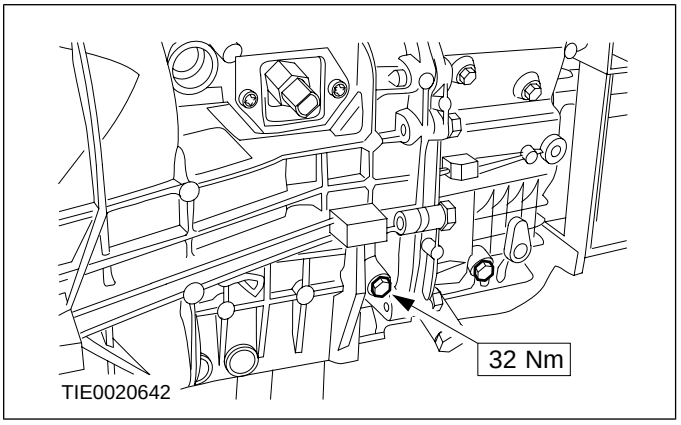
NOTE: Install new reversing lamp switch retaining bolts.

Install the reversing lamp switch.



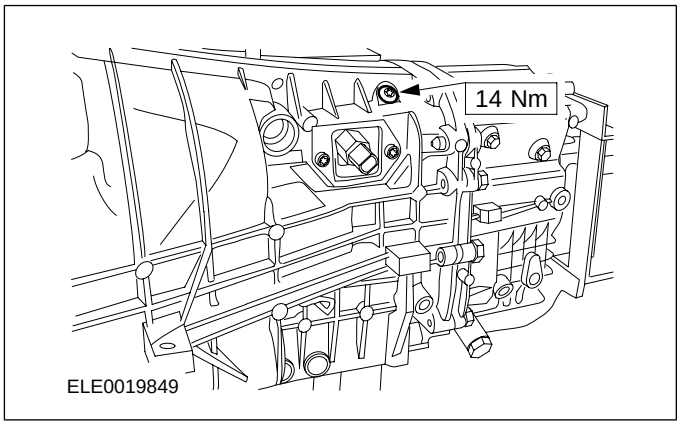
28. **Install the reverse gear idler shaft front retaining bolt**

- Tighten the reverse gear idler shaft retaining bolts.

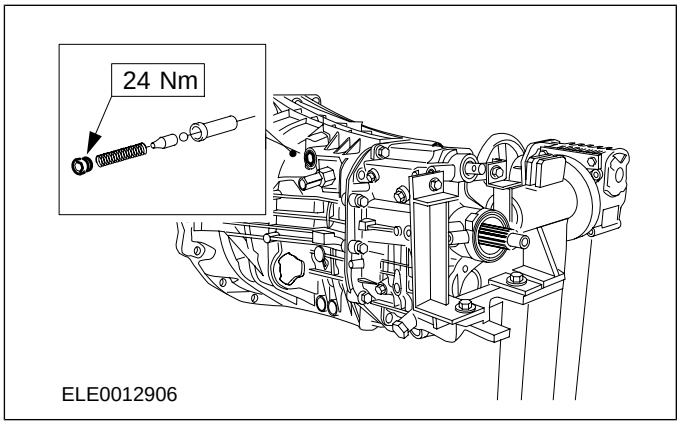


ASSEMBLY

29. **Install the selector shaft locking plate bolt.**

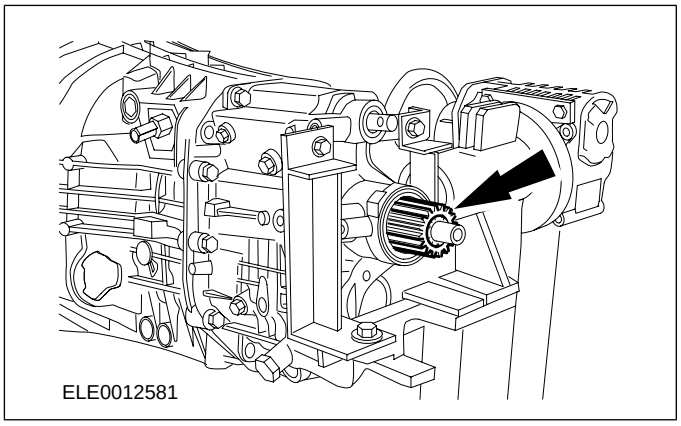


30. **Apply sealant to the selector interlock mechanism retaining plug.**
31. **Install the selector interlock mechanism.**

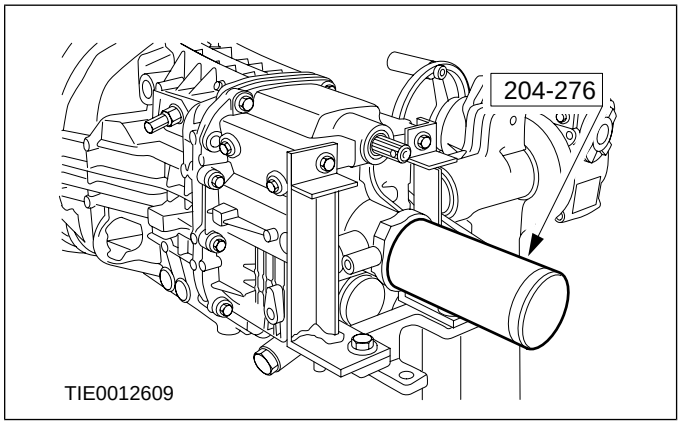


32. **NOTE:Make sure that the inside splines of the sensor ring are facing the output shaft flange.**

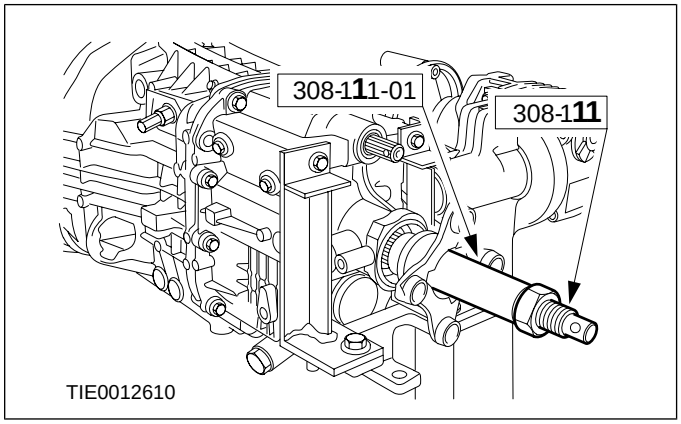
    Install the VSS ring.



33. **Coat the lip of the output shaft oil seal with grease.**
34. **Using the special tool, install the output shaft oil seal.**
    - Install the splash shield.

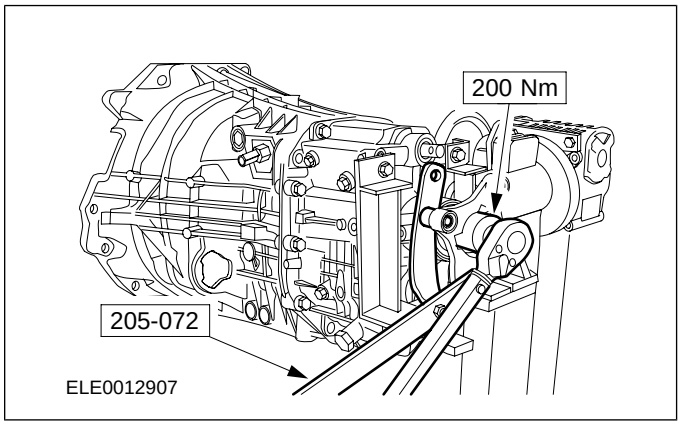


35. **Using the special tools, install the output shaft flange.**
    - Hold the spindle with a drift.



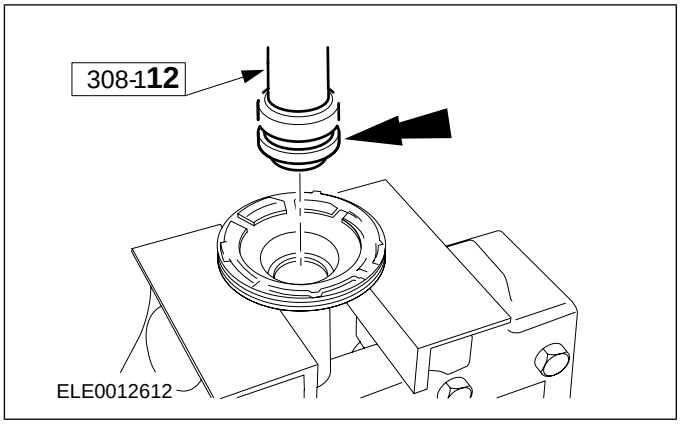
36. **NOTE:Install a new output shaft flange retaining nut.**

    Coat the threads and the mating surface of the output shaft retaining nut with sealant.
37. **Using the special tool, install the output shaft flange retaining nut.**

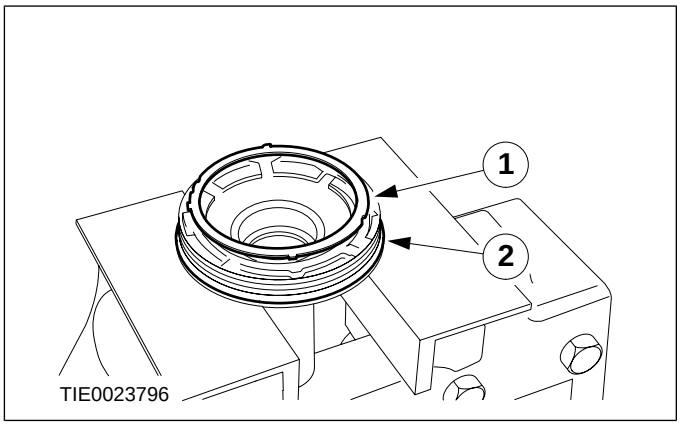


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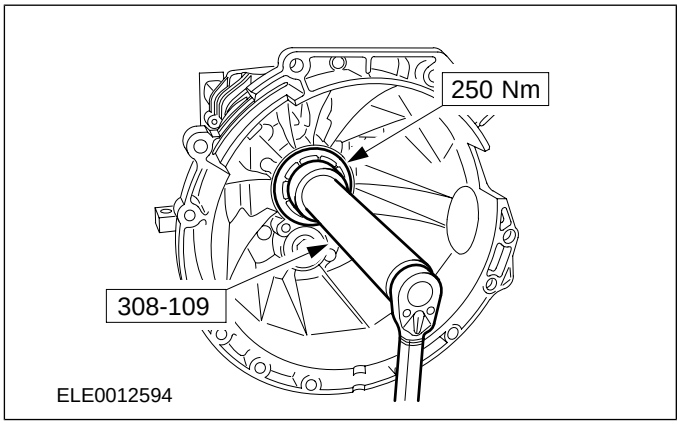
38. **Using the special tool, install the input shaft guide sleeve oil seal.**



39. **Assemble the input shaft guide sleeve.**
    1. Install the thrust washer.
    2. Install the O-ring seal.

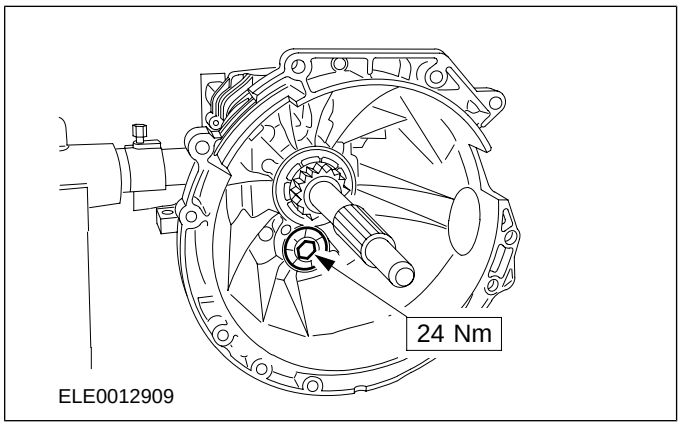


40. **Coat the threads of the input shaft guide sleeve and the O-ring seal with grease**
41. **Using the special tool, install the input shaft guide sleeve.**

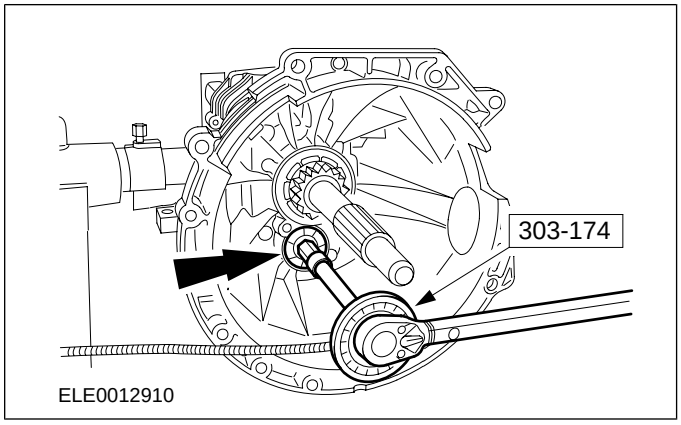


42. **Coat the threads of the countershaft bearing retainer and the O-ring seal with grease.**
43. **NOTE:Install a new countershaft bearing retainer O-ring seal.**

    Install the countershaft bearing retainer.



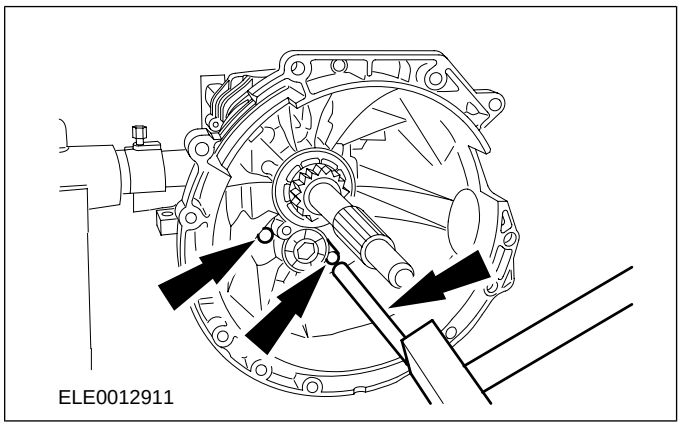
44. **Using the special tool, loosen the bearing retainer by 80 degrees.**



45. **NOTE:Rotate the transmission housing downwards at least 45 degrees.**

    Adjust the countershaft.

    - Using a suitable brass drift and a soft faced hammer, strike two blows on each of the bosses. This will seat the countershaft front bearing against the bearing retainer.

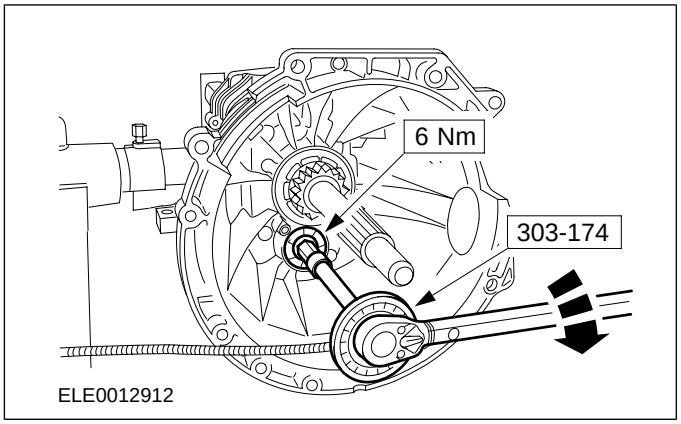


ASSEMBLY

46. ⚠CAUTION:The indicated torque must be achieved.

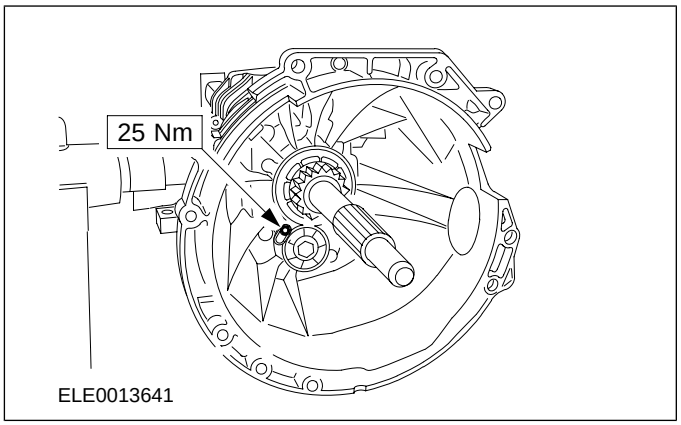
Using the special tool, tighten the bearing retainer 20 degrees.

- If the indicated torque is not achieved, repeat the previous two steps.

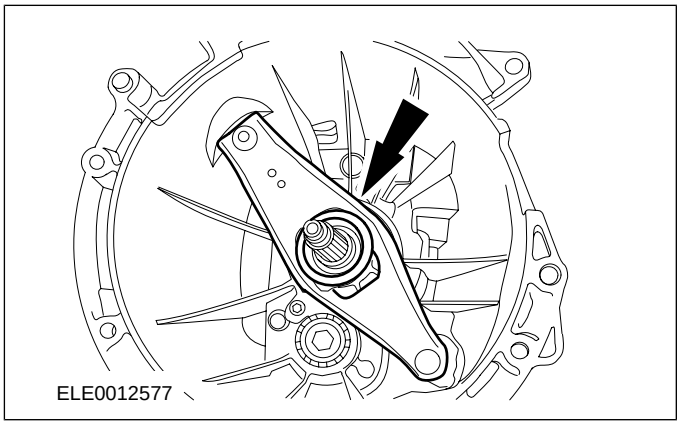


47. NOTE:Install a new countershaft bearing retainer locking plate bolt.

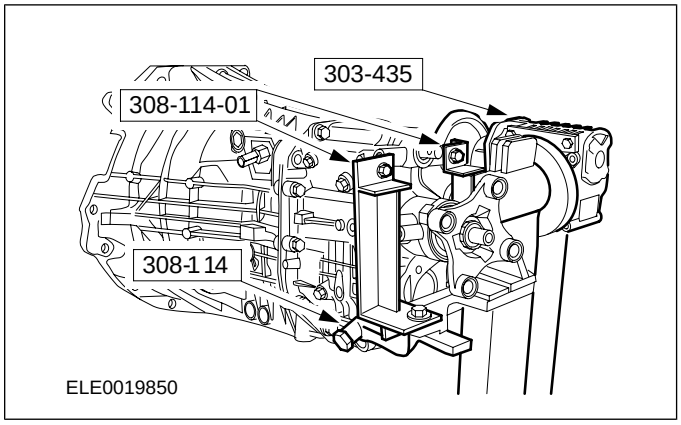
Install the countershaft bearing retainer locking plate.



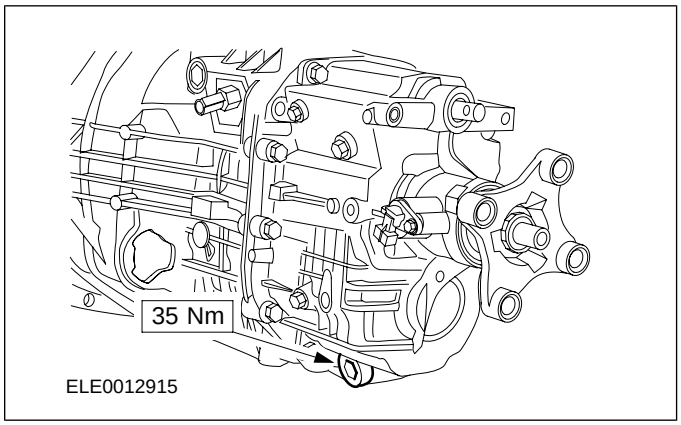
48. Install the clutch release bearing and the clutch release lever.



49. Remove the transmission from the mounting stand.

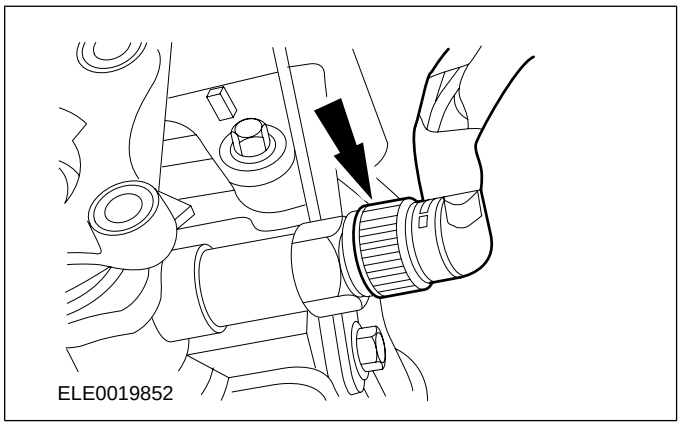


50. Install the drain plug.



Vehicles with tachograph

51. Install the tachograph sensor.



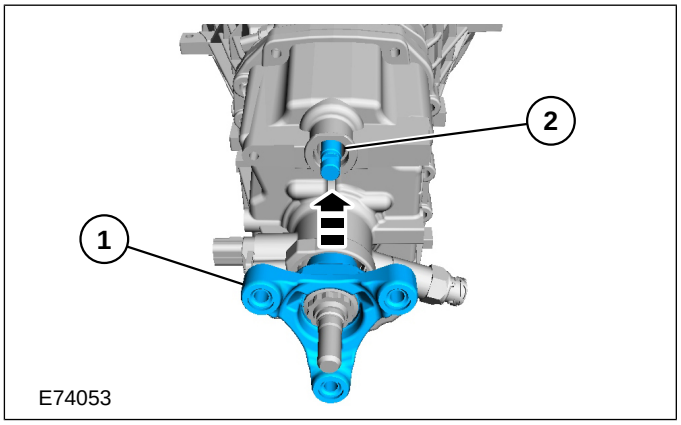
All vehicles

52. Prepare the transmission for the external gearshift control bracket installation.

1. Turn the output shaft flange with the flat side to the top.

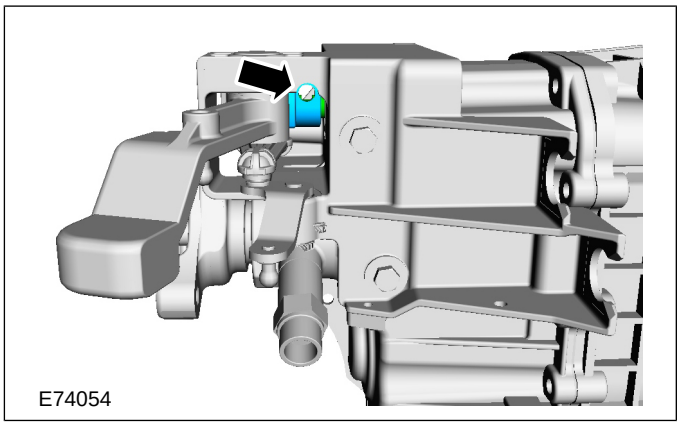
ASSEMBLY

2. Shift the transmission into 4th gear.

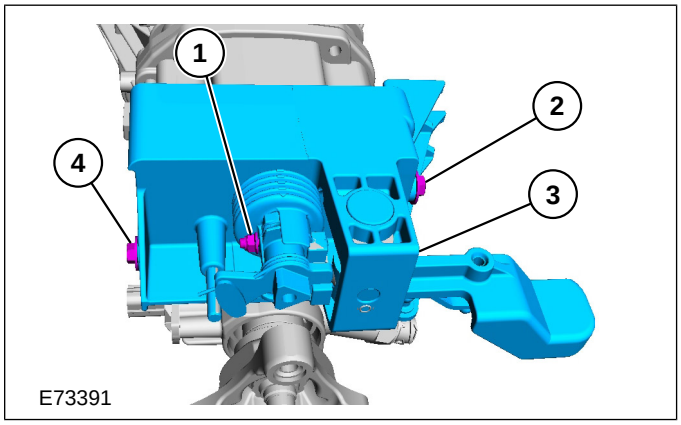


53. **CAUTION:Only tighten the external gearshift control bracket retaining bolts and the main selector shaft pin bolt and nut finger tight.**

Install the external gearshift control bracket and align the main selector shaft to the external control lever.



54. **Tighten the external gearshift control bracket bolts and the main selector shaft pin bolt and nut in the sequence shown.**
    - Tighten the bolts and the nut in the sequence shown:
    - Nut 1: 13 Nm.
    - Bolts 2 to 4: 25 Nm.



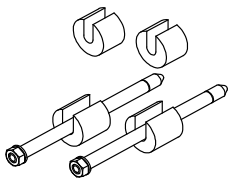
55. **Fill the transmission with manual transmission fluid .**

For additional information, refer to:Transmission Draining and Filling (308-03 Manual Transmission/Transaxle - Vehicles With: MT-75, General Procedures).

INSTALLATION

Transmission — 2.4L Duratorq-Di (Puma) Diesel

Special Tool(s)

 E62036	Spacer, Subframe 204-606

General Equipment

Two transmission jacks

Materials	
Name	**Specification**
Grease	ESD-M2C220-A

Installation

All Vehicles

1. **Check the pilot bearing for damage. If damaged, install a new pilot bearing**

   For additional information, refer to: Pilot Bearing (308-01 Clutch - Vehicles With: MT-75, Removal and Installation).

2. **NOTE: Do not apply grease to a newly installed pilot bearing.**

   Apply approximately one gram of grease to the pilot bearing.

3. **Apply a thin film of grease to the input shaft guide sleeve.**

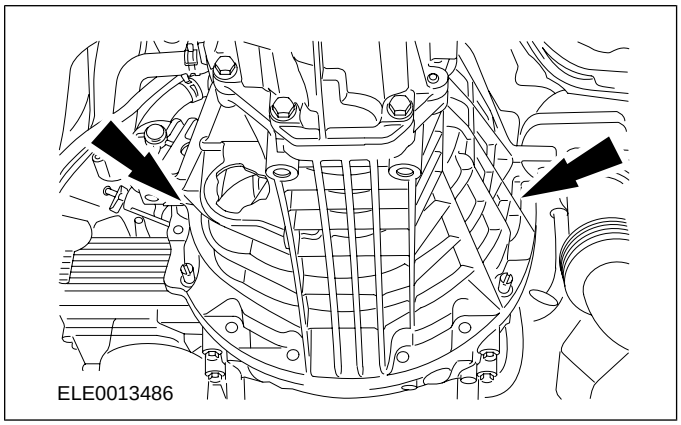
4. **Shift the transmission into third gear.**

5. **CAUTION: Do not tilt the transmission during installation. This may cause damage to the pilot bearing.**

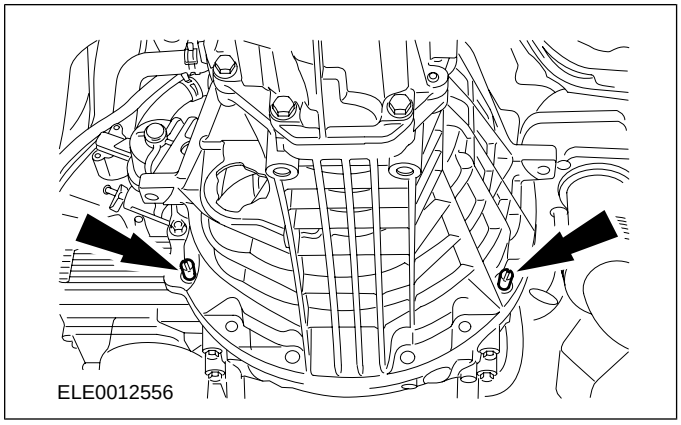
   Using a suitable transmission jack, install the transmission to the engine.

6. **NOTE: Do not fully tighten the transmission retaining bolts at this stage.**

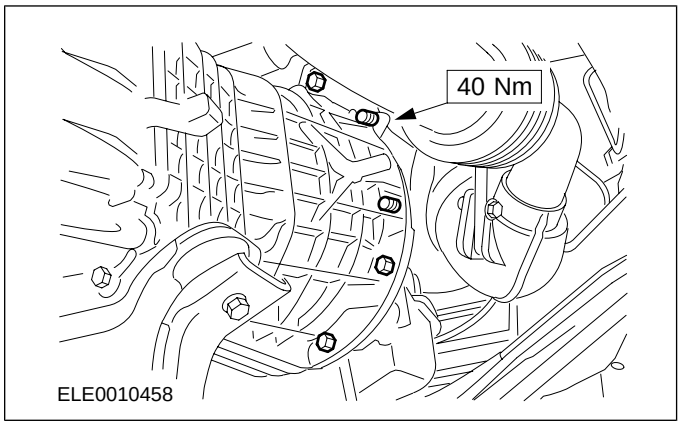
Install one transmission retaining bolt to the right-hand side and one to the left-hand side.



7. **Remove the locating studs.**

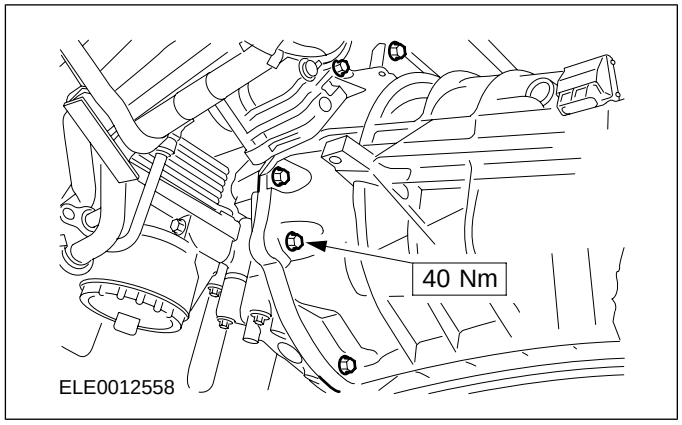


8. **Install the remaining transmission retaining bolts to the right-hand side.**

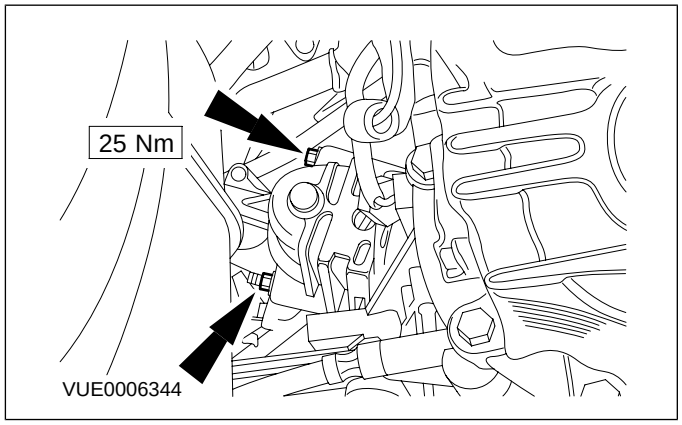


INSTALLATION

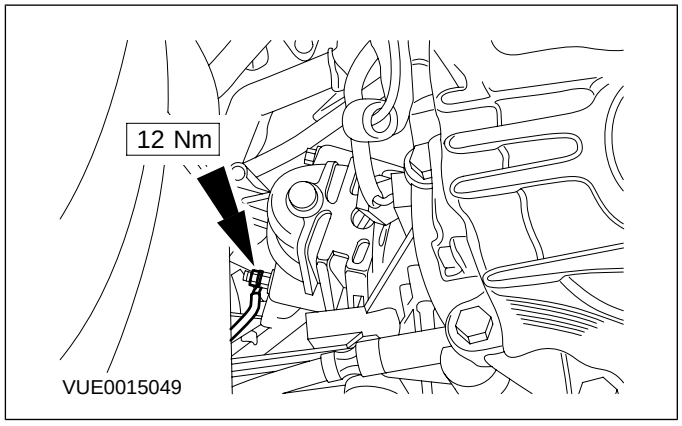
9. Install the remaining transmission retaining bolts to the left-hand side.



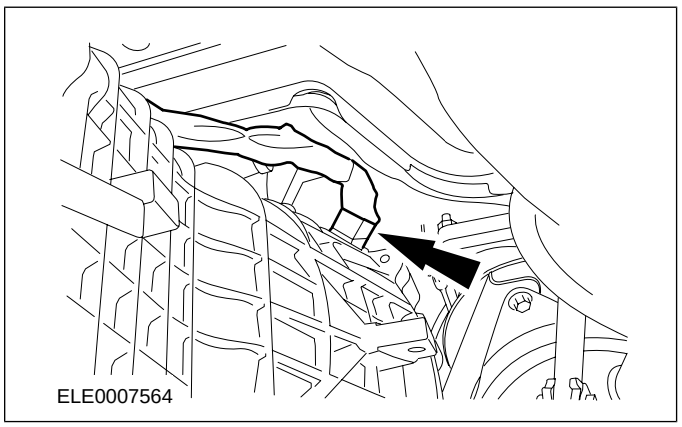
10. Attach the starter motor to the transmission.



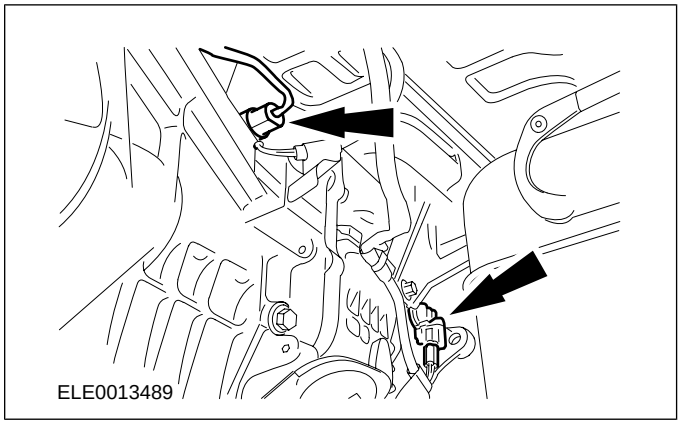
11. Install the starter motor ground cable.



12. Connect the crankshaft position (CKP) sensor electrical connector and attach the shield.

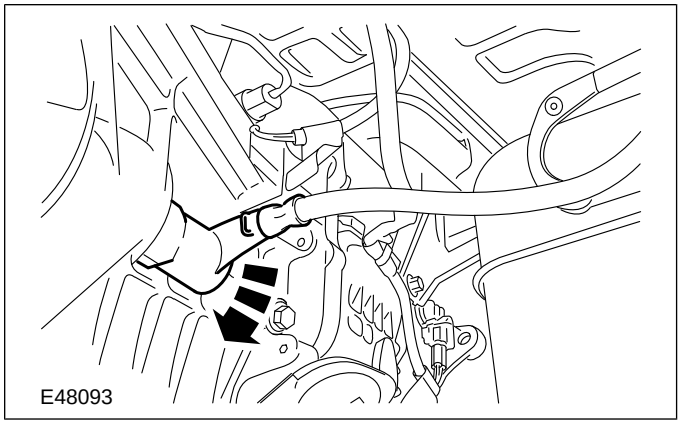


13. Connect the reversing lamp switch and the vehicle speed sensor (VSS) electrical connectors.



14. NOTE:Make sure that the clutch slave cylinder actuating rod correctly engages with the clutch release lever.

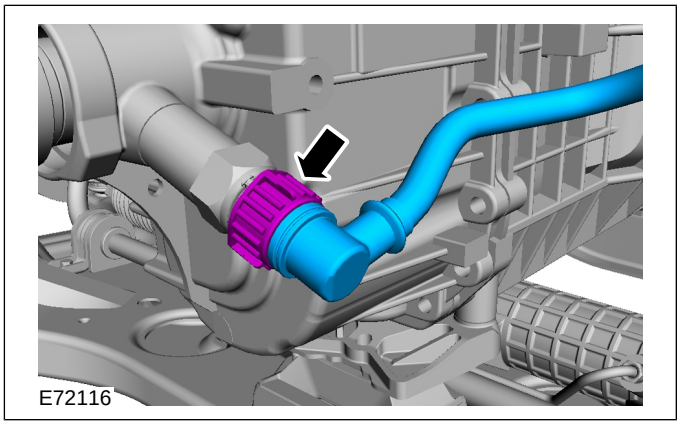
    Turning the clutch slave cylinder clockwise, attach the clutch slave cylinder to the transmission.



INSTALLATION

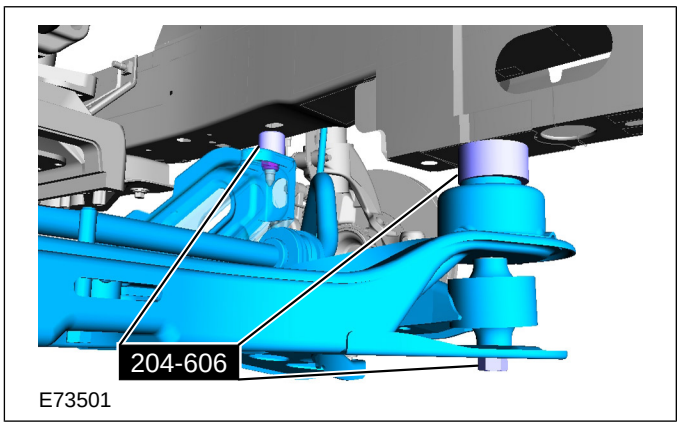
Vehicles with tachograph

15. Connect the tachograph sensor electrical connector.

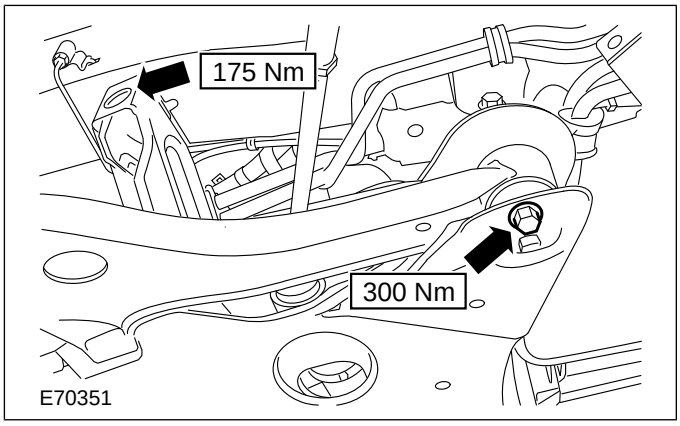


All vehicles

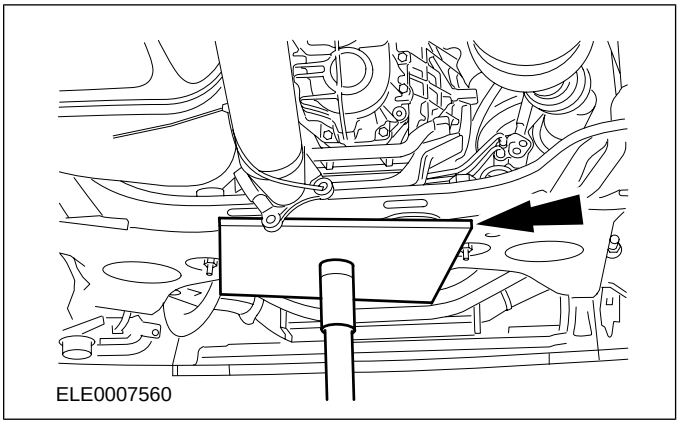
16. Remove the special tool.



17. Raise the front axle crossmember and tighten the four retaining bolts (left-hand side shown).

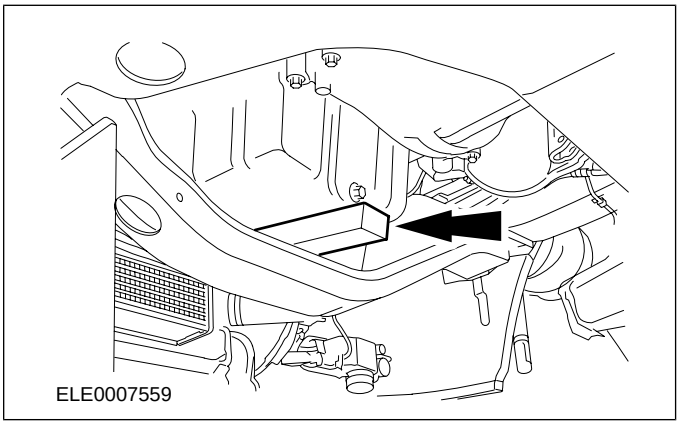


18. Remove the transmission jack from under the front axle crossmember.



19. NOTE:When using a two post lift.

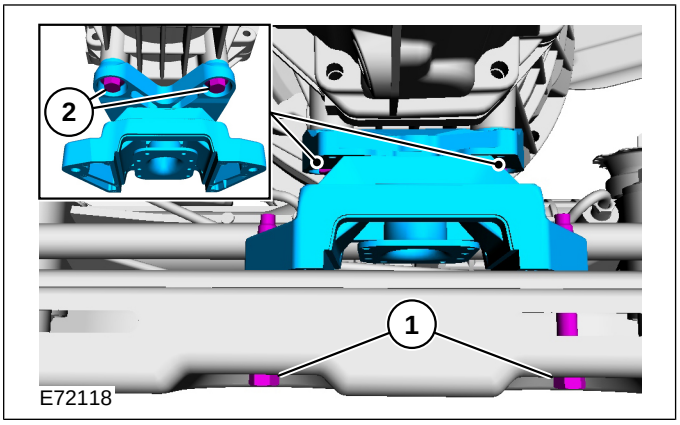
Remove the wooden block.



20. Install the transmission support insulator.

- Install all retaining bolts.

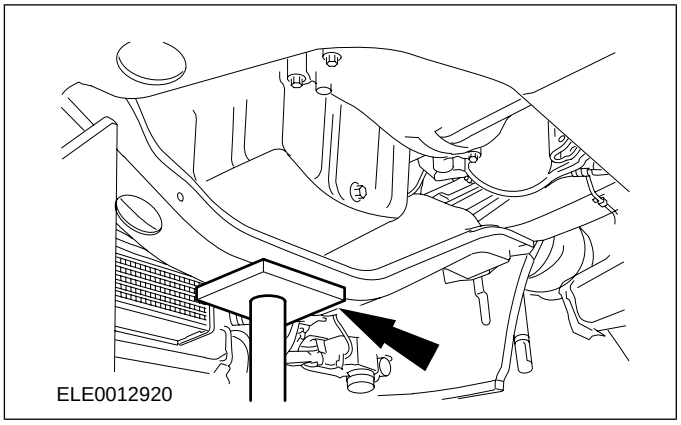
1. Install the front axle to bracket retaining bolts.
2. Install the bracket to transmission retaining bolts.



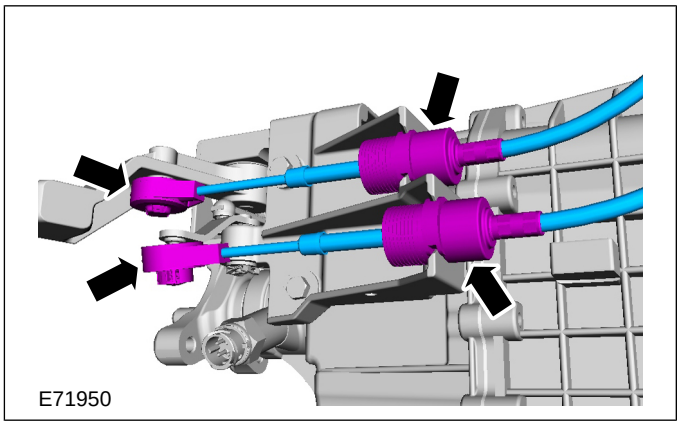
21. NOTE:When using a four post lift.

INSTALLATION

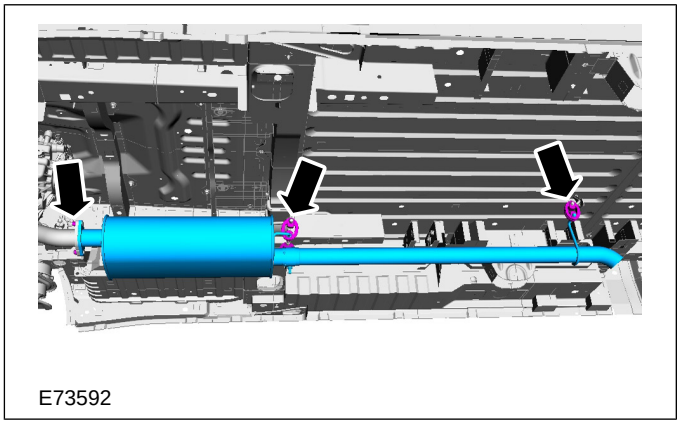
Remove the transmission jack from under the engine crossmember.



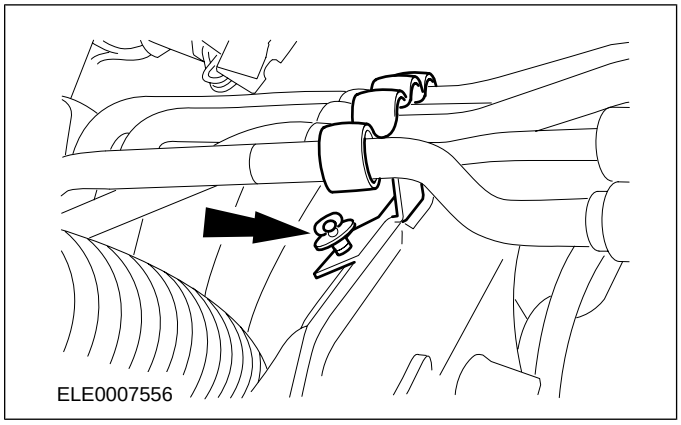
22. Install the gearshift cables.



23. Install the exhaust muffler.



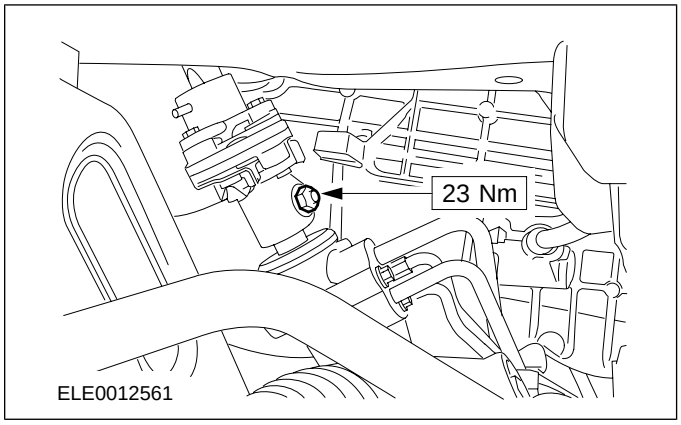
24. Attach the power steering lines to the front axle crossmember.



25. WARNING:Install a new steering column flexible coupling nut. Failure to follow this instruction may result in personal injury.

NOTE: Make sure the road wheels are in the straight ahead position.

Connect the steering column flexible coupling to the steering gear pinion.

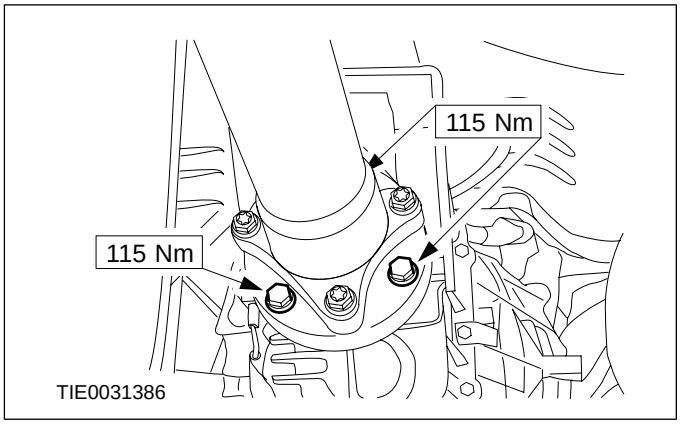


26. NOTE:Align the mark on the driveshaft flange with the mark on the transmission output shaft flange.

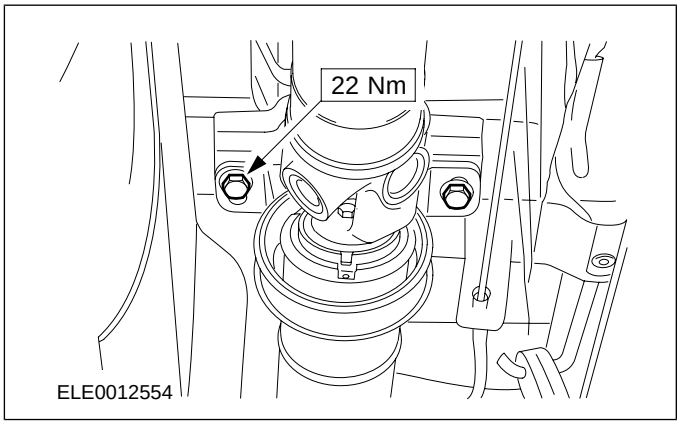
NOTE: Install new driveshaft to transmission output shaft flange retaining bolts.

INSTALLATION

Attach the driveshaft to the transmission output shaft flange.



27. **Tighten the driveshaft front center bearing retaining bolts.**



28. **Lower the vehicle.**
29. **Connect the battery ground cable.**

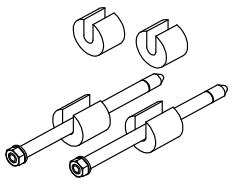
    For additional information, refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).
30. **Adjust the gearshft cables.**

    For additional information, refer to:Gearshift Cables (308-06 Manual Transmission/Transaxle External Controls - Vehicles With: MT-75, Removal and Installation).

INSTALLATION

Transmission — 2.3L Duratec-HE (MI4)

Special Tool(s)

 E62036	Spacer, Subframe 204-606

General Equipment

Two M10 x 60 mm locating studs
Transmission jack

Materials

Name	Specification
Grease	ESD-M2C220-A

Installation

All Vehicles

1. **Check the pilot bearing for damage. If damaged, install a new pilot bearing**

   For additional information, refer to: Pilot Bearing (308-01 Clutch - Vehicles With: MT-75, Removal and Installation).

2. **NOTE: Do not apply grease to a newly installed pilot bearing.**

   Apply approximately one gram of grease to the pilot bearing.

3. **Apply a thin film of grease to the input shaft guide sleeve.**

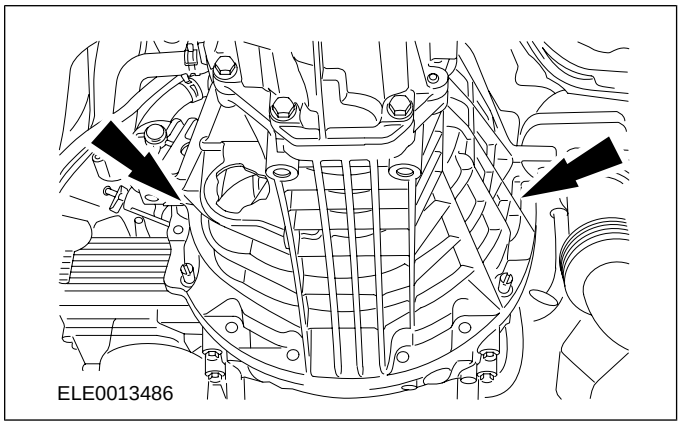
4. **Shift the transmission into third gear.**

5. **CAUTION: Do not tilt the transmission during installation. This may cause damage to the pilot bearing.**

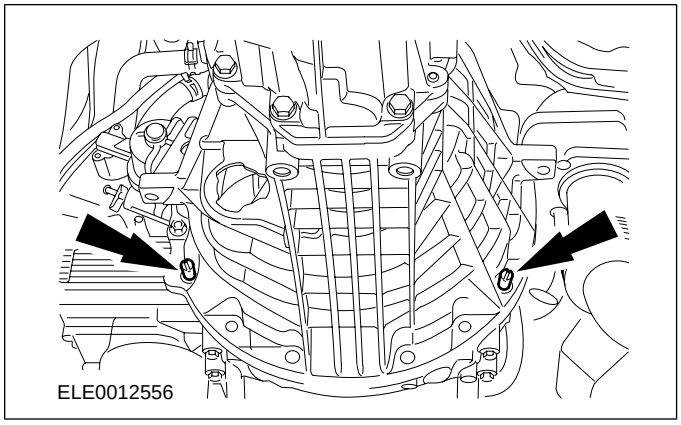
   Using a suitable transmission jack, install the transmission to the engine.

6. **NOTE: Do not fully tighten the transmission retaining bolts at this stage.**

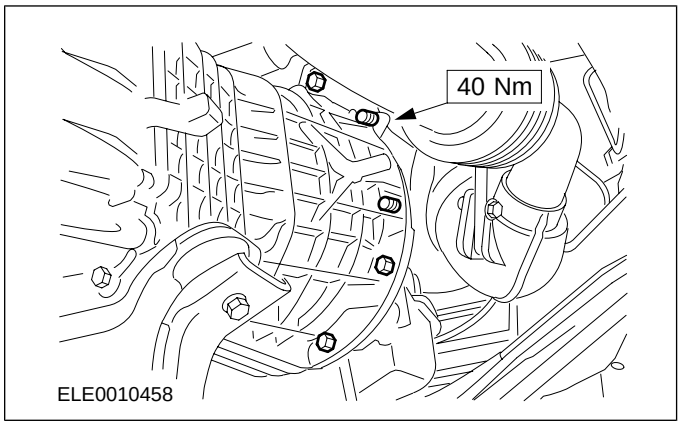
   Install one transmission retaining bolt to the right-hand side and one to the left-hand side.



7. **Remove the locating studs.**

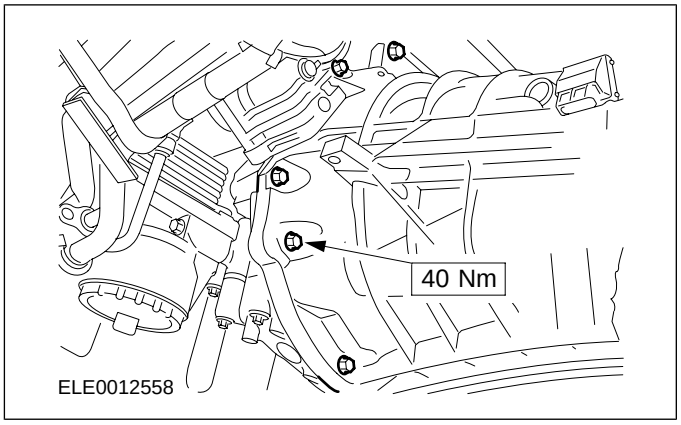


8. **Install the remaining transmission retaining bolts to the right-hand side.**

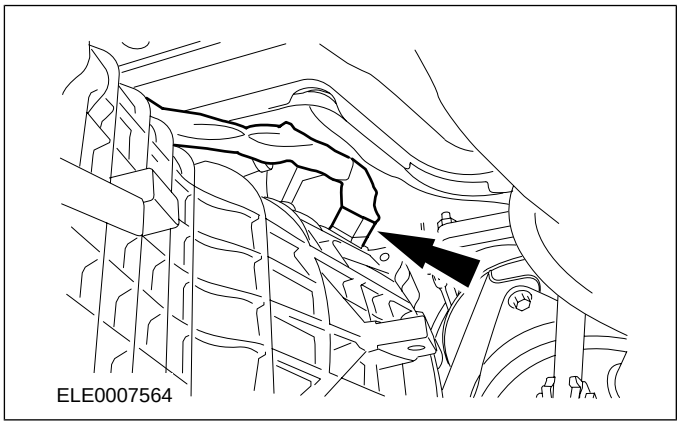


INSTALLATION

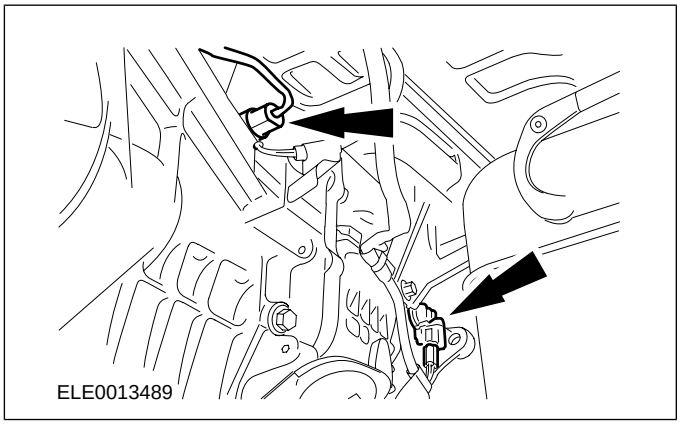
9. Install the remaining transmission retaining bolts to the left-hand side.



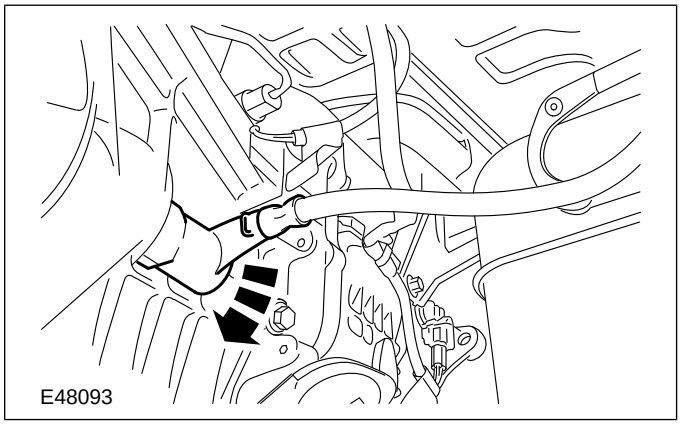
10. Connect the crankshaft position (CKP) sensor electrical connector and attach the shield.



11. Connect the reversing lamp switch and the vehicle speed sensor (VSS) electrical connectors.

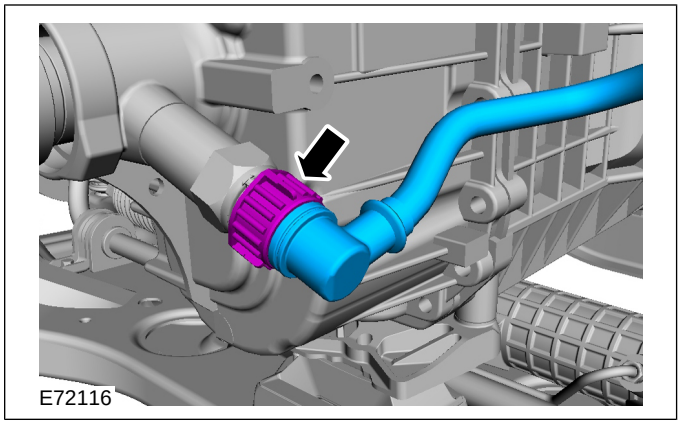


12. NOTE:Make sure that the clutch slave cylinder actuating rod correctly engages with the clutch release lever.
Turning the clutch slave cylinder clockwise, attach the clutch slave cylinder to the transmission.



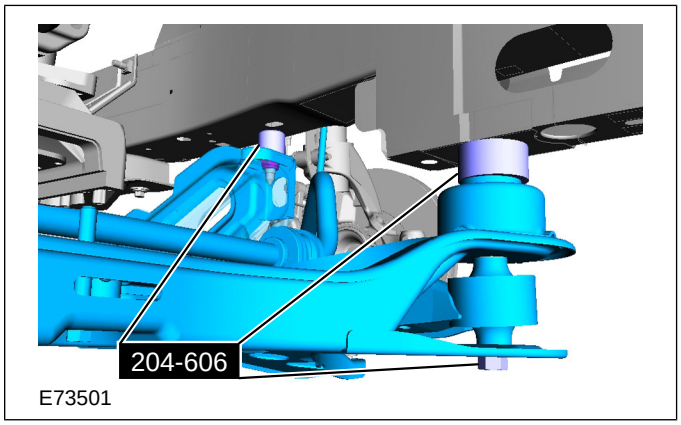
Vehicles with tachograph

13. Connect the tachograph sensor electrical connector.



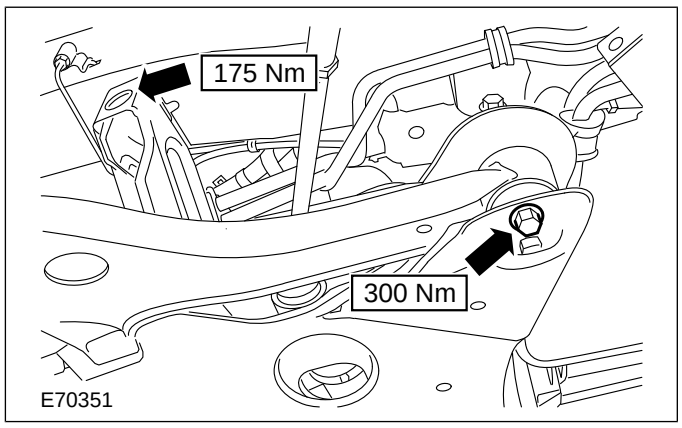
All vehicles

14. Remove the special tool.

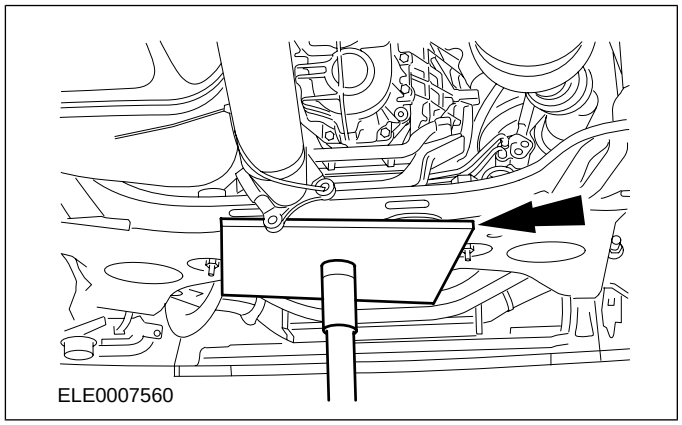


INSTALLATION

15. Raise the front axle crossmember and tighten the four retaining bolts (left-hand side shown).

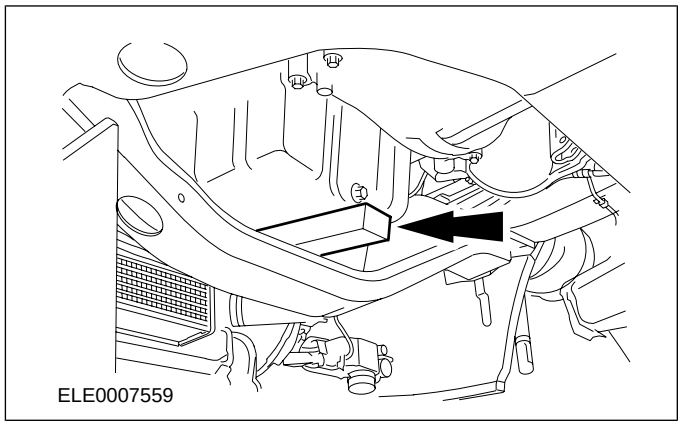


16. Remove the transmission jack from under the front axle crossmember.



17. NOTE:When using a two post lift.

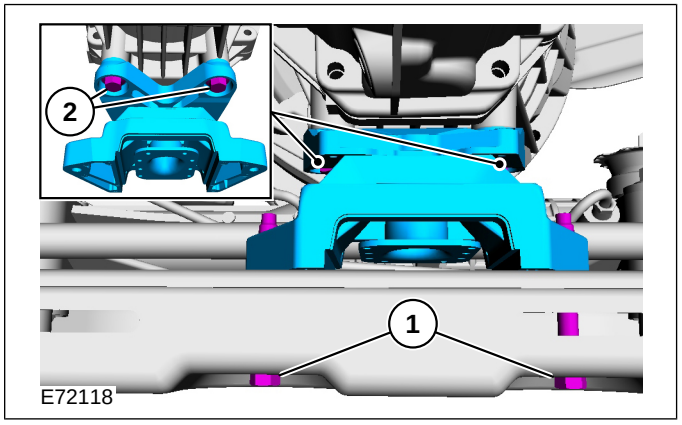
Remove the wooden block.



18. Install the transmission support insulator.

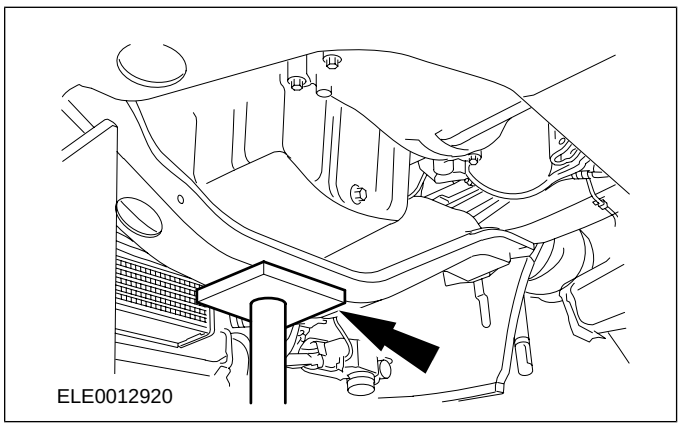
- Install all retaining bolts.

1. Install the front axle to bracket retaining bolts.
2. Install the bracket to transmission retaining bolts.

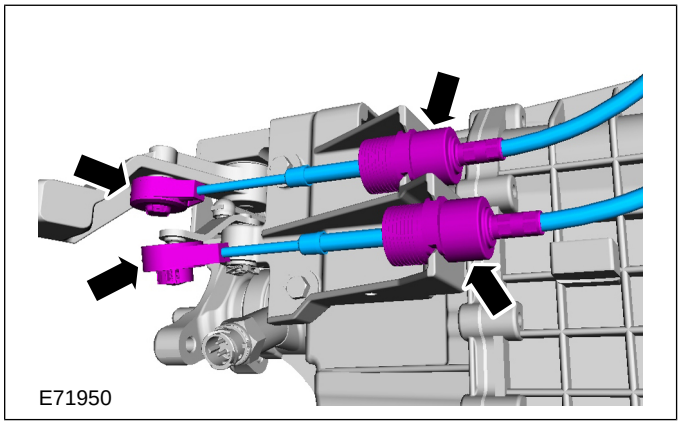


19. NOTE:When using a four post lift.

Remove the transmission jack from under the engine crossmember.

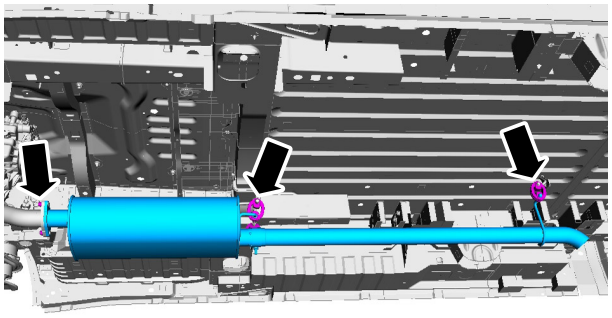


20. Install the gearshift cables.



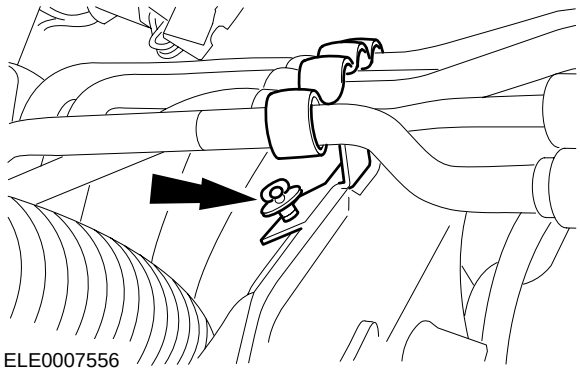
INSTALLATION

21. **Install the exhaust muffler.**


E73592

Vehicles with auxiliary heating

22. **Attach the power steering lines to the front axle crossmember.**

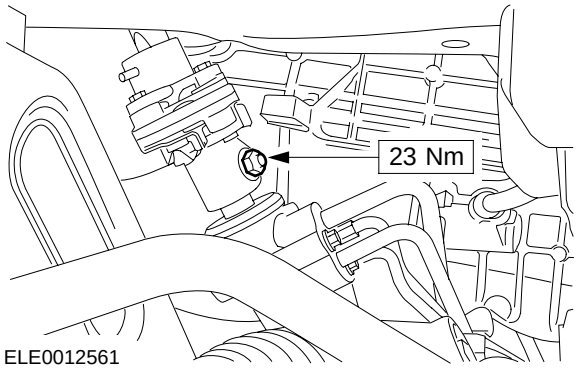

ELE0007556

All vehicles

23. **WARNING:Install a new steering column flexible coupling nut. Failure to follow this instruction may result in personal injury.**

NOTE: Make sure the road wheels are in the straight ahead position.

Connect the steering column flexible coupling to the steering gear pinion.

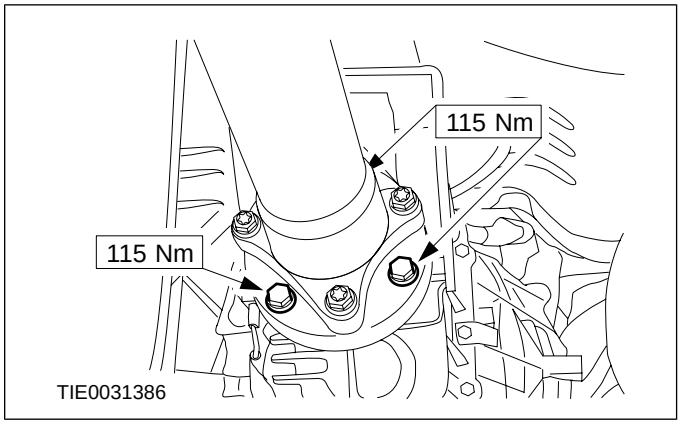


ELE0012561

24. **NOTE:Align the mark on the driveshaft flange with the mark on the transmission output shaft flange.**

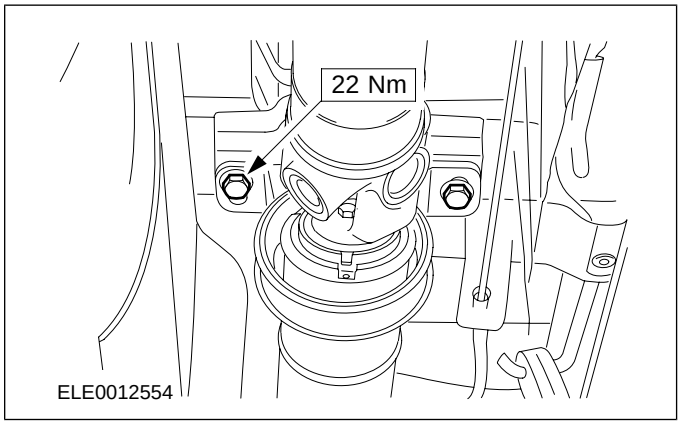
NOTE: Install new driveshaft to transmission output shaft flange retaining bolts.

Attach the driveshaft to the transmission output shaft flange.



TIE0031386

25. **Tighten the driveshaft front center bearing retaining bolts.**



ELE0012554

26. **Lower the vehicle.**
27. **Connect the battery ground cable.**

For additional information, refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

28. **Adjust the gearshft cables.**

For additional information, refer to:Gearshift Cables (308-06 Manual Transmission/Transaxle External Controls - Vehicles With: MT-75, Removal and Installation).

SECTION 308-06 Manual Transmission/Transaxle External Controls — Vehicles With: MT-75

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

External Controls 308-06-2
External Controls 308-06-2

DIAGNOSIS AND TESTING

External Controls 308-06-3
Inspection and Verification 308-06-3
Symptom Chart 308-06-3
Pinpoint Tests 308-06-3

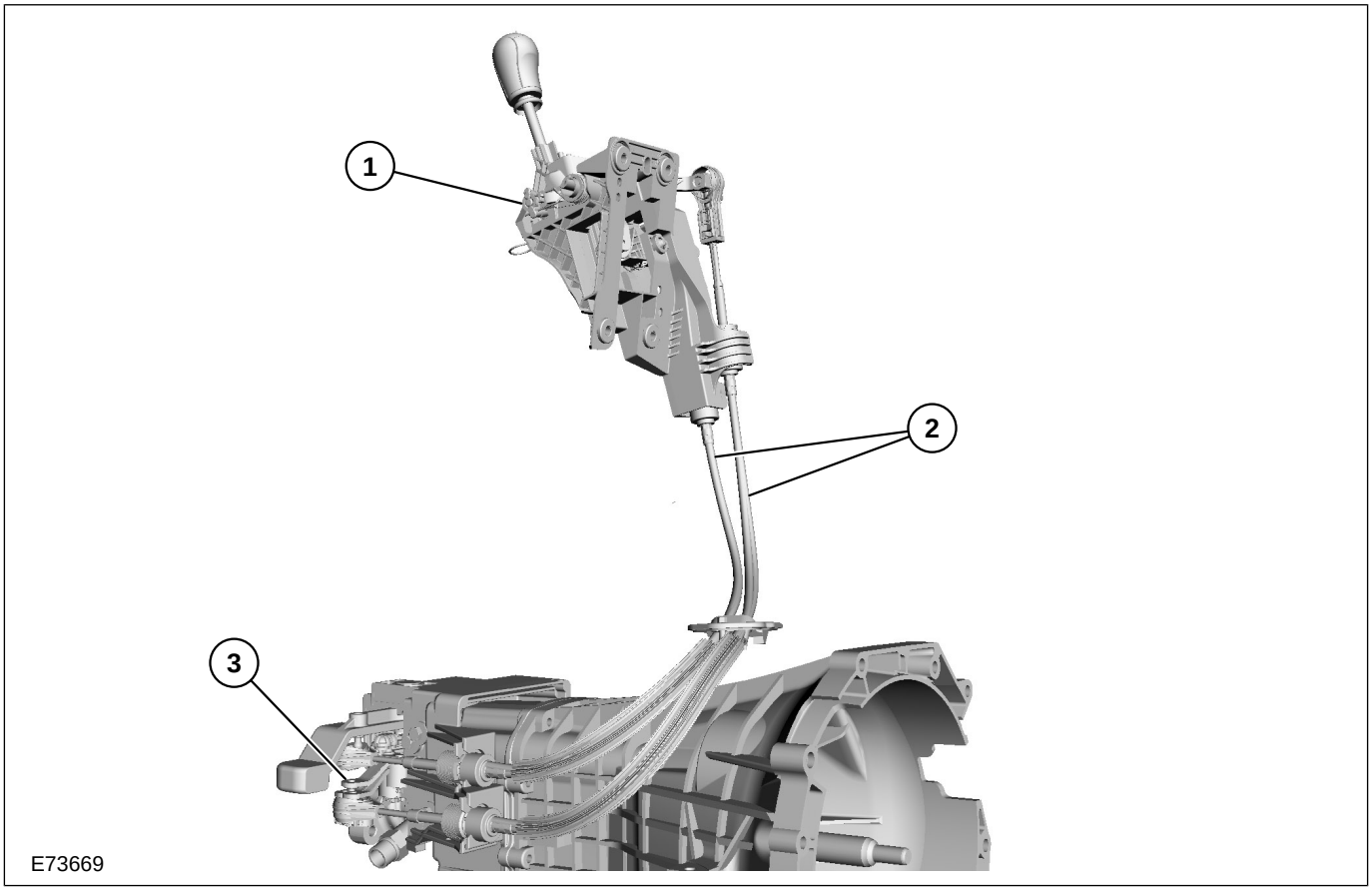
REMOVAL AND INSTALLATION

Gearshift Cables 308-06-5

DESCRIPTION AND OPERATION

External Controls

External Controls



Item	Description
1	Gearshift lever
2	Gearshift cables
3	Selector mechanism

DIAGNOSIS AND TESTING

External Controls

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical damage.
3. Make sure that the gearshift cables are correctly routed and not under any tension from other components.
4. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
5. If the concern is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• External controls do not operate freely.	• Gearshift cables incorrectly adjusted.	• ADJUST the gearshift cables. REFER to:Gearshift Cable Adjustment - Vehicles With: MT-75/MT82 (308-00 Manual Transmission/Transaxle and Clutch - General Information, General Procedures).
	• Gearshift lever damaged. • Selector mechanism damaged. • Gearshift cables damaged.	• GO to Pinpoint Test A.

Pinpoint Tests

PINPOINT TEST A : STIFF GEARSHIFT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK THE GEARSHIFT LEVER	
	1 Detach the gearshift cables from the gearshift lever. • Is the gearshift lever difficult to operate? → **Yes** Install a new gearshift lever. → **No** GO to A2.
A2: CHECK THE GEARSHIFT CABLES	
	1 Attach the gearshift cables to the gearshift lever.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Detach the gearshift cables from the transaxle. • Is the gearshift lever difficult to operate? → **Yes** Install new gearshift cables. REFER to:Gearshift Cables (308-06 Manual Transmission/Transaxle External Controls - Vehicles With: MT82, Removal and Installation). → **No** Check the selector mechanism.

REMOVAL AND INSTALLATION

Gearshift Cables

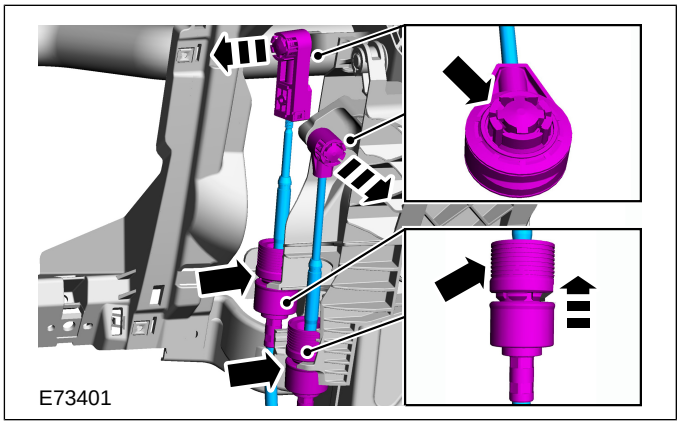
Removal

CAUTION:Do not bend or kink the gearshift cables.

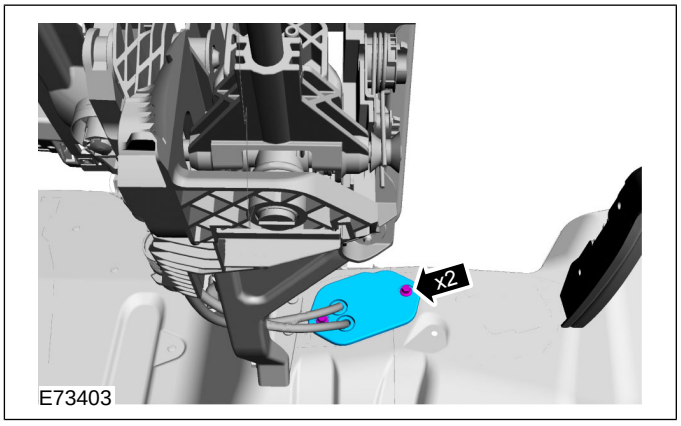
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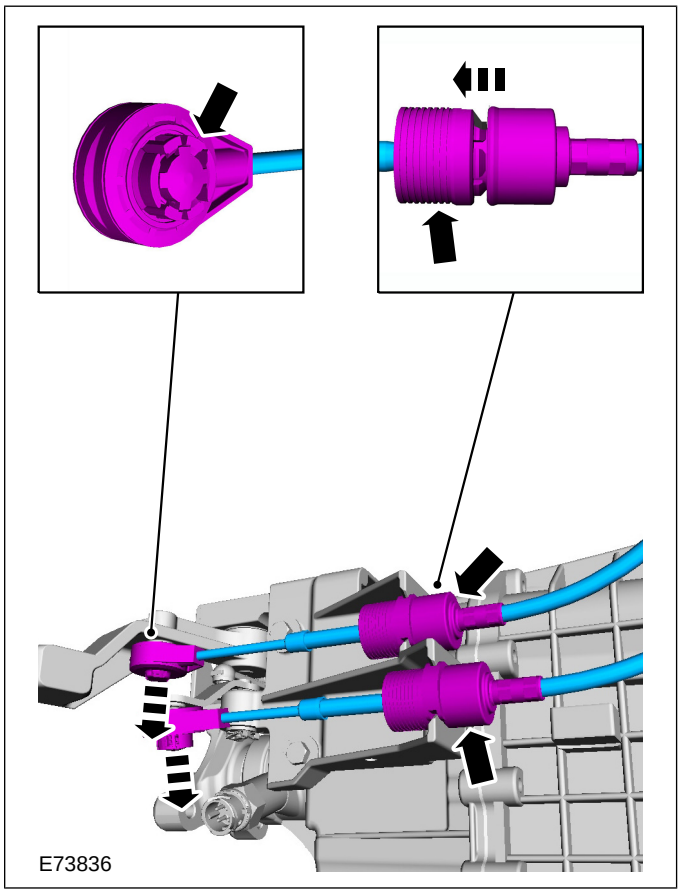
2.



3.

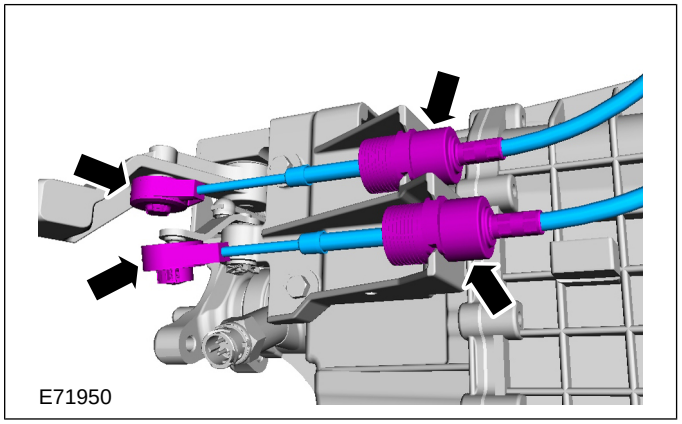


4.



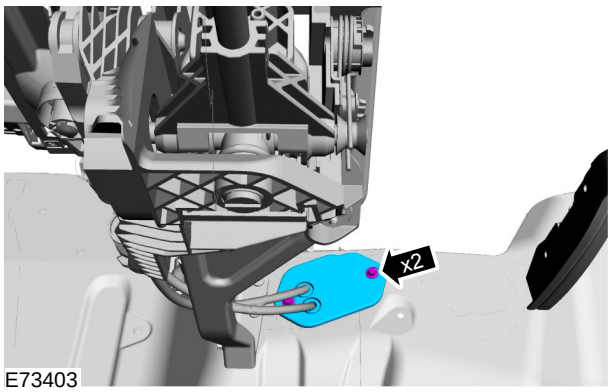
Installation

1.

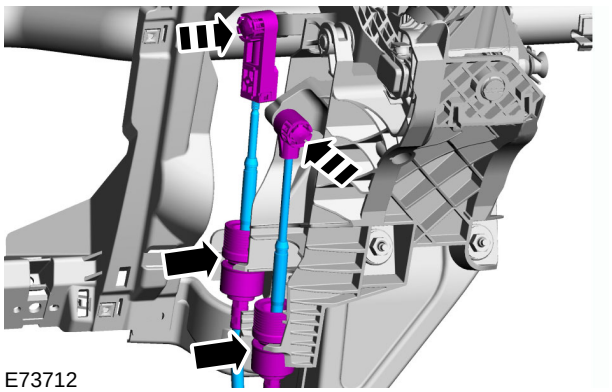


REMOVAL AND INSTALLATION

2. Torque: 9 Nm



3.



4. Adjust the selector cable.

Refer to:Gearshift Cable Adjustment - Vehicles With: MT-75/MT82 (308-00 Manual Transmission/Transaxle and Clutch - General Information, General Procedures).

5. Torque: 5 Nm



SECTION 309-00 Exhaust System

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 309-00-2

REMOVAL AND INSTALLATION

Catalytic Converter — 2.4L Duratorq-TDCi (Puma) Diesel..... 309-00-3
Catalytic Converter — 2.3L Duratec-HE (MI4)..... 309-00-5

SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Catalytic converter to turbocharger nuts – Vehicles with diesel engine	48	35	–
Catalytic converter to exhaust manifold nuts – Vehicles with petrol engine	48	35	–
Catalytic converter to support bracket bolts	25	18	–
Catalytic converter to support bracket nuts	25	18	–
Catalytic converter to muffler and tailpipe assembly nuts – Vehicles with diesel engine	48	35	–
Catalytic converter to muffler and tailpipe assembly nuts – Vehicles with petrol engine	47	35	–
Catalytic converter support bracket to catalytic converter nut – Vehicles with petrol engine	11	8	–
Heated oxygen sensor (HO2S)	47	35	–
Catalyst monitor sensor	47	35	–
Catalytic converter heat shield bolts	12	9	–

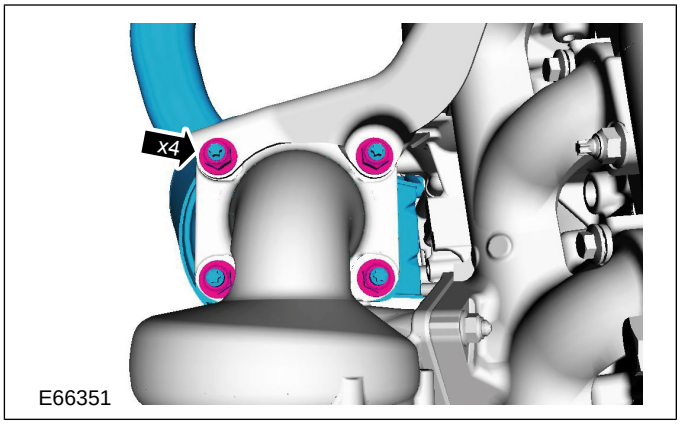
REMOVAL AND INSTALLATION

Catalytic Converter — 2.4L Duratorq-TDCi (Puma) Diesel

Materials	
Name	**Specification**
Grease	SA-M1C9107-A

Removal

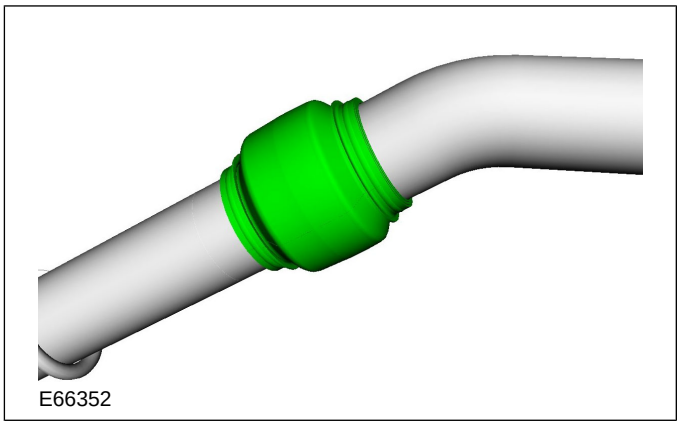
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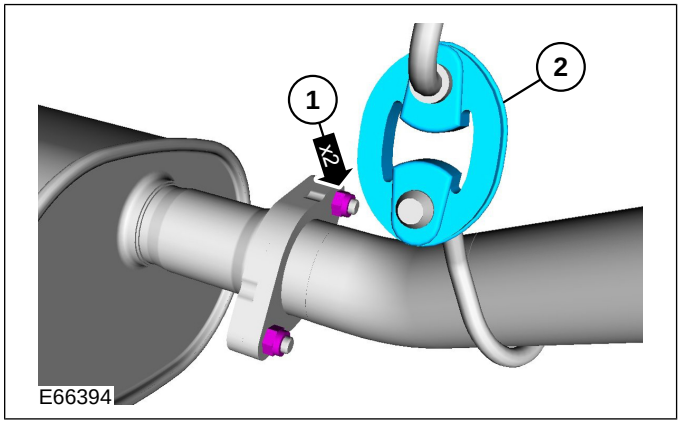
2. Raise and support the vehicle.

Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

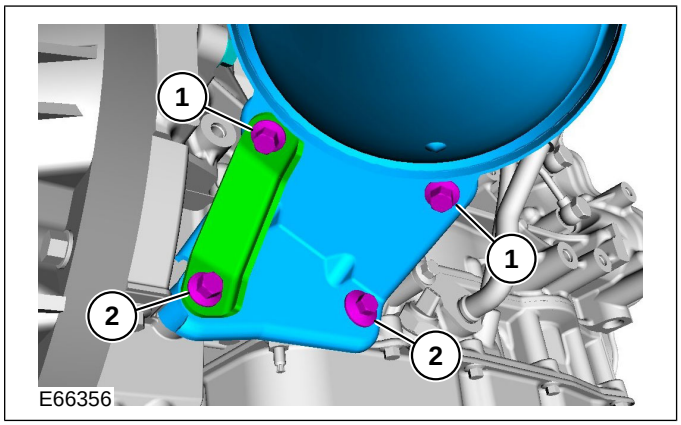
3. ⚠ **CAUTION:Make sure that the exhaust flexible pipe is not forcibly bent.**



4. **NOTE:**Make sure that the exhaust flexible pipe is not twisted.



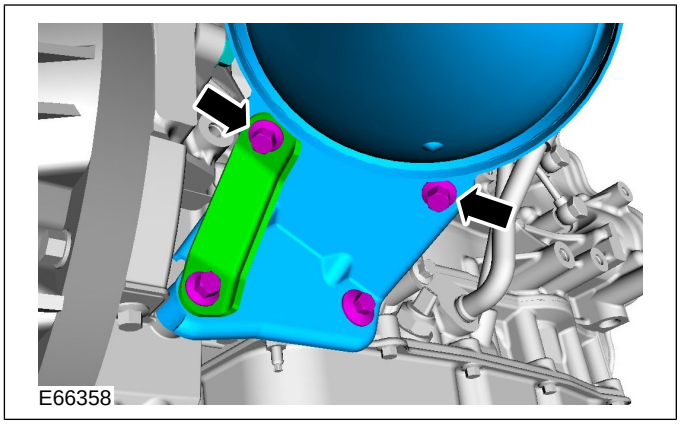
5. 1. Remove the bolts.
2. Loosen the bolts.



REMOVAL AND INSTALLATION

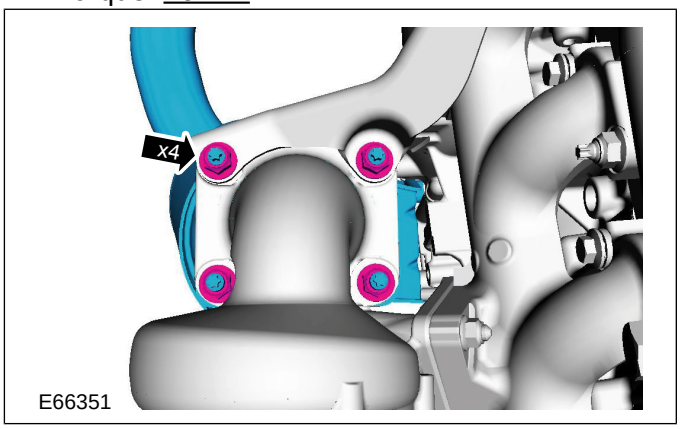
Installation

1. **NOTE:**Only tighten the bolts finger tight at this stage.


E66358

2. Lower the vehicle.
3. **CAUTION:Jointing compound must not be used forward of the catalytic converter.**

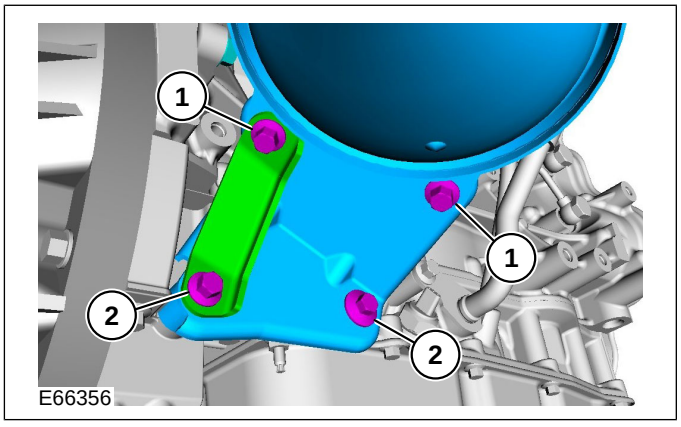
   Torque: 48 Nm



E66351

4. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).
5. 1. Torque: 25 Nm
   2. Torque: 25 Nm

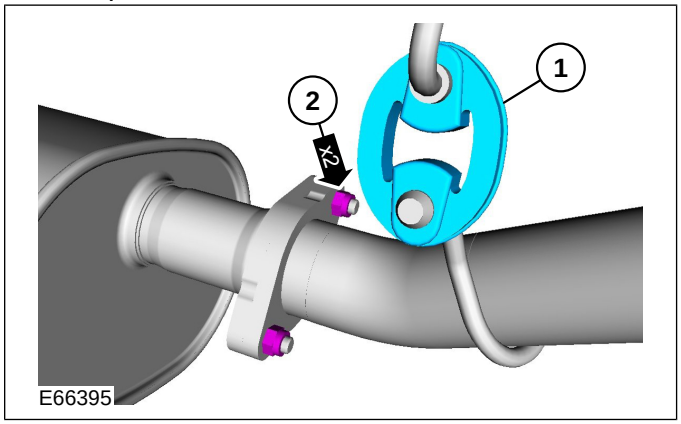


E66356

6. **NOTE:**Make sure that the exhaust flexible pipe is not twisted.

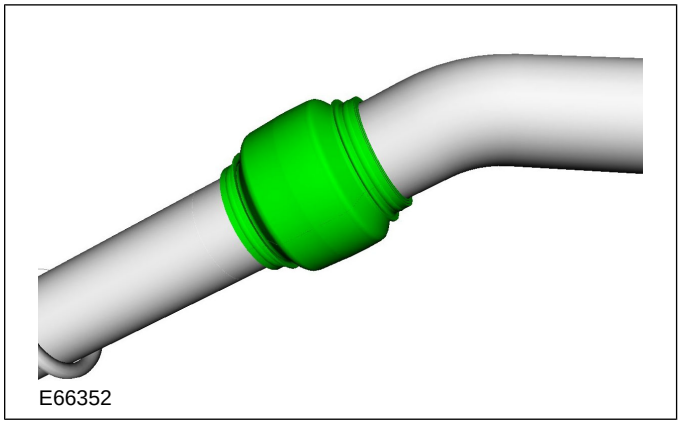
   Coat the studs with grease.

   Material: Grease
   Torque: 48 Nm



E66395

7. **CAUTION:Make sure that the exhaust flexible pipe is not forcibly bent.**


E66352

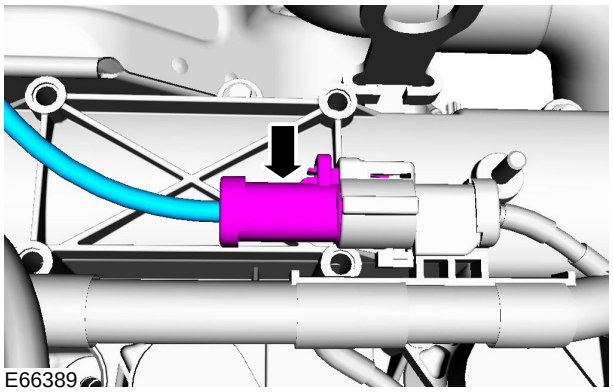
REMOVAL AND INSTALLATION

Catalytic Converter — 2.3L Duratec-HE (MI4)

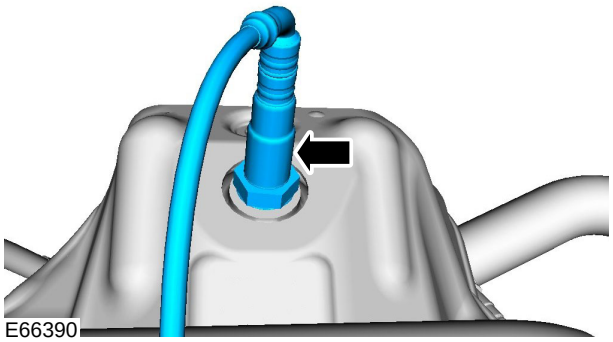
Materials	
Name	**Specification**
Grease	SA-M1C9107-A

Removal

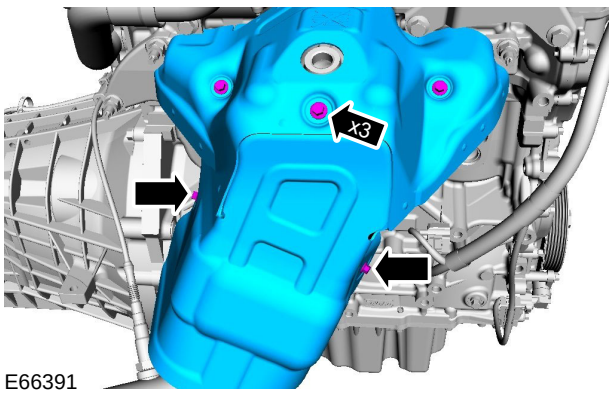
1.



2.



3.

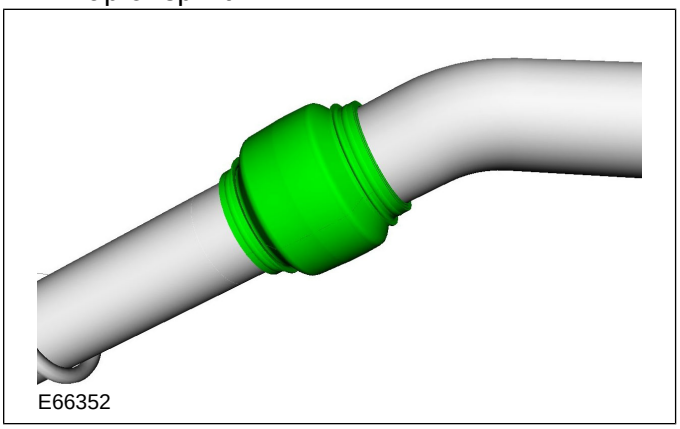


4. Raise and support the vehicle.

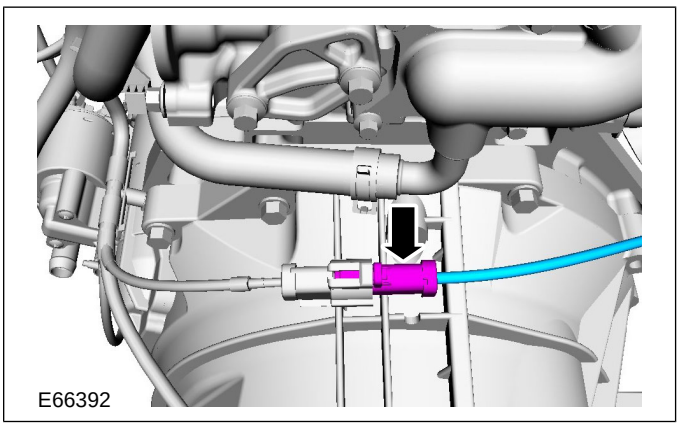
Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

5. **CAUTION:Make sure that the exhaust flexible pipe is not forcibly bent.**

Support the exhaust flexible pipe with a support wrap or splint.

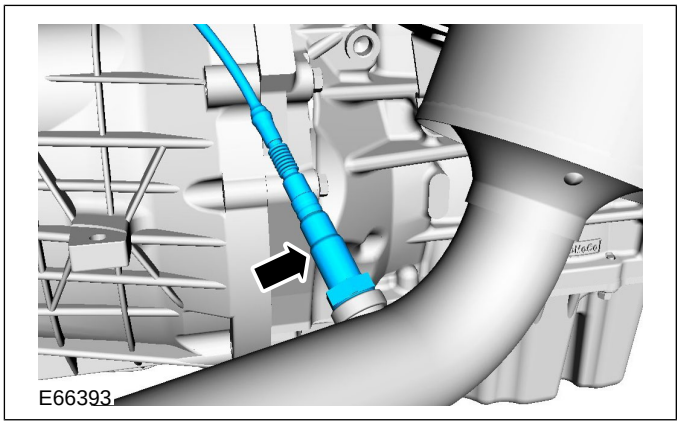


6.

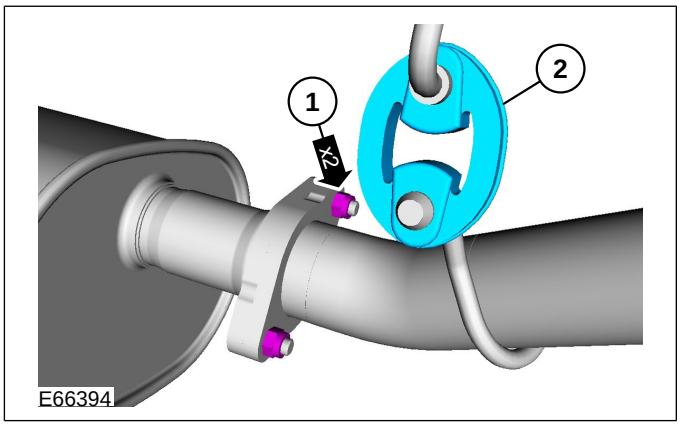


REMOVAL AND INSTALLATION

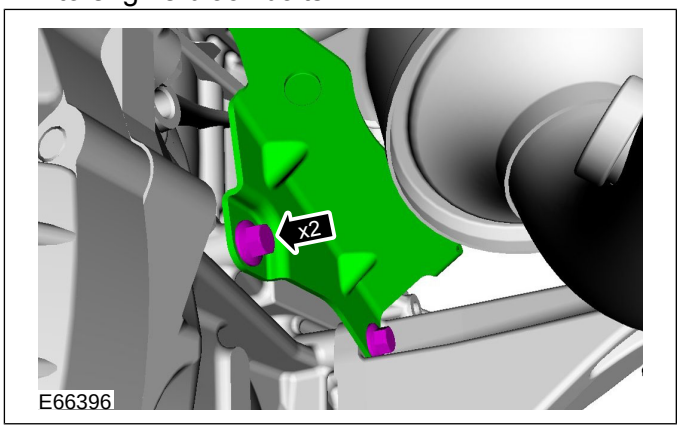
7.



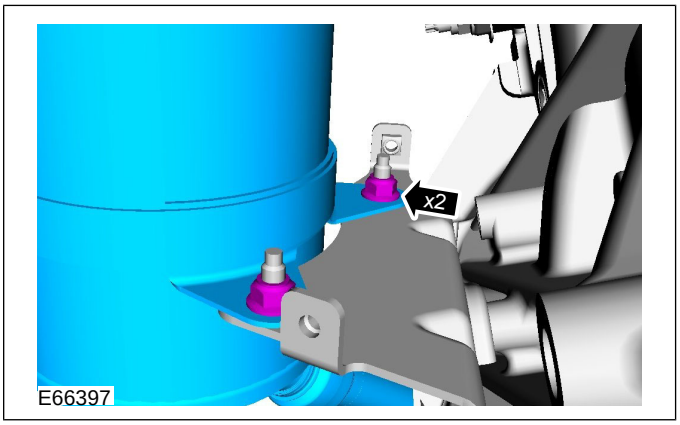
8. **NOTE:** Make sure that the exhaust flexible pipe is not twisted.



9. Loosen the catalytic converter support bracket to engine block bolts.

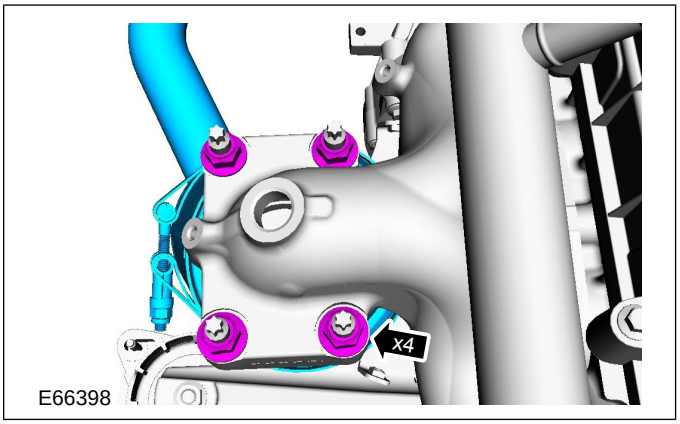


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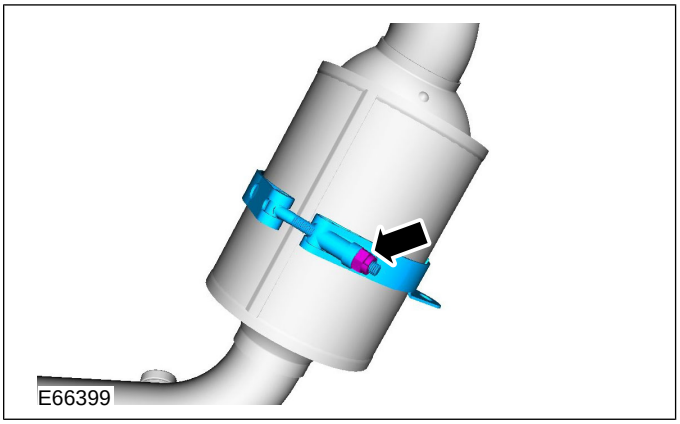


11. Lower the vehicle.

12.



13. **NOTE:** Make sure that this component is installed to the noted removal position.

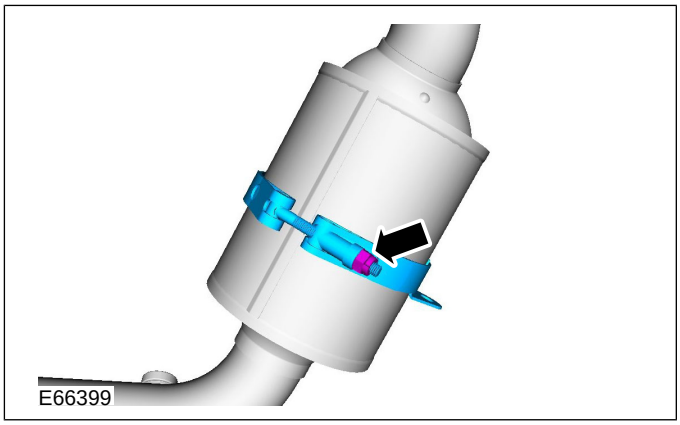


Installation

1. **NOTE:** Make sure that this component is installed to the noted removal position.

REMOVAL AND INSTALLATION

NOTE: Only tighten the nut finger tight at this stage.

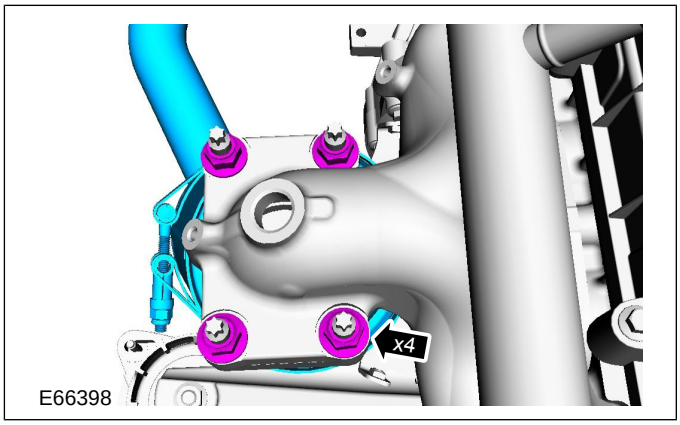


2. ⚠ **CAUTION:Jointing compound must not be used forward of the catalytic converter.**

   NOTE: Only tighten the nuts finger tight at this stage.

   Coat the studs with grease.

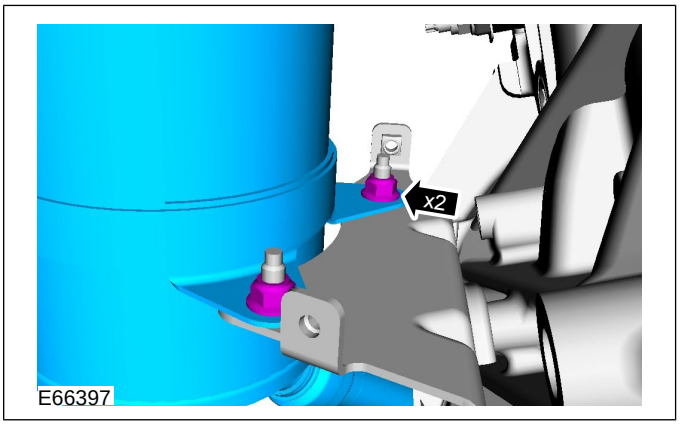
   Material: Grease



3. Raise and support the vehicle.

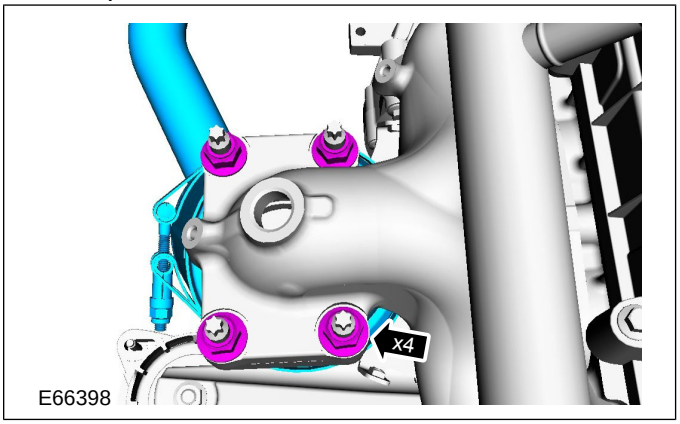
   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

4. **NOTE:**Only tighten the nuts finger tight at this stage.



5. Lower the vehicle.

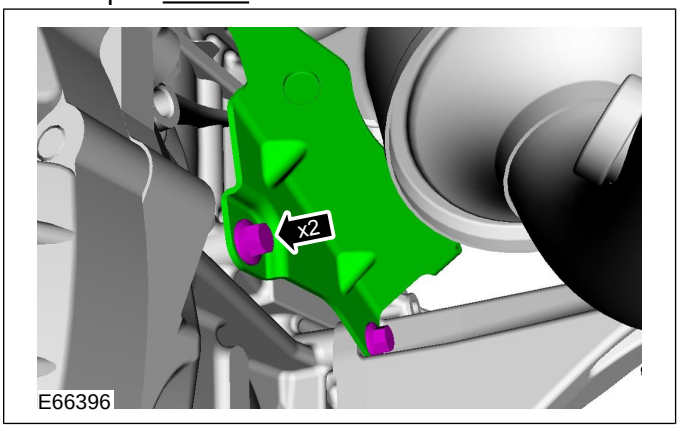
6. Torque: 48 Nm



7. Raise and support the vehicle.

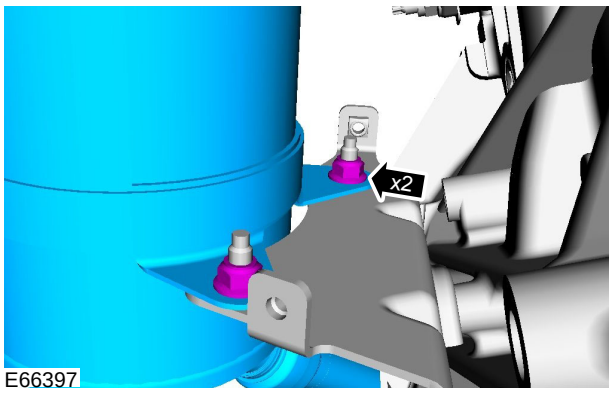
   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

8. Torque: 25 Nm

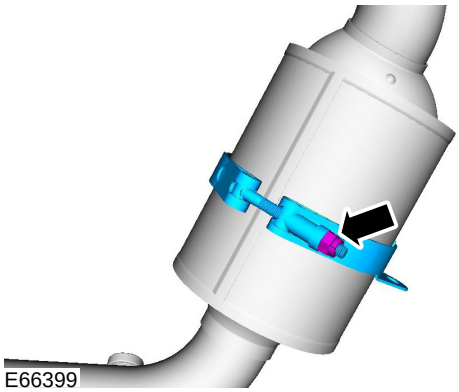


REMOVAL AND INSTALLATION

9. Torque: 25 Nm



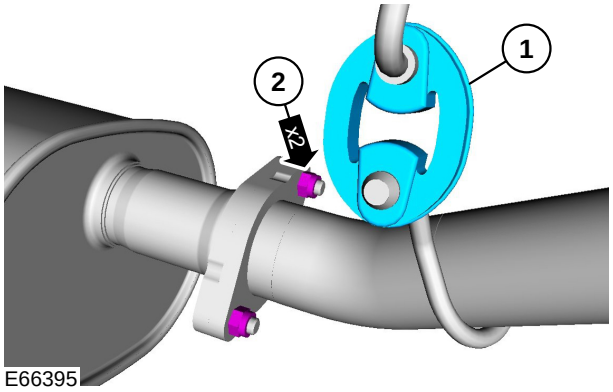
10. Torque: 11 Nm



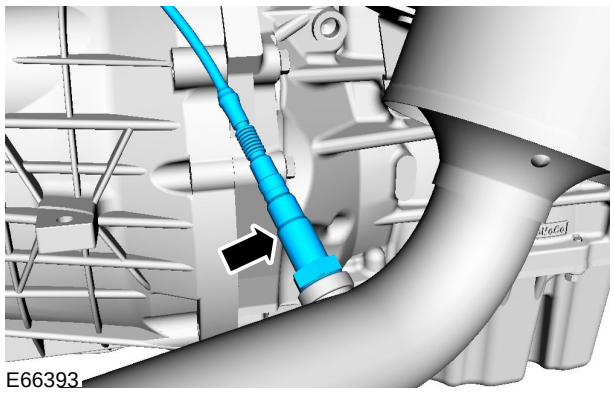
11. **NOTE:** Make sure that the exhaust flexible pipe is not twisted.

1. Coat the studs with grease.

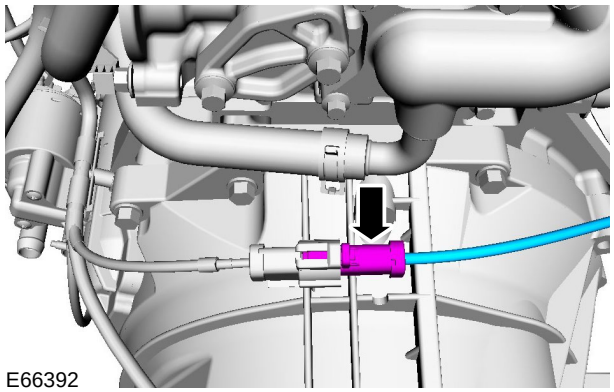
   Material: Grease
2. Torque: 47 Nm



12. Torque: 47 Nm

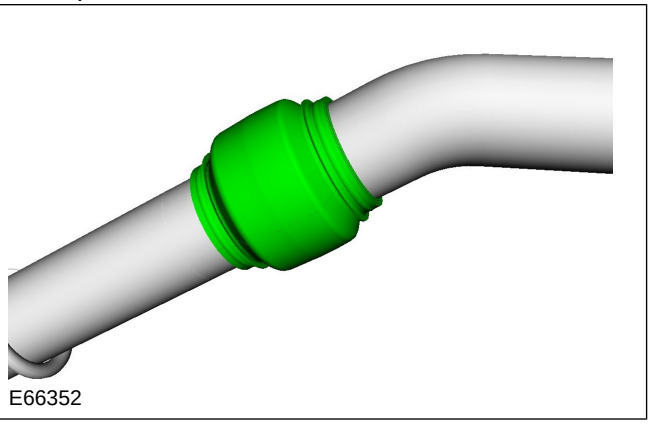


13.



14. **CAUTION: Make sure that the exhaust flexible pipe is not forcibly bent.**

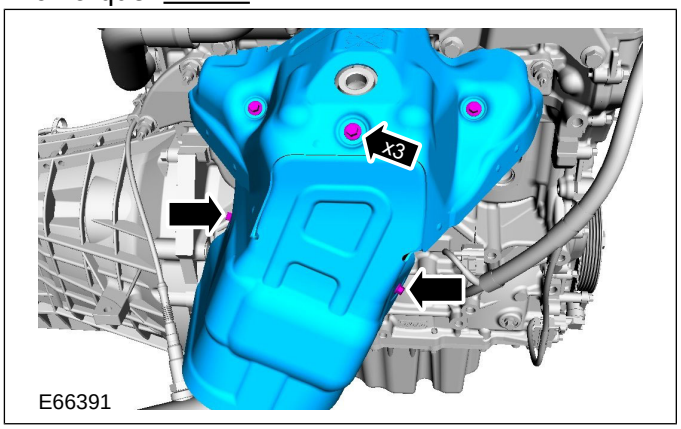
Remove the exhaust flexible pipe support wrap or splint.



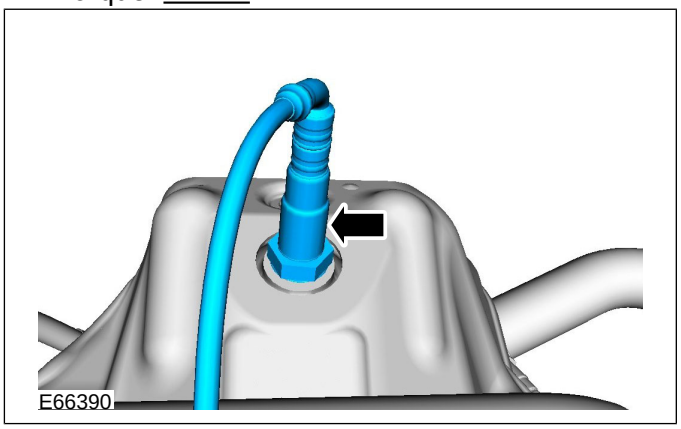
15. Lower the vehicle.

REMOVAL AND INSTALLATION

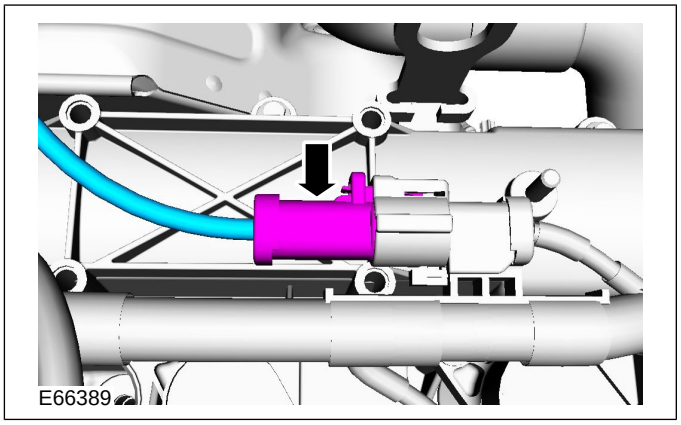
16. Torque: 12 Nm



17. Torque: 47 Nm



18.



SECTION 310-00 Fuel System - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Fuel System 310-00-2
Inspection and Verification 310-00-2
Symptom Chart 310-00-2
Pinpoint Tests 310-00-8
Component Tests 310-00-10

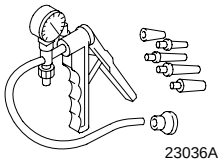
GENERAL PROCEDURES

Fuel System Pressure Release — 2.3L Duratec-HE (MI4) ..... (23 420 0) 310-00-13
Fuel Tank Draining ..... (23 551 0) 310-00-14
Quick Release Coupling 310-00-15
Fuel System Pressure Check — 2.3L Duratec-HE (MI4) 310-00-17

DIAGNOSIS AND TESTING

Fuel System

Special Tool(s)

 23036A	Hand Vacuum/Pressure Pump 416-D001 (23-036A)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Fuel level – Fuel filter minder gauge - vehicles with diesel engine – Fuel connector(s) – Gasket(s) – Seal(s) – Fuel line(s) – Fuel filter/water separator - vehicles with diesel engine – Fuel filter - vehicles with 2.3L engine – Fuel tank – Fuel tank filler pipe – Fuel filler cap – Fuel tank rollover valve(s) – Fuel cooler - vehicles with diesel engine with exhaust gas recirculation (EGR)	– Fuse(s) – Water-in-fuel lamp - vehicles with diesel engine – Wiring harness – Electrical connector(s) – Water-in-fuel sensor - vehicles with diesel engine – Fuel filter - vehicles with 2.3L engine – Inertia fuel shutoff (IFS) switch - vehicles with EGR – Fuel pump

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to WDS - vehicles with 2.3L engine.
5. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart - vehicles with diesel engine.

Symptom Chart

Symptom Chart

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Engine cranks but does not start	• Fuel charging and controls.	• REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
	• Air ingress into the fuel lines.	• GO to Pinpoint Test A.
• Poor starting	• Fuel charging and controls.	• REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
	• Air ingress into the fuel lines.	• GO to Pinpoint Test A.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Engine starts but immediately stops	• Fuel charging and controls.	• REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
	• Air ingress into the fuel lines.	• GO to Pinpoint Test A.
• Poor idling	• Fuel charging and controls.	• REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
	• Air ingress into the fuel lines.	• GO to Pinpoint Test A.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Engine lacks power	• Fuel charging and controls.	• REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
	• Air ingress into the fuel lines.	• GO to Pinpoint Test A.
• Engine misfire	• Fuel charging and controls.	• REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
	• Air ingress into the fuel lines.	• GO to Pinpoint Test A.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Excessive fuel consumption	• Fuel charging and controls.	• REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
	• Air ingress into the fuel lines.	• GO to Pinpoint Test A.
• Fuel filter minder gauge indicating red	• Fuel filter element blocked.	• CARRY OUT the Fuel Filter Element Component Test in this section.
	• Fuel supply line from the fuel tank to fuel filter blocked.	• CHECK fuel supply lines for damage. REPAIR as necessary. • CHECK fuel supply line for blockage. Using a hand vacuum/pressure pump, APPLY a vacuum to the supply line at the fuel filter inlet. Fuel should draw easily from the fuel tank.
	• Fuel level sensor supply inlet blocked.	• CHECK for fuel level sensor inlet blockage. Using a hand vacuum/pressure pump, APPLY a vacuum to the fuel supply line at the fuel line junction on the left-hand body rail. Fuel should draw easily from the fuel tank. • If fault not found in above, REMOVE fuel supply lines and REPAIR blockage. • If unable to draw fuel easily. REMOVE the fuel tank and REMOVE the fuel tank sender unit to INSPECT and REPAIR supply inlet.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Fuel filter/water separator internal restriction.	• CHECK fuel filter supply circuit flow. Using a hand vacuum/pressure pump, APPLY a vacuum to the fuel filter supply outlet (large fitting on the left-hand side of the fuel filter). Fuel should draw easily from this port. INSTALL a new fuel filter/water separator if fuel does not flow easily.
	• Fuel filter minder gauge malfunction.	• CARRY out the Fuel Filter Minder Gauge Component Test in this section.
	• Fuel lift pump inoperative - vehicles with 120 PS engine with EGR.	• CARRY OUT the Fuel Lift Pump Component Test in this section.
• Water-in-fuel warning lamp staying on	• Water in fuel filter assembly.	• DRAIN the water from the fuel filter.
	• Water in fuel tank.	• DRAIN the water from the fuel filter. CHECK the water-in-fuel warning light operation prior to starting the vehicle. If water-in-fuel warning light reappears, fuel tank should be drained and filled with clean fuel.
	• Water-in-fuel warning lamp.	• CARRY OUT the Water-In-Fuel Sensor Component Test in this section.
• Fuel filler nozzle shuts off prematurely	• Fuel filler vent tube blocked.	• CHECK filler vent tube and REPAIR as necessary.
	• Fuel filler pipe and hose blocked.	• CHECK filler pipe and hose and REPAIR as necessary.
	• Fuel gauge indication.	• CHECK fuel level in the tank. CHECK fuel indication system. REFER to Section 413-01 [Instrument Cluster].
	• Fuel filler nozzle at fill station not functioning properly.	• CHECK condition at known good filling station.
• Fuel loss after nozzle shutoff or during fill	• Fuel filler vent tube or hose blocked.	• CHECK filler vent tube and hose and REPAIR as necessary.
	• Leak in fuel tank or vent tube.	• CHECK fuel tank and vent tube for evidence of fuel leak.

DIAGNOSIS AND TESTING

Pinpoint Tests

PINPOINT TEST A : AIR INGRESS INTO THE FUEL SYSTEM

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK FOR AIR INGRESS INTO THE FUEL SYSTEM	
WARNINGS: **Do not smoke or carry lighted tobacco of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may ignite. Failure to follow these instructions may result in personal injury.**	
This procedure involves fuel handling. Be prepared for fuel spillage at all times and always observe fuel handling precautions. Failure to follow this instruction may result in personal injury.	
	CAUTION:The generator must be protected from contamination. Failure to follow this instruction may cause premature failure of the generator 1 Protect the generator with lint-free material to prevent contamination (vehicles with 2.0 L diesel engine).
	2 Using a suitable piece of clear plastic pipe, manufacture a pipe that may be installed between the fuel injection pump and the fuel filter return line.
	3 Install the clear plastic pipe between the fuel injection pump and the fuel injection pump to fuel filter return line.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Start the engine, wait a few minutes and then visually observe the clear plastic pipe for signs of air ingress. • Are any signs of air present in the clear plastic pipe? → **Yes** GO to A2. → **No** REMOVE the clear pipe and CONNECT the fuel return line to the fuel injection pump. For additional diagnostics for Fuel Charging and Controls REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].REFER to Section 303-04A [Fuel Charging and Controls -- 2.3L Duratec-HE (MI4)] / 303-04B [Fuel Charging and Controls - Turbocharger] / 303-04C [Fuel Charging and Controls -- 2.2L Duratorq-TDCi (Puma) Diesel] / 303-04D [Fuel Charging and Controls -- 2.4L Duratorq-TDCi (Puma) Diesel].
A2: CHECK WHERE AIR IS ENTERING THE SYSTEM	
	1 Using suitable clean engine oil, apply the oil to each of the fuel supply and fuel return connections, unions and joints in turn and observe the clear pipe for visible signs of air after each oil application. • Did the amount air in the clear plastic pipe decrease when any of the connectors, unions or joints were oiled? → **Yes** REPAIR the connector(s) or union(s) in question. Test the system for normal operation. → **No** GO to A3.
A3: CHECK THE FUEL FILTER HOUSING FOR SIGN OF AIR INGRESS	
	1 Ignition switch in position 0.
	2 Disconnect the fuel injection pump return line from the fuel filter and the fuel filter to fuel tank return line.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Using a suitable connector, connect the fuel injection pump return line to the fuel filter to fuel tank return line.
	4 Start the engine and observe the clear plastic pipe for visible signs of air. • Did the air decrease in the clear plastic pipe? → **Yes** Air ingress is at the fuel filter or housing. REPAIR or INSTALL a new fuel filter or housing as necessary. Test the system for normal operation. → **No** INSTALL a new fuel level sensor. REFER to Section 310-01 [Fuel Tank and Lines].

Component Tests

Fuel Filter Element - Vehicles with 75 PS, 90 PS or 100 PS Engine

Carry out the following test to determine if a new fuel filter element should be installed.

1. With the engine switched OFF, check the position of the yellow plunger in the fuel filter minder gauge.
2. If the yellow plunger is in the clear or red zones, press the yellow button on the top of the fuel filter minder gauge and hold for 3 seconds to reset it.
3. Start the engine. Slowly raise the engine speed to 4000 rpm and hold for 7 seconds.
4. Check the position of the yellow plunger in the fuel filter minder gauge.
5. If the yellow plunger is in the green zone, a new fuel filter element does not have to be installed.
6. If the yellow plunger is in the clear zone and the vehicle is in for a service, a new fuel filter element should be installed.
7. If the yellow plunger is in the red zone, a new fuel filter element must be installed.

Fuel Filter Element - Vehicles with 120 PS Engine

Carry out the following test to determine if a new fuel filter element should be installed.

1. With the engine running at idle speed, check the position of the yellow plunger in the fuel filter minder gauge.
2. If the yellow plunger is in the clear or red zones, press the yellow button on the top of the fuel filter minder gauge and hold for 3 seconds to reset it.
3. Slowly raise the engine speed to 4000 rpm and hold for 7 seconds.
4. Check the position of the yellow plunger in the fuel filter minder gauge.
5. If the yellow plunger is in the green zone, a new fuel filter element does not have to be installed.
6. If the yellow plunger is in the clear zone and the vehicle is in for a service, a new fuel filter element should be installed.
7. If the yellow plunger is in the red zone, a new fuel filter element must be installed.

Fuel Filter Minder Gauge - Vehicles with Diesel Engine

WARNINGS:

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may ignite. Failure to follow these instructions may result in personal injury.

DIAGNOSIS AND TESTING

This procedure involves fuel handling. Be prepared for fuel spillage at all times and always observe fuel handling procedures. Failure to follow this instruction may result in personal injury.

1. Remove the fuel filter minder gauge from the fuel filter.
2. Press the yellow button on the top of the fuel filter minder gauge and hold for 3 seconds to reset it. Using a hand vacuum/pressure pump, apply a vacuum of 17 Kpa to the fuel filter minder gauge. The yellow plunger should be at the first lock in the green zone.
3. Press the yellow button on the top of the fuel filter minder gauge and hold for 3 seconds to reset it. Apply a vacuum of 21 Kpa to the fuel filter minder gauge. The yellow plunger should be at the second lock in the green zone.
4. Press the yellow button on the top of the fuel filter minder gauge and hold for 3 seconds to reset it. Apply a vacuum of 25 Kpa to the fuel filter minder gauge. The yellow plunger should be at the third lock in the clear zone.
5. Press the yellow button on the top of the fuel filter minder gauge and hold for 3 seconds to reset it. Apply a vacuum of 30 Kpa to the fuel filter minder gauge. The yellow plunger should be at the fourth lock in the red zone.
6. If the fuel filter minder gauge does not function as above, INSTALL a new fuel filter minder gauge.

Fuel Lift Pump - Vehicles with 120 PS Engine with EGR

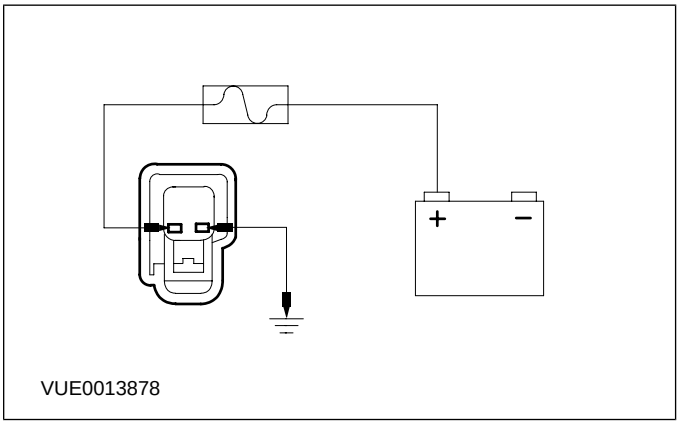
WARNINGS:

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may ignite. Failure to follow these instructions may result in personal injury.

This procedure involves fuel handling. Be prepared for fuel spillage at all times and always observe fuel handling procedures. Failure to follow this instruction may result in personal injury.

NOTE: Battery voltage is not always present at the fuel lift pump electrical connector with the key in the ON position. If no battery voltage is present wait approximately one to two minutes and recheck for battery voltage before repairing the circuit.

1. Disconnect the fuel lift pump electrical connector.
2. With the key in the ON position check for battery voltage at the fuel lift pump harness side electrical connector.
3. Disconnect the fuel injection pump supply line from the fuel filter and install a suitable pipe in its place.
4. Place the open end of the pipe into a suitable 2 liter measuring container.



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5. Using a fused 15A jumper wire, supply battery voltage and a good ground to the fuel lift pump electrical connector for 20 seconds only.
6. The fuel lift pump should deliver approximately 90 ml of fuel in 20 seconds.

Water-In-Fuel Sensor - Vehicles with Diesel Engine

WARNINGS:

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may ignite. Failure to follow these instructions may result in personal injury.

This procedure involves fuel handling. Be prepared for fuel spillage at all times and always observe fuel handling procedures. Failure to follow this instruction may result in personal injury.

1. Disconnect the electrical connector from the water-in-fuel sensor.

DIAGNOSIS AND TESTING

2. Visually inspect the water-in-fuel warning lamp. If the water-in-fuel warning lamp extinguishes, INSTALL a new water-in-fuel sensor.
3. If the water-in fuel warning lamp is still illuminated, disconnect the electrical connector from the fuel filter.
4. Visually observe the water-in-fuel warning lamp. If the water-in-fuel warning lamp extinguishes, INSTALL a new fuel filter. REFER to Section 310-01 [Fuel Tank and Lines].

GENERAL PROCEDURES

Fuel System Pressure Release — 2.3L Duratec-HE (MI4) (23 420 0)

Release

1. **WARNINGS:**

   Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

   The fuel system remains pressurized for a long time after the ignition is switched off. The fuel pressure must be released before attempting any repairs. Failure to follow this instruction may result in personal injury.

   Remove the fuel pump fuse.
2. **Start the engine and allow to idle until the engine stalls.**
3. **Crank the engine for approximately five seconds to make sure the fuel injection supply manifold pressure has been released.**
4. **Install the fuel pump fuse.**

GENERAL PROCEDURES

Fuel Tank Draining (23 551 0)

General Equipment

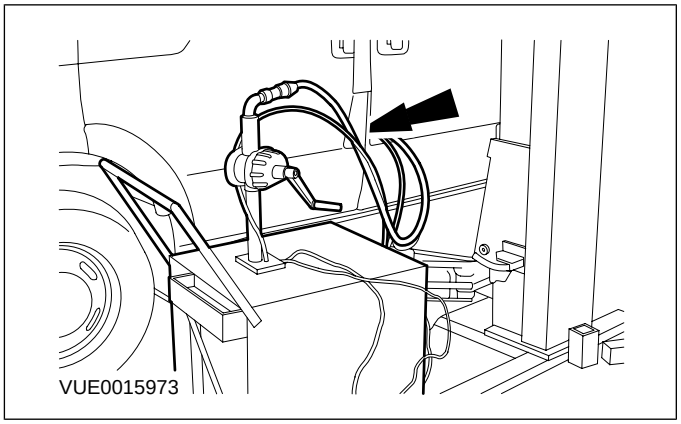
Fuel tank draining equipment

WARNING:Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may ignite. Failure to follow these instructions may result in personal injury.

CAUTION:Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install blanking plugs to any open orifices or lines.

1. **Disconnect the battery ground cable. For additional information, refer to Section 414-01 [Battery, Mounting and Cables].**
2. **Remove the fuel filler cap.**
3. **WARNING:Depending on the type of drain tube being used, fuel may still be present in the fuel tank after draining. Do not assume that the fuel tank is empty. Failure to follow this instruction may result in personal injury.**

   Using suitable fuel tank draining equipment, drain the fuel tank.



GENERAL PROCEDURES

Quick Release Coupling

Materials	
Name	**Specification**
Engine oil	WSS-M2C913-A or WSS-2C912-A1

Disconnection

WARNING:Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may ignite. Failure to follow these instructions may result in personal injury.

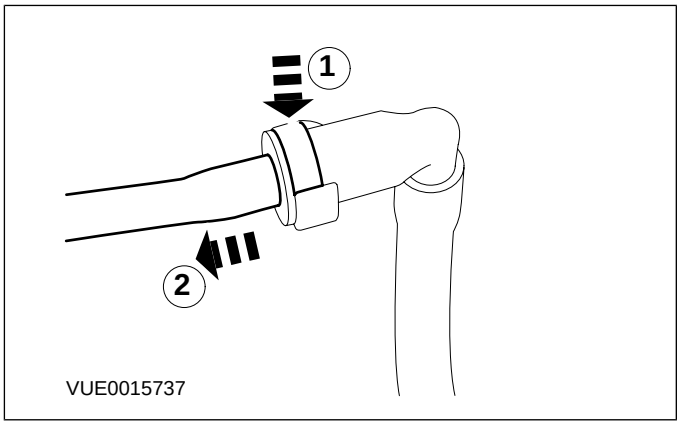
CAUTIONS:

Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install blanking plugs to any open orifices or lines.

Do not use tools or excessive force to disconnect quick release couplings.

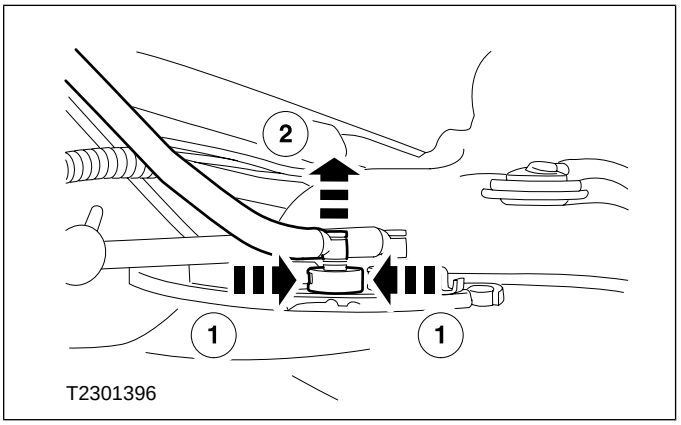
1. Disconnect the fuel line quick release coupling

1. Press the tang.
2. Disconnect the fuel line quick release coupling.



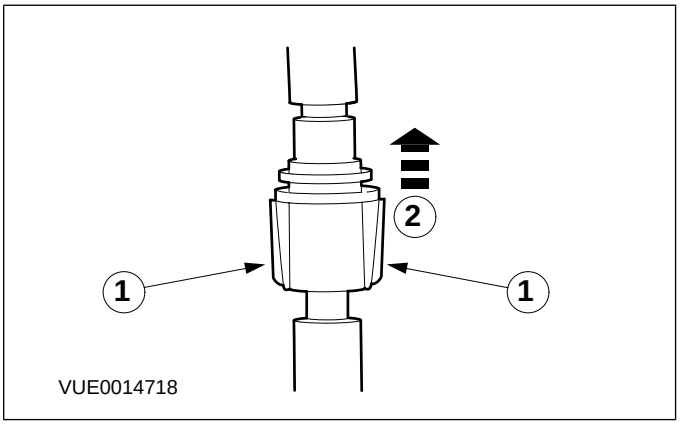
2. Disconnect the fuel line quick release coupling

1. Press the tangs.
2. Disconnect the fuel line quick release coupling.



3. Disconnect the fuel line quick release coupling

1. Press the tangs.
2. Disconnect the fuel line quick release coupling.



Connection

WARNING:Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may ignite. Failure to follow these instructions may result in personal injury.

CAUTIONS:

Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install blanking plugs to any open orifices or lines.

GENERAL PROCEDURES

When connecting a quick release coupling, make sure it makes an audible click. Check that the quick release coupling cannot be separated without pressing the tang(s). Failure to follow these instructions may result in a fuel leak.

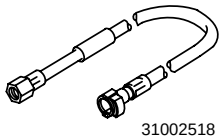
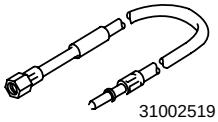
Make sure the quick release couplings are free from contamination and that the O-ring seals are not damaged. Install new O-ring seals if necessary.

1. **Coat the quick release coupling O-ring seals with clear engine oil.**
2. **To connect, reverse the disconnection procedure.**

GENERAL PROCEDURES

Fuel System Pressure Check — 2.3L Duratec-HE (MI4)

Special Tool(s)

 31002518	Test Hose for 310-025 310-025-18 (23-024-10)
 31002519	Test Hose for 310-025 310-025-19A (23-024-11A)

General Equipment

Worldwide Diagnostic System (WDS) (418-F224)

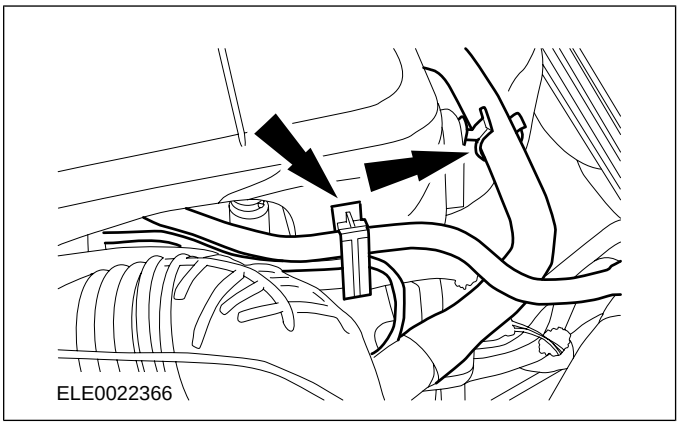
1. **WARNING:Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.**

This procedure involves fuel handling. Be prepared for fuel spillage at all times and always observe fuel handling precautions. Failure to follow these instructions may result in personal injury.

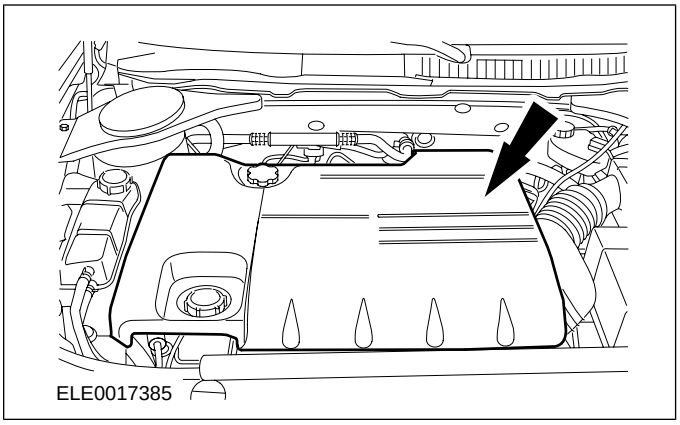
Release the fuel system pressure.

For additional information, refer to:Fuel System Pressure Release - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).

2. **Detach the positive crankcase ventilation (PCV) hose and the vacuum hose from the engine upper cover.**



3. **Remove the engine upper cover.**

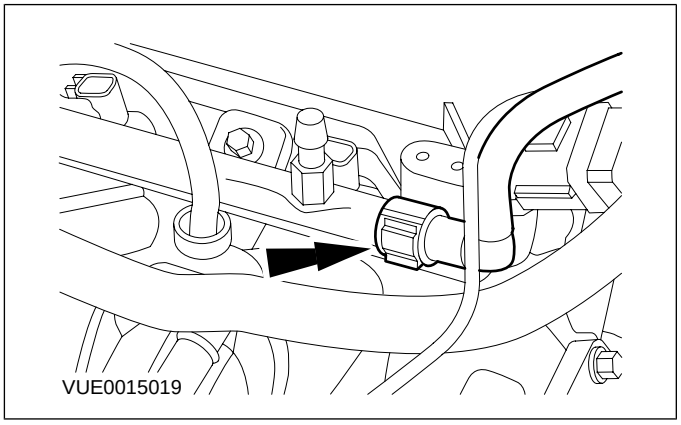


4. **NOTE:Fuel supply line connectors are white or are identified by a white band. Fuel return line connectors are red or are identified by a red band.**

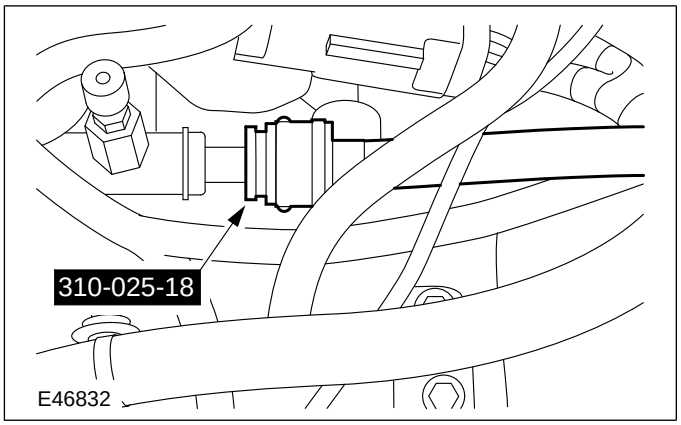
GENERAL PROCEDURES

Disconnect the fuel supply line from the fuel injection supply manifold.

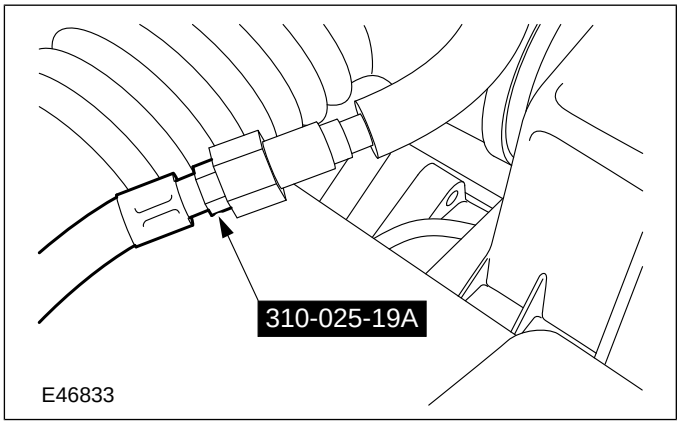
For additional information, refer to: Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).



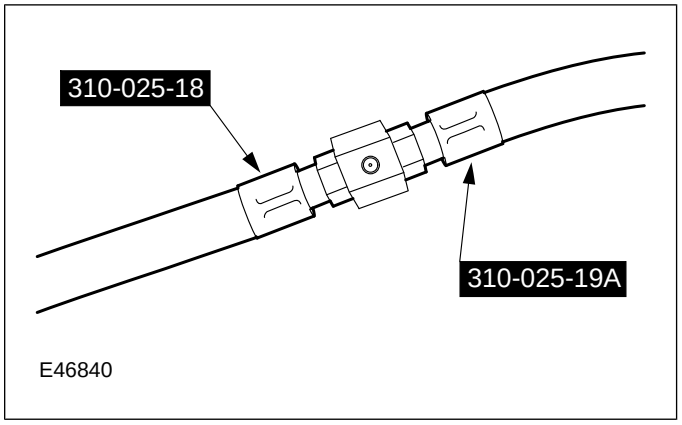
5. Connect the special tool to the fuel injection supply manifold.



6. Connect the special tool to the fuel injection supply manifold fuel supply line.



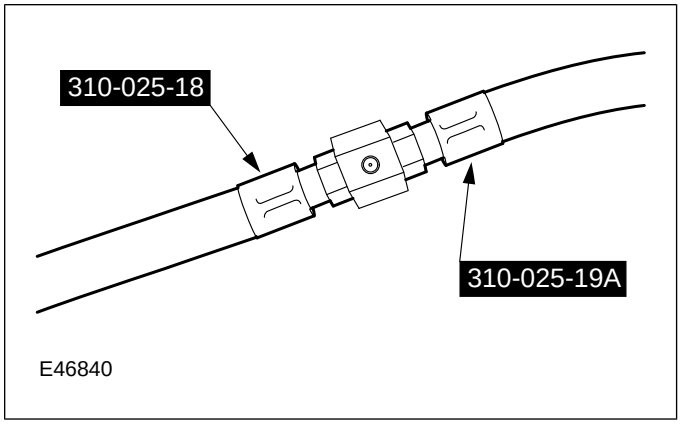
7. Connect the WDS pressure/vacuum transducer adapter to the special tools.



8. Connect the WDS pressure/vacuum transducer to the WDS pressure/vacuum transducer adapter.
9. NOTE: The fuel system pressure should be 3.8 ± 0.2 bar after key on and it should maintain this pressure when the engine is running.

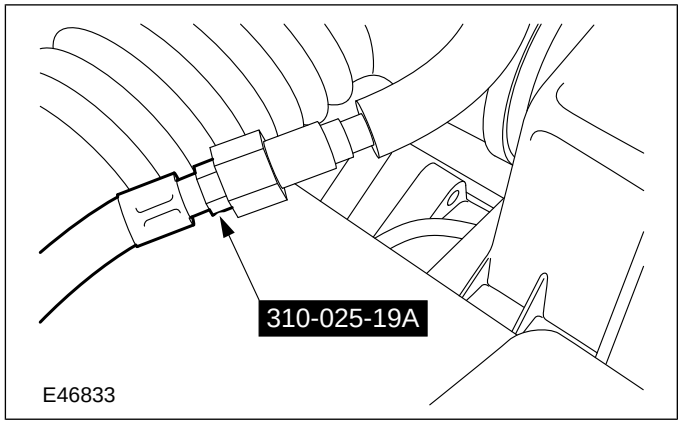
   Using the digital multi-meter function in WDS, start the engine and measure the fuel system pressure.
10. Release the fuel system pressure.

    For additional information, refer to: Fuel System Pressure Release - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).
11. Disconnect the WDS pressure/vacuum transducer from the WDS pressure/vacuum transducer adapter.
12. Disconnect the WDS pressure/vacuum transducer adapter from the special tools.

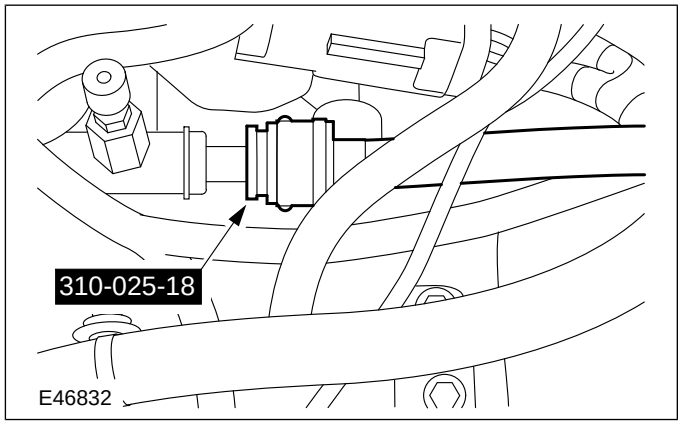


GENERAL PROCEDURES

13. Disconnect the special tool from the fuel injection supply manifold fuel supply line.



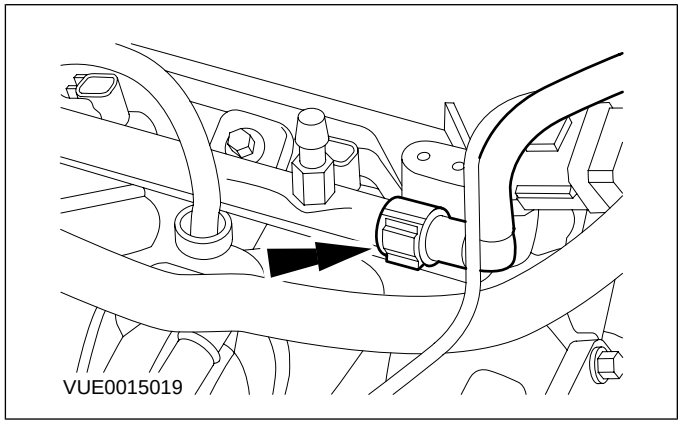
14. Disconnect the special tool from the fuel injection supply manifold.



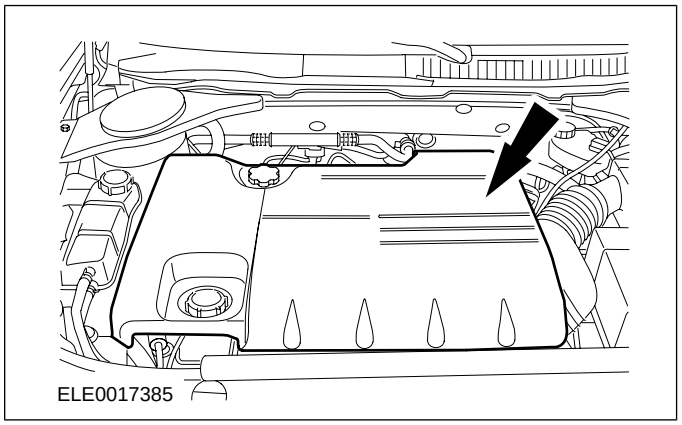
15. NOTE:Fuel supply line connectors are white or are identified by a white band. Fuel return line connectors are red or are identified by a red band.

    Connect the fuel supply line to the fuel injection supply manifold.

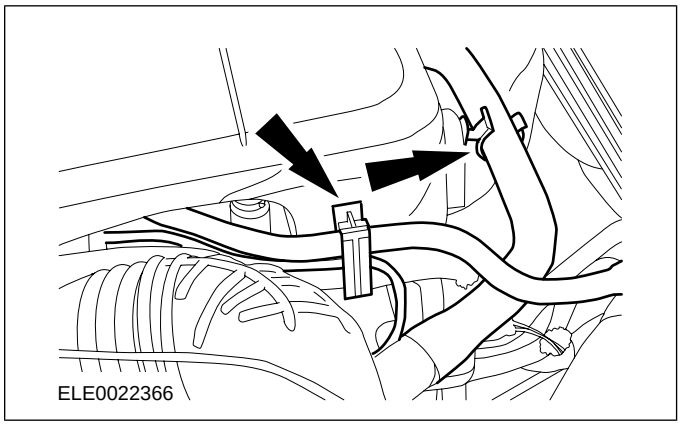
    For additional information, refer to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).



16. Install the engine upper cover.



17. Attach the PCV hose and the vacuum hose to the engine upper cover.



SECTION 310-01 Fuel Tank and Lines

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Fuel Tank and Lines 310-01-2
Vehicles with 2.2L/2.4L Duratorq-TDCi (Puma) diesel engine 310-01-2
Vehicles with 2.3L Duratec-HE (MI4) engine 310-01-5
All vehicles 310-01-8

DIAGNOSIS AND TESTING

Fuel Tank and Lines 310-01-9

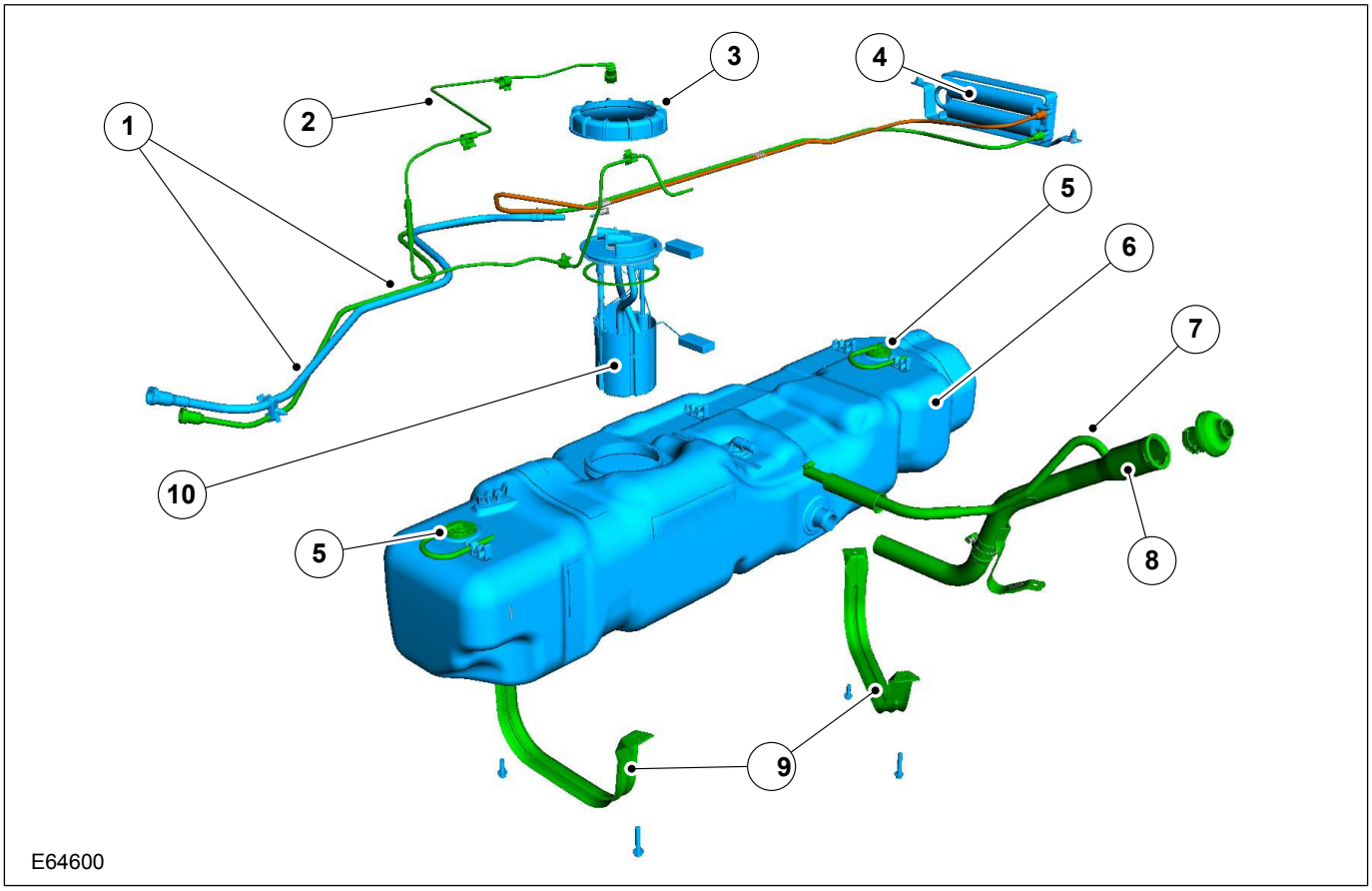
REMOVAL AND INSTALLATION

Fuel Tank ..... (23 554 0) 310-01-10
Fuel Filter — 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel 310-01-13
Fuel Filter — 2.3L Duratec-HE (MI4) 310-01-15
Fuel Filter Element — 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel 310-01-16
Water-in-Fuel Sensor 310-01-20

DESCRIPTION AND OPERATION

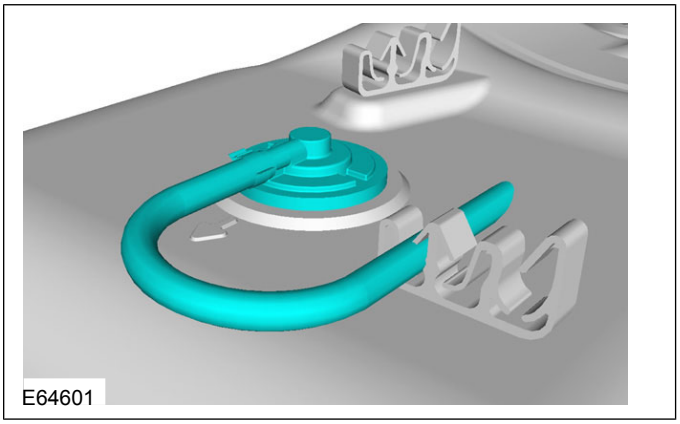
Fuel Tank and Lines

Vehicles with 2.2L/2.4L Duratorq-TDCi (Puma) diesel engine



Item	Description
1	Fuel supply and return lines
2	Fuel fired booster heater fuel supply line
3	Fuel level sensor locking ring
4	Fuel cooler
5	Fuel tank vent valve(s)
6	Fuel tank
7	Fuel tank filler pipe breather pipe
8	Fuel tank filler pipe
9	Fuel tank support straps
10	Fuel level sensor

Fuel Tank Vent Valves



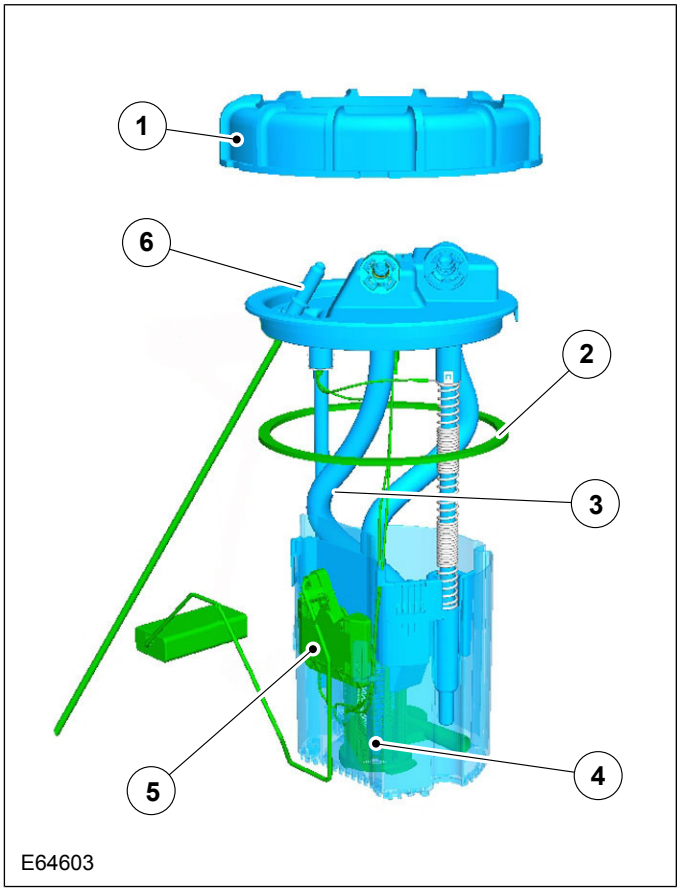
Fuel tank ventilation is achieved by two fuel tank vent valves. The fuel tank vent valves are integral to the fuel tank and will prevent fuel loss from the fuel tank if the vehicle becomes inverted.

DESCRIPTION AND OPERATION

Under normal working conditions, the pressure within the fuel tank is controlled by allowing the fuel vapor to vent through the fuel tank vent valves to atmosphere. If the fuel tank becomes inverted, the fuel tank vent valves close preventing fuel being lost from the fuel tank.

If the fuel tank vent valves or the fuel vapor lines connected to the vent valves become restricted, vehicle performance will become impaired. The inability of the fuel tank to substitute the fuel demanded by the fuel charging system with air, will create a negative pressure in the fuel tank which will result in reduced fuel flow to the fuel pump.

Fuel Level Sensor



E64603

Item	Description
1	Fuel level sensor locking ring
2	Fuel level sensor sealing ring
3	Fuel tank fuel return
4	Fuel jet pump and filter
5	Fuel level sensor resistor card
6	Fuel fired booster heater fuel pickup connector

The fuel level sensor is located in the top of the fuel tank and is retained by a fuel level sensor locking ring and seal.

The fuel level sensor consists of a mechanical float attached to a variable resistor card by means of a rigid wire lever. The resistor card has two electrical elements. One element is solid and one element is a variable resistor. The resistance value created by the resistor card is sent to the central junction box (CJB) through a hard wired circuit. The CJB distributes the information from the fuel level sensor to the instrument cluster and the powertrain control module (PCM) using the controller area network (CAN) circuits.

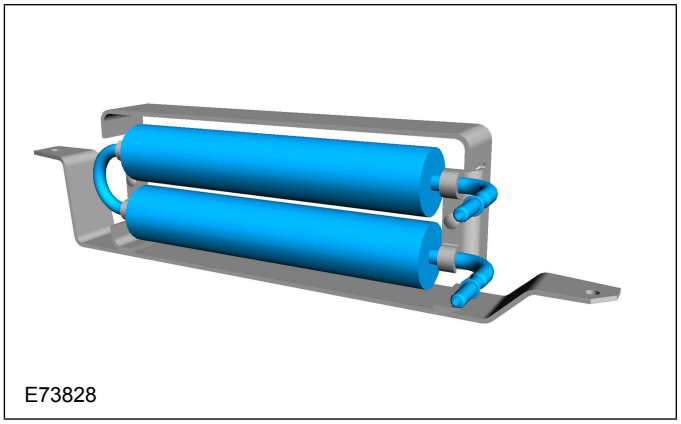
The fuel level sensor resistor card can be susceptible to contaminated fuel, which can affect electrical continuity. This condition is normally temporary and self-rectifying. If the fuel level sensor has been removed, moving the rigid wire lever from empty to full a minimum of 10 times will normally be as effective as installing a new fuel level sensor. The most common symptom of contamination occurs after refuelling where the electrical contact moves to an area of the resistor card which has not been used for several days. This results in a very slow movement of the fuel gauge pointer from empty to full over approximately 15 minutes. In more extreme cases where the resistor card resistance is continuously outside the permitted range for more than 33 seconds, a DTC will be set in the CJB and the fuel gauge pointer will fall to its key-off position. In all cases where the fuel level sensor is suspected of being inoperative, worn or damaged, the Worldwide Diagnostic System (WDS) diagnostic procedures must be followed before any parts are dismantled.

The base of the fuel level sensor is a chamber that sits in the swirl bowl at the bottom of the fuel tank. Built into the chamber is a filter element.

The fuel level sensor also incorporates a fuel jet pump. The return fuel from the fuel charging system is passed through a venturi in the jet pump which causes a pressure drop across an open orifice. This draws in fuel through the base of the unit which then passes through the fuel supply tube.

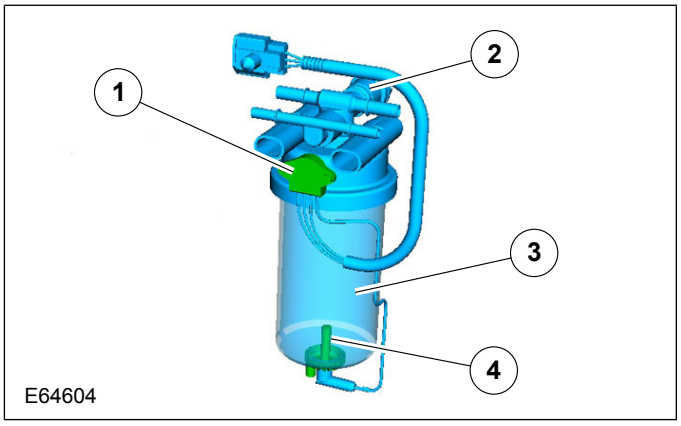
DESCRIPTION AND OPERATION

Fuel Cooler (if equipped)



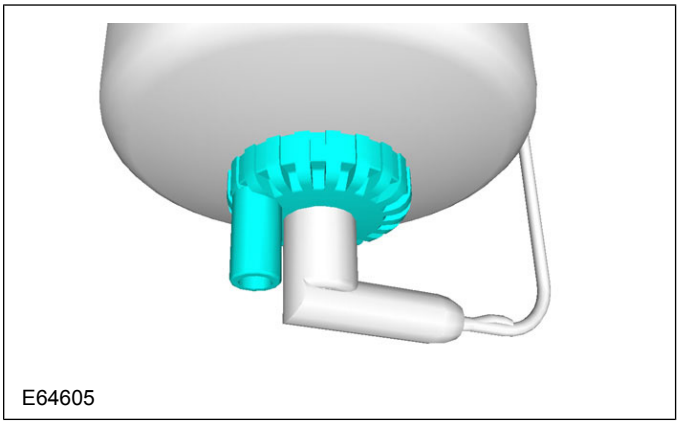
The return fuel from the engine passes through a fuel cooler to reduce the temperature of the fuel before it returns to the fuel tank.

Fuel Filter



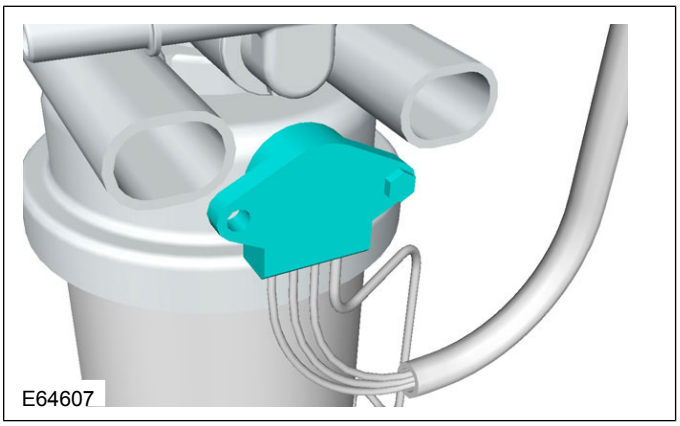
Item	Description
1	Water-in-fuel sensor
2	Fuel filter service indicator
3	Fuel filter element/water separator
4	Water-in-fuel sensor probe/fuel filter drain valve

Water-In-Fuel Sensor Probe (if equipped)/Fuel Filter Drain Valve



The fuel filter is equipped with a water-in-fuel sensor probe which is located at the base of the fuel filter element. This sensor probe detects the amount of water which has collected in the fuel filter element.

Water-In-Fuel Sensor

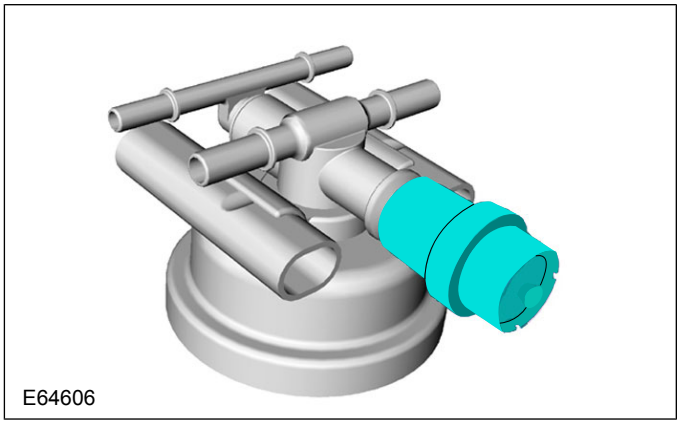


The water-in-fuel sensor monitors the level of water in the fuel filter element using the water-in-fuel sensor probe.

If the quantity of water present is greater than 90 ml, the resistance between the sensor probe and the water-in-fuel sensor will change, this will send a signal to the PCM and the water-in-fuel warning light within the instrument cluster will be illuminated. The fuel filter should then be drained of water.

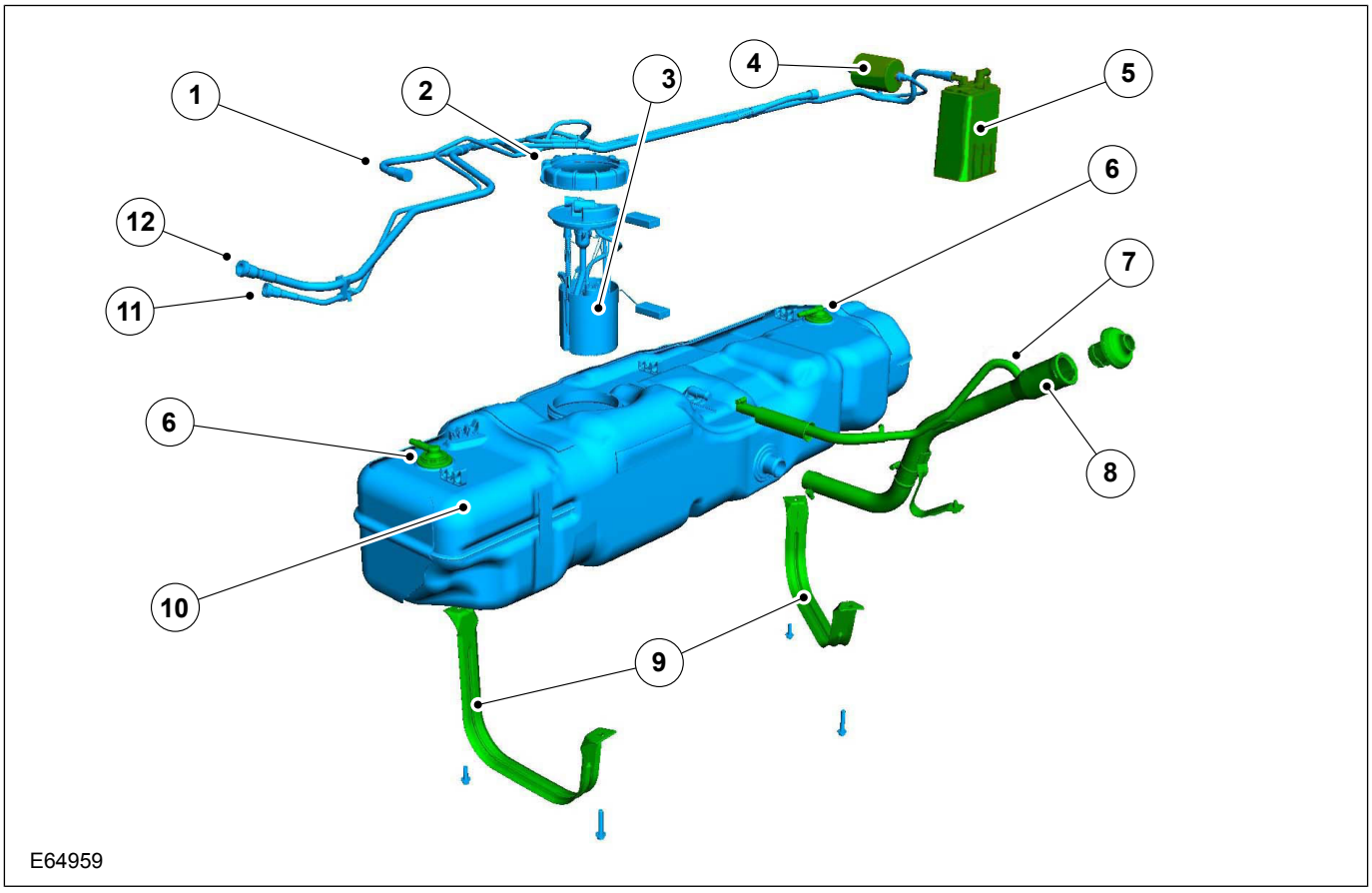
DESCRIPTION AND OPERATION

Fuel Filter Service Indicator



The fuel filter is equipped with a fuel filter service indicator which indicates the serviceability of the fuel filter element. The fuel filter service indicator is able to detect restrictions present within the fuel supply system and indicate them by means of a yellow plunger and a series of marks on the body which indicate the severity of the restriction.

Vehicles with 2.3L Duratec-HE (MI4) engine



Item	Description
1	Fuel tank vent valve to evaporative emission canister fuel vapor line
2	Fuel pump and sender unit locking ring
3	Fuel pump and sender unit
4	Fuel filter
5	Evaporative emission canister

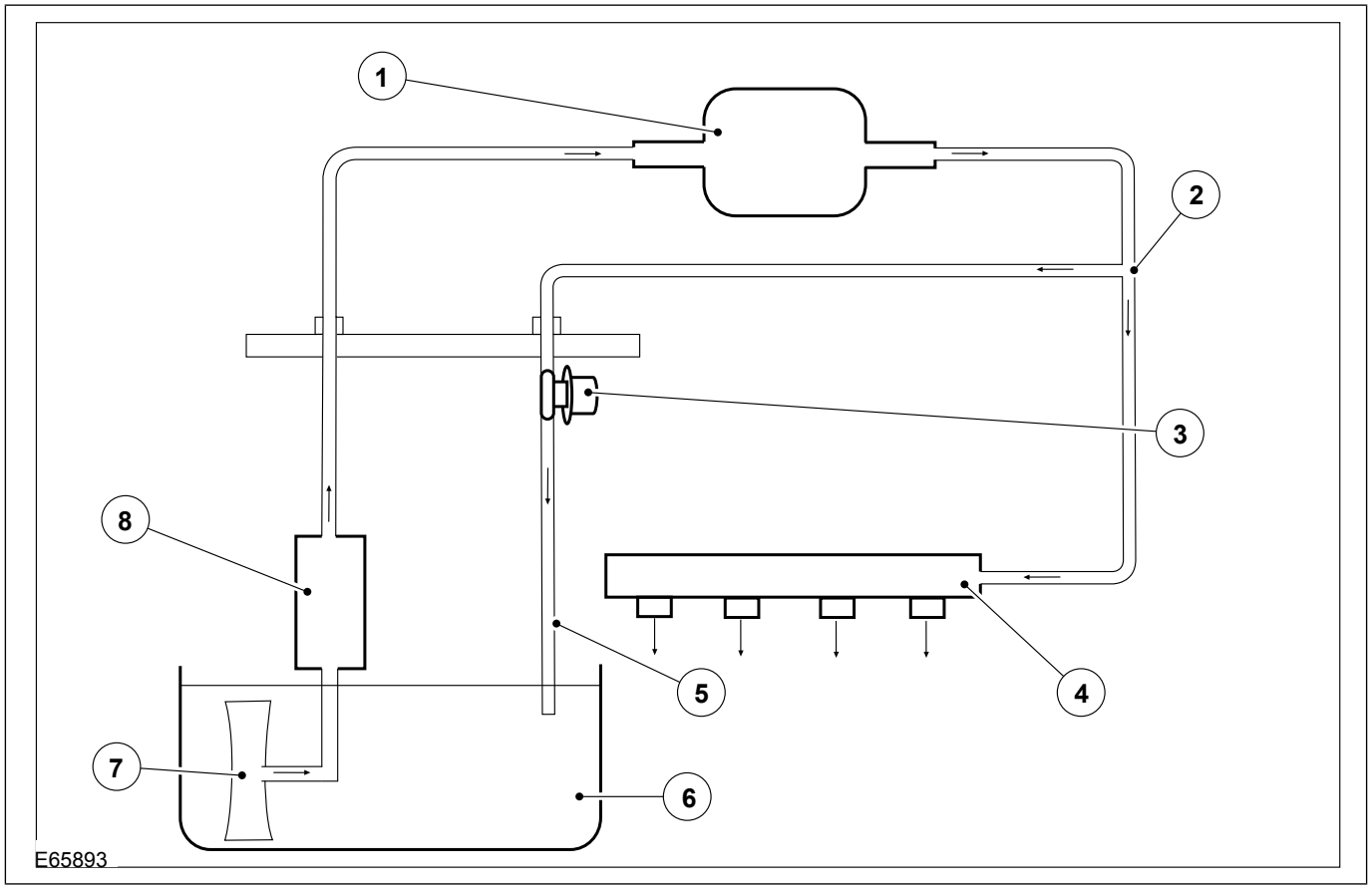
Item	Description
6	Vent valve(s)
7	Fuel tank filler pipe breather pipe
8	Fuel tank filler pipe
9	Fuel tank support straps
10	Fuel tank

DESCRIPTION AND OPERATION

Item	Description
11	Fuel supply line
12	Evaporative emission canister to engine fuel vapor line

Fuel is stored in the fuel tank and delivered to the fuel injectors by means of a submersed fuel pump through an inline fuel filter.

Fuel Return System



Item	Description
1	Fuel filter
2	Fuel line fuel return T-piece
3	Fuel pressure regulator
4	Fuel rail
5	Fuel return line
6	Fuel tank
7	Fuel jet pump
8	Fuel pump

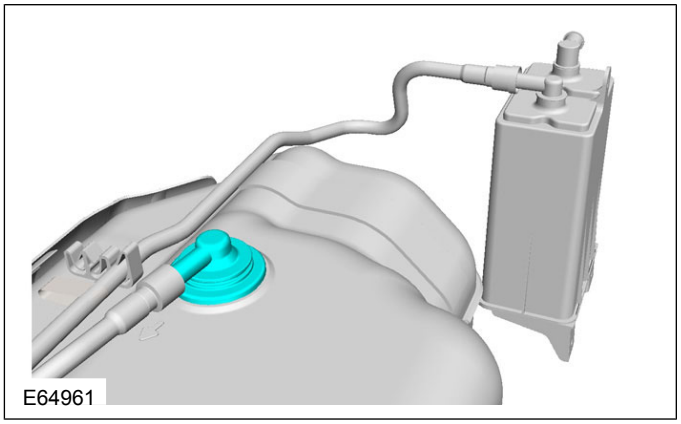
The fuel pressure at the fuel injectors is controlled by a fuel pressure regulator mounted in the fuel return system.

Fuel is pumped from the fuel tank, to the fuel filter. From the fuel filter, fuel is delivered to the fuel rail. A T-piece is fitted into the fuel injector fuel supply line above the fuel tank. This T-piece acts as the fuel return line and has a fuel pressure regulator fitted in the circuit.

By allowing excess fuel pressure to return to the fuel tank, a constant pressure can be maintained at the fuel injectors.

DESCRIPTION AND OPERATION

Fuel Tank Vent Valves

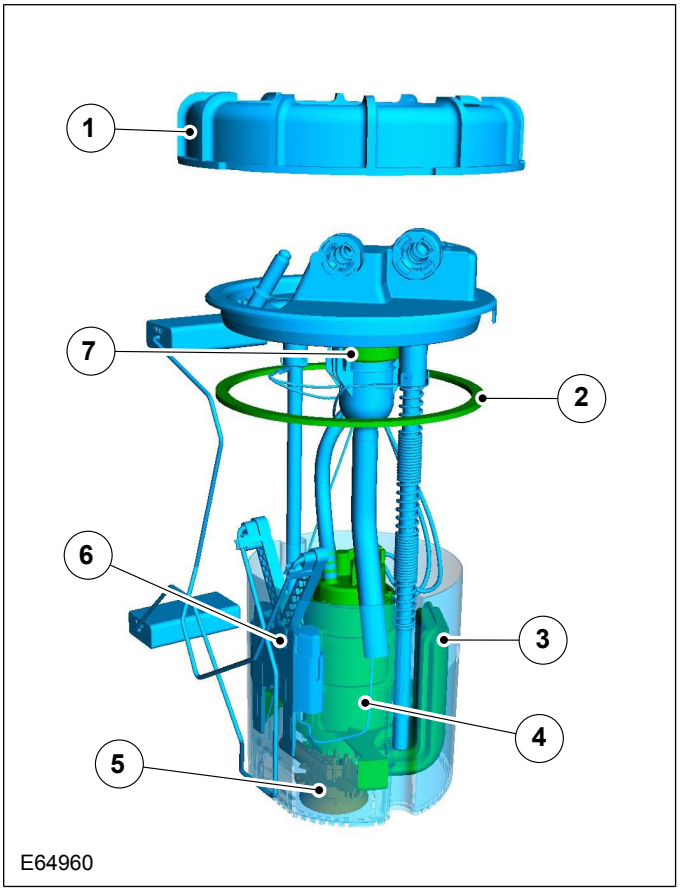

E64961

Unlike the fuel tank on vehicles with diesel engine, the fuel vapor is not permitted to vent to atmosphere. Instead the fuel vapor is collected in the evaporative emission canister until the correct driving conditions permit the fuel vapor to be burnt in the engine combustion chambers. This reduces the overall emissions from the vehicle.

If the fuel tank becomes inverted, the fuel tank vent valves close preventing the evaporative emission canister being filled with fuel.

If the fuel tank vent valves, fuel vapor lines or the evaporative emission canister become restricted, vehicle performance will become impaired. The inability of the fuel tank to substitute the fuel demanded by the fuel pump with air, will create a negative pressure in the fuel tank which could result in deformation of the fuel tank.

Fuel Pump and Sender Unit



E64960

Item	Description
1	Fuel pump and sender unit locking ring
2	Fuel pump and sender unit sealing ring
3	Sock filter
4	Fuel pump
5	Fuel jet pump
6	Fuel level sensor resistor card
7	Fuel pressure regulator

The fuel pump and sender are a combined unit and cannot be serviced separately.

The fuel pump and sender unit is located in the top of the fuel tank and is retained by a fuel pump and sender unit locking ring and seal.

The fuel pump and sender consists of a mechanical float attached to a variable resistor card by means of a rigid wire lever. The resistor card has two electrical elements. One element is solid and one element is a variable resistor. The resistance value created by the resistor card is sent to the central junction box (CJB) through a hard wired circuit. The CJB distributes the information from the fuel

DESCRIPTION AND OPERATION

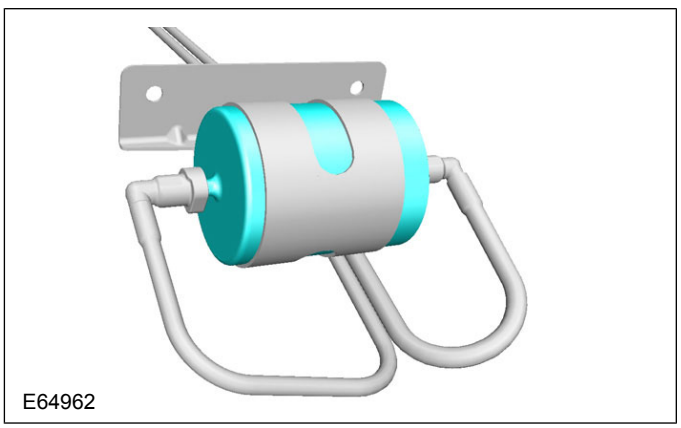
pump and sender to the instrument cluster and the powertrain control module (PCM) using the controller area network (CAN) circuits.

The fuel pump and sender resistor card can be susceptible to contaminated fuel, which can affect electrical continuity. This condition is normally temporary and self-rectifying. If the fuel pump and sender has been removed, moving the rigid wire lever from empty to full a minimum of 10 times will normally be as effective as installing a new fuel pump and sender. The most common symptom of contamination occurs after refuelling where the electrical contact moves to an area of the resistor card which has not been used for several days. This results in a very slow movement of the fuel gauge pointer from empty to full over approximately 15 minutes. In more extreme cases where the resistor card resistance is continuously outside the permitted range for more than 33 seconds, a DTC will be set in the CJB and the fuel gauge pointer will fall to its key-off position. In all cases where the fuel pump and sender is suspected of being inoperative, worn or damaged, the Worldwide Diagnostic System (WDS) diagnostic procedures must be followed before any parts are dismantled.

The fuel pump supplies fuel to the fuel charging system at a constant regulated pressure. The fuel pressure is controlled by the fuel pressure regulator, built into the fuel pump fuel return circuit.

The fuel pump and sender also incorporates a fuel jet pump. The return fuel from the fuel charging system is passed through a venturi in the jet pump which causes a pressure drop across an open orifice. This draws in fuel through the base of the unit which then passes through the sock filter to the fuel pump.

Fuel Filter


E64962

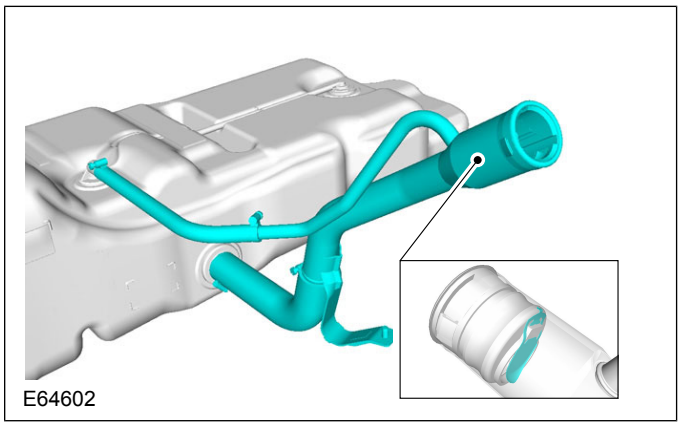
This vehicle is equipped with an in line fuel filter. The fuel filter is located to the rear of the fuel tank and is secured to the vehicle chassis with a support bracket.

All vehicles

Fuel Tank

The fuel tank is of a plastic construction and has the capacity to hold 80 liters of fuel. The fuel tank is secured to the vehicle by two metal support straps bolted to the underside of the vehicle.

Fuel Tank Filler Pipe


E64602

The fuel tank filler pipe incorporates a fuel tank vent pipe. The fuel tank vent pipe is connected to the top of the fuel tank and exits just below the top of the fuel tank filler pipe. The fuel tank vent pipe allows the displaced air above the fuel in the fuel tank to escape without pushing the fuel entering the fuel tank during refill back up the fuel tank filler pipe.

Fuel Filler Cap

This vehicle uses a lockable fuel filler cap.

The fuel filler cap is sealed to the fuel filler neck. This is to prevent the escape of fuel vapor during normal operation and to prevent fuel loss in the event of a vehicle accident.

DIAGNOSIS AND TESTING

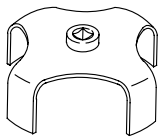
Fuel Tank and Lines

REFER to Section 310-00 [Fuel System - General Information].

REMOVAL AND INSTALLATION

Fuel Tank (23 554 0)

Special Tool(s)

 23055	Wrench, Fuel Tank Sender Unit 310-069 (23-055)

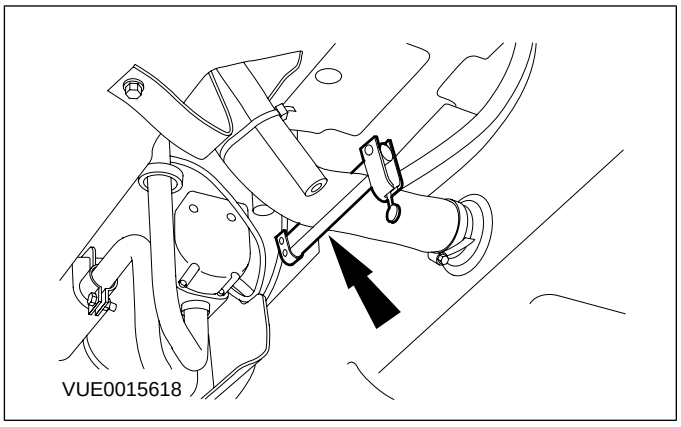
General Equipment

Brake Hose Clamp
Transmission Jack

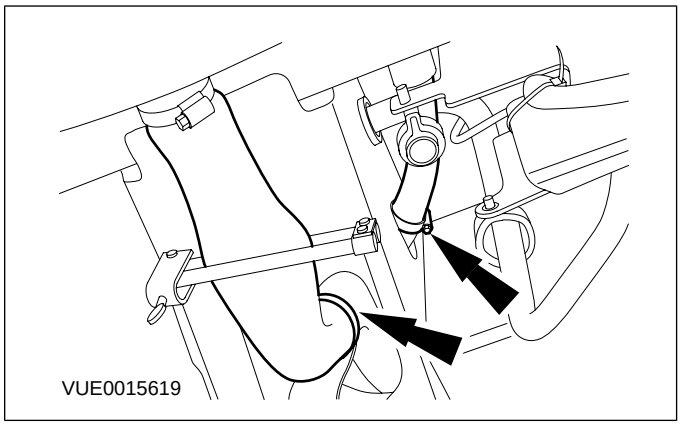
Removal

All vehicles

1. **Drain the fuel tank. For additional information, refer to Section 310-00 [Fuel System - General Information].**
2. **Raise and support the vehicle. For additional information, refer to Section 100-02 [Jacking and Lifting].**
3. **Using a suitable brake hose clamp, clamp the fuel tank filler hose.**

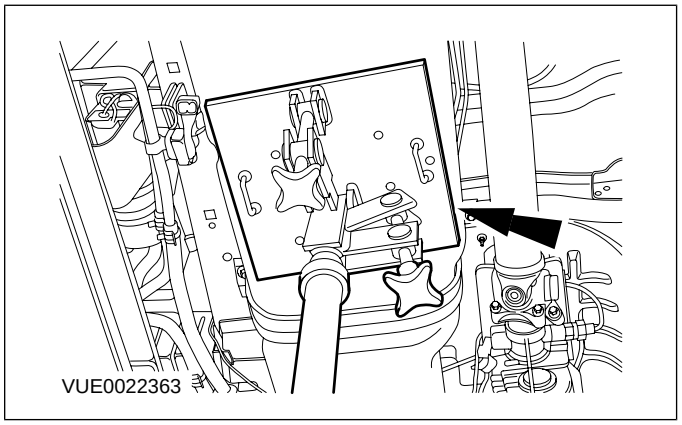


4. **Disconnect the fuel tank filler hose and the fuel tank ventilation hose from the fuel tank filler pipe.**

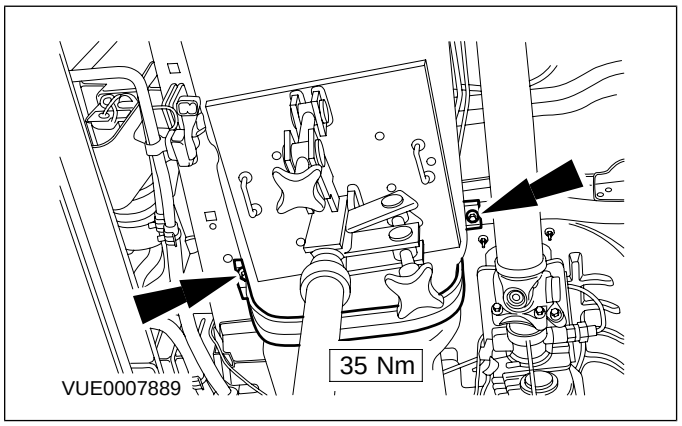


5. **⚠CAUTION:Use a suitable packing material to prevent damage to the underside of the fuel tank.**

   Using a suitable transmission jack, support the fuel tank.

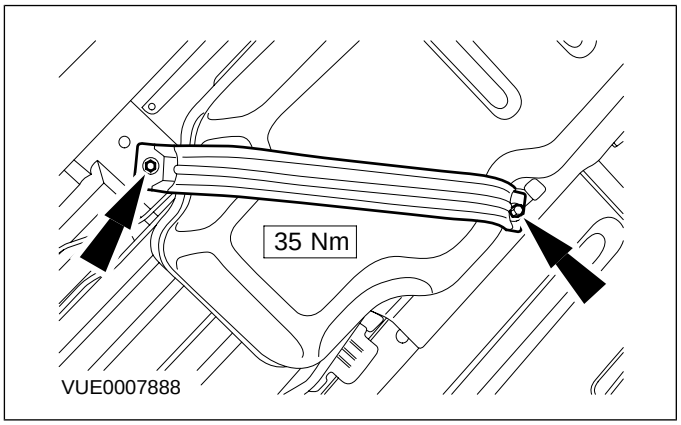


6. **Remove the fuel tank front support strap.**



REMOVAL AND INSTALLATION

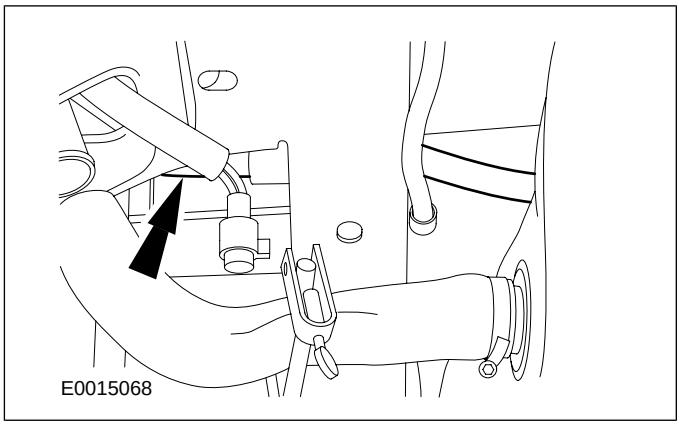
7. **Remove the fuel tank rear support strap.**



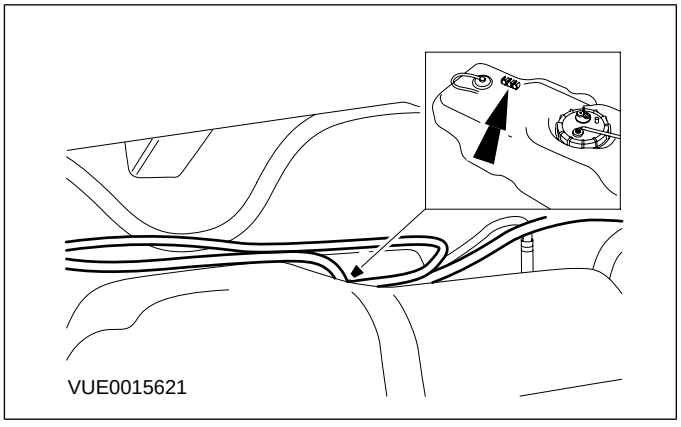
8. **⚠CAUTION:Do not place excessive strain on the fuel lines and wiring harness.**

   Partially lower the fuel tank.

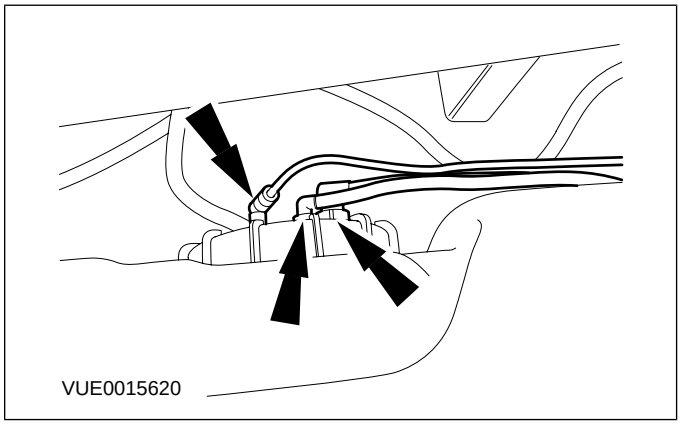
9. **Detach the fuel tank ventilation hose from the fuel tank.**



10. **Detach the fuel lines from the fuel tank.**

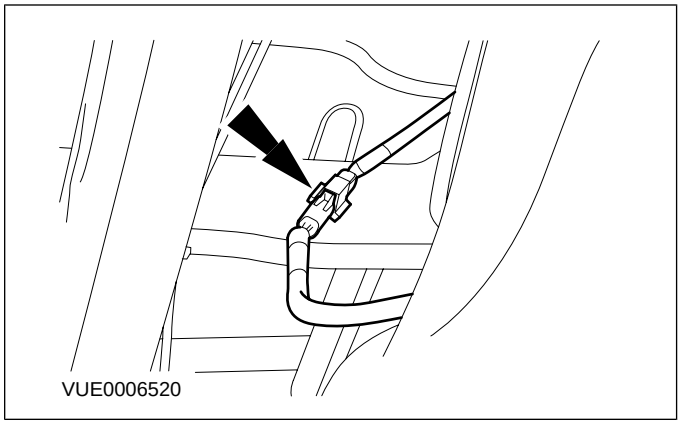


11. **Disconnect the fuel lines. For additional information, refer to Section 310-00 [Fuel System - General Information].**

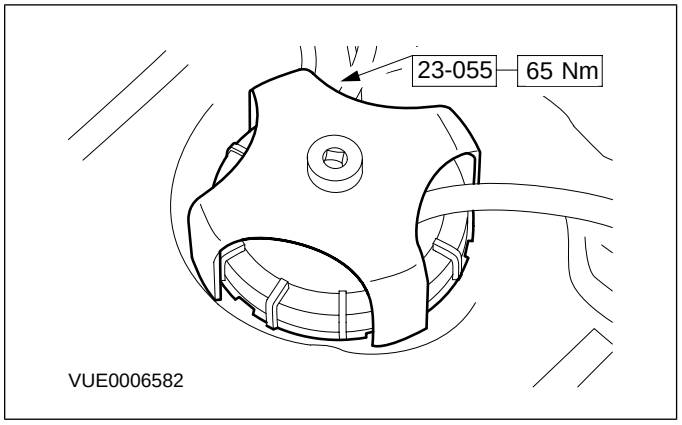


Vehicles with diesel engine

12. **Disconnect the fuel level sensor electrical connector.**



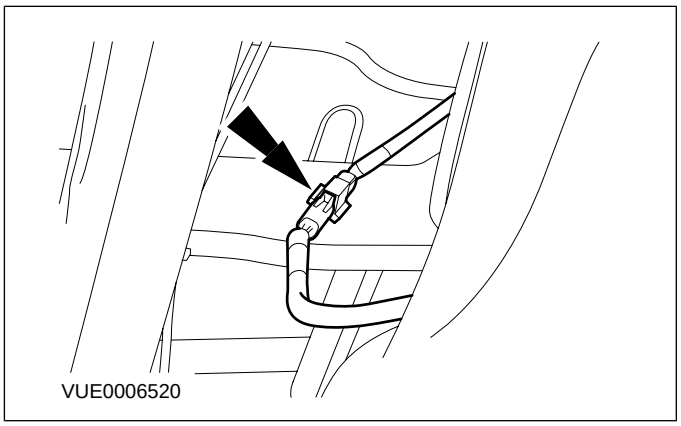
13. **Remove the fuel tank.**
14. **Using the special tool, remove the fuel level sensor.**
    - Discard the O-ring seal.



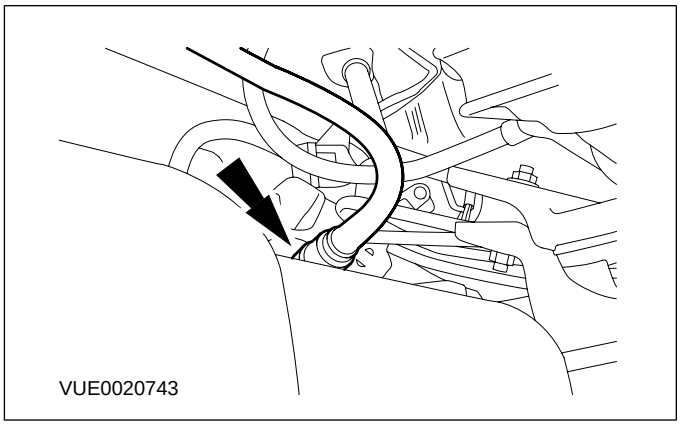
REMOVAL AND INSTALLATION

Vehicles with 2.3L engine

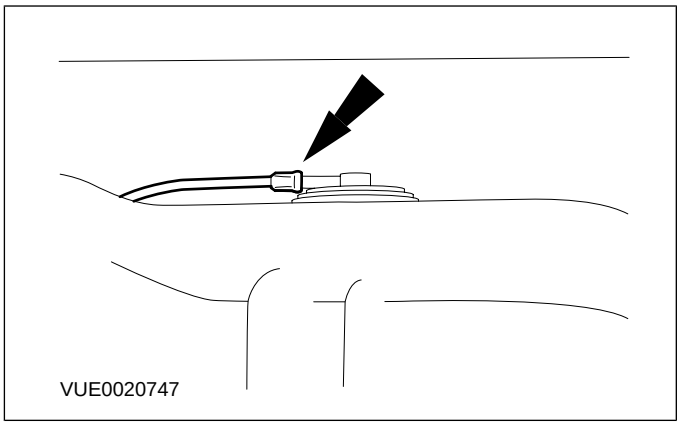
15. **Disconnect the fuel pump module electrical connector.**



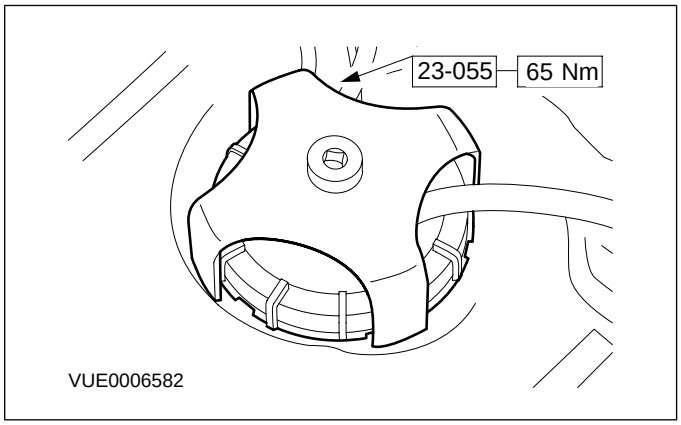
16. **Disconnect the fuel vapor line from the fuel tank rollover valve located at the front of the fuel tank. For additional information, refer to Section 310-00 [Fuel System - General Information].**



17. **Disconnect the fuel vapor line from the fuel tank rollover valve located at the rear of the fuel tank. For additional information, refer to Section 310-00 [Fuel System - General Information].**



18. **Remove the fuel tank.**
19. **Using the special tool, remove the fuel pump module.**
    - Discard the O-ring seal.



Installation

Vehicles with diesel engine

1. **NOTE:Install a new fuel level sensor O-ring seal.**

   To install, reverse the removal procedure.

Vehicles with 2.3L engine

2. **NOTE:Install a new fuel pump module O-ring seal**

   To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Filter — 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel

Removal

1. **WARNING:**

   Refer to:Diesel Fuel System Health and Safety Precautions (100-00 General Information, Description and Operation).

2. Clean the area around the fuel filter connections and fuel lines.

   Refer to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).

3. Remove the fuel filter element.

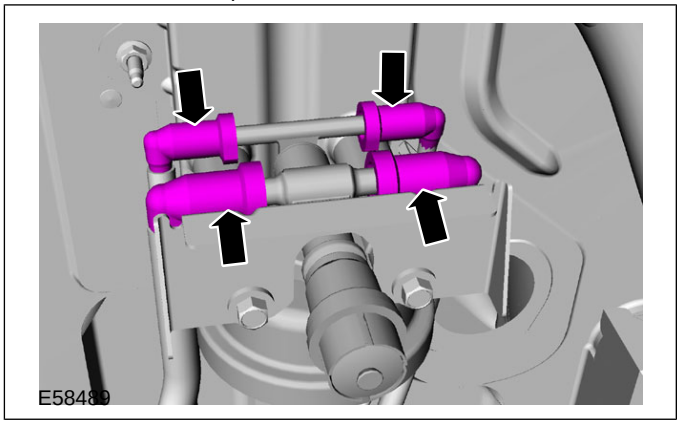
   Refer to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation).

4. • Vacuum foreign material from the fuel filter and fuel lines.

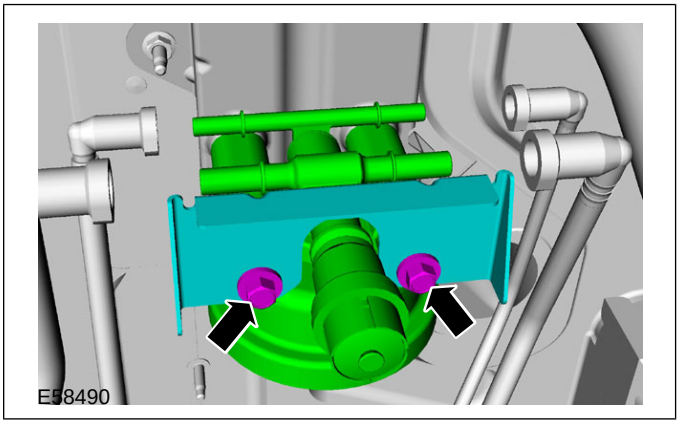
   Refer to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).

5. **CAUTION:Make sure that all openings are sealed. Use new blanking caps.**

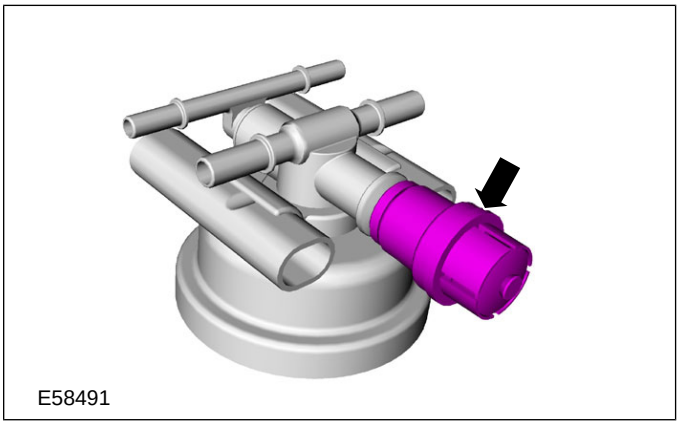
   Refer to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).



6.



7.



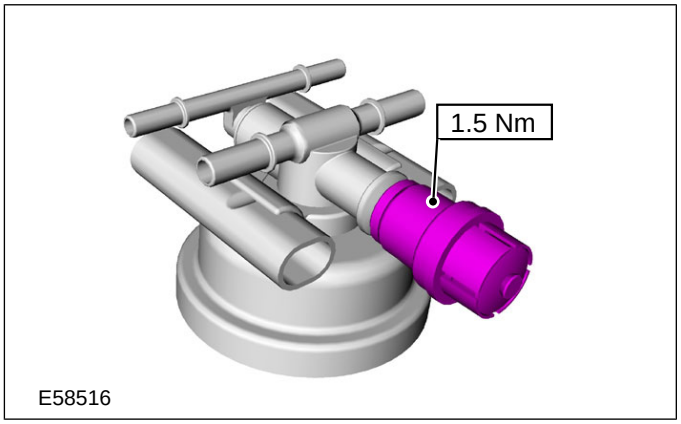
Installation

1. **WARNING:**

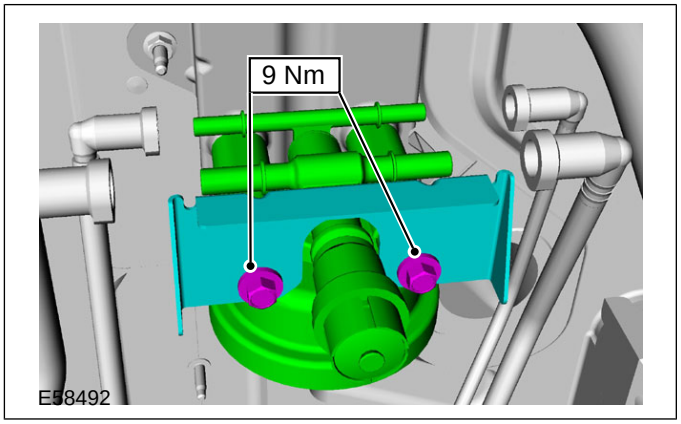
   Refer to:Diesel Fuel System Health and Safety Precautions (100-00 General Information, Description and Operation).

REMOVAL AND INSTALLATION

2.
- Install the fuel filter service indicator finger tight.
- Rotate the fuel filter service indicator one quarter turn clockwise.



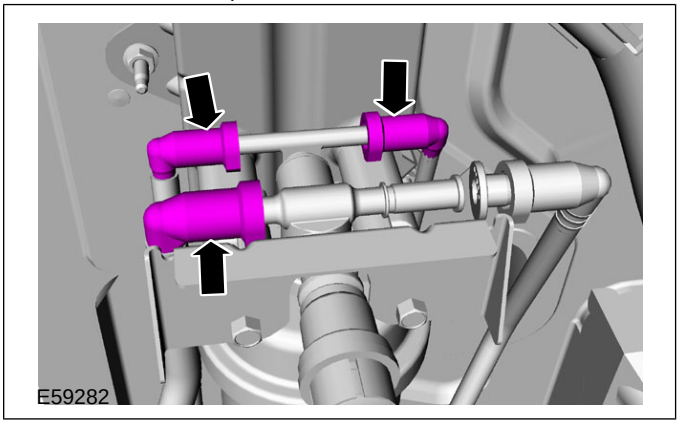
3.



4.
- Vacuum foreign material from the fuel filter and fuel lines.

  Refer to:Fuel Injection Component Cleaning (303-04 Fuel Charging and Controls - 2.2L Duratorq-TDCi (Puma) Diesel, General Procedures).
- Remove and discard the blanking plugs from the fuel filter fuel line connections.

5. Refer to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).



6. Install a new fuel filter element.

Refer to:Fuel Filter Element - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel (310-01 Fuel Tank and Lines, Removal and Installation).

REMOVAL AND INSTALLATION

Fuel Filter — 2.3L Duratec-HE (MI4)

Removal

WARNING:

Refer to:Health and Safety Precautions (100-00 General Information, Description and Operation).

1. Release the fuel system pressure.

   Refer to:Fuel System Pressure Release - 2.3L Duratec-HE (MI4) (310-00 Fuel System - General Information, General Procedures).

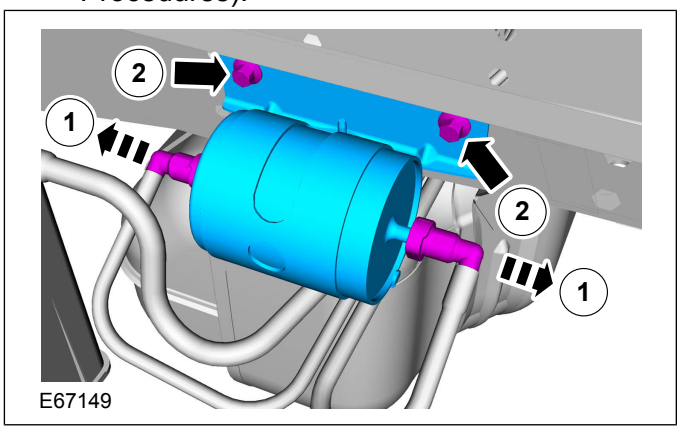
2. Disconnect the battery ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

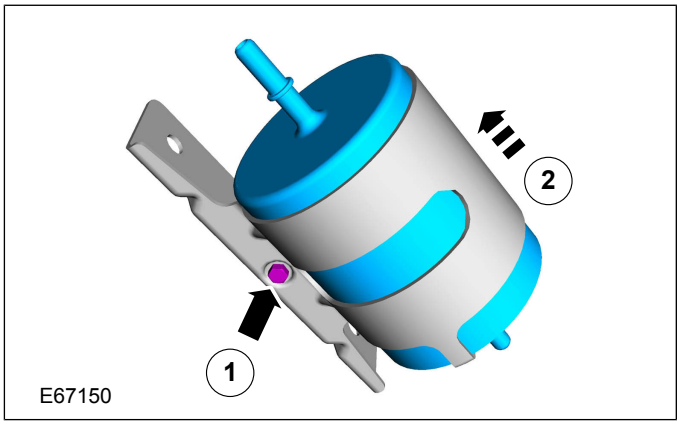
3. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

4. Refer to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).



5.



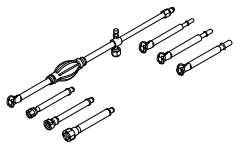
Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Filter Element — 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel

Special Tool(s)

 E50230	Hand Pressure Pump with Adapter Kit 310-110A

Special Tool(s)

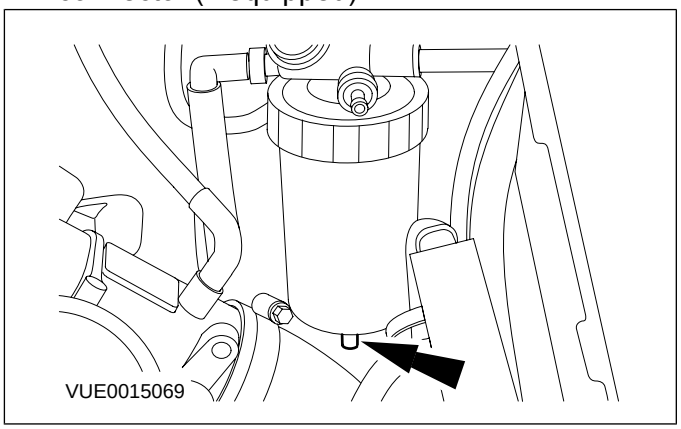
Removal

All vehicles

1. **WARNING:**

   Refer to: Diesel Fuel System Health and Safety Precautions (100-00 General Information, Description and Operation).

2. Disconnect the water-in-fuel sensor electrical connector (if equipped).



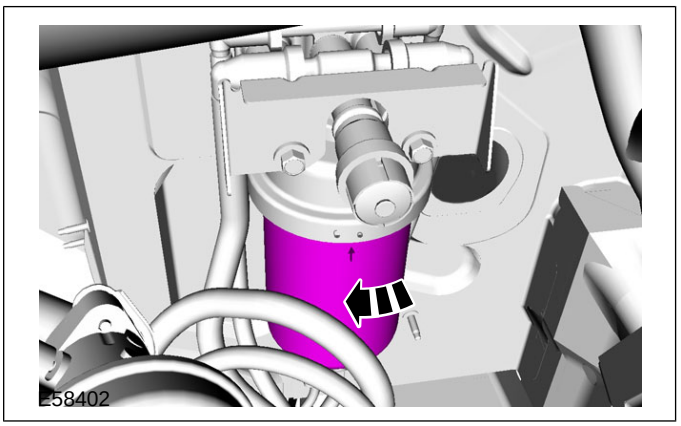
Left-hand drive vehicles

3. **CAUTION:Use lint free cloth.**

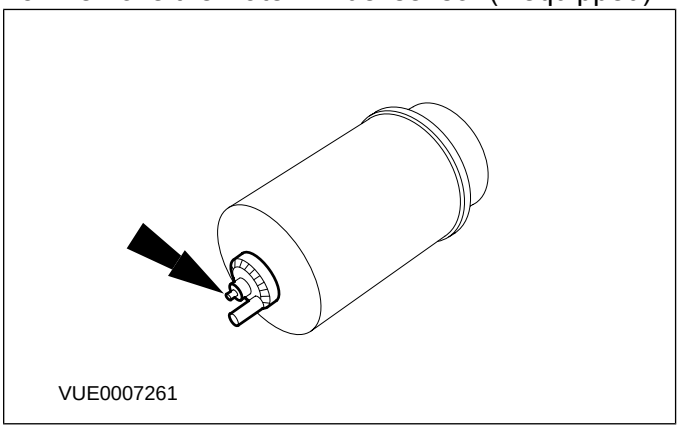
   Protect the generator with lint-free cloth to prevent contamination.

All vehicles

4.



5. Remove the water-in-fuel sensor (if equipped).



6. Discard the fuel filter.

REMOVAL AND INSTALLATION

Installation

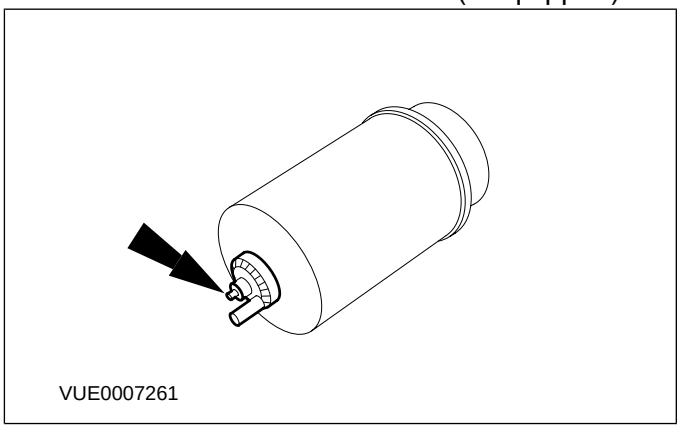
All vehicles

1. **WARNING:**

   Refer to:Diesel Fuel System Health and Safety Precautions (100-00 General Information, Description and Operation).

2. **NOTE:**Make sure that a new component is installed.

   Install the water-in-fuel sensor (if equipped).



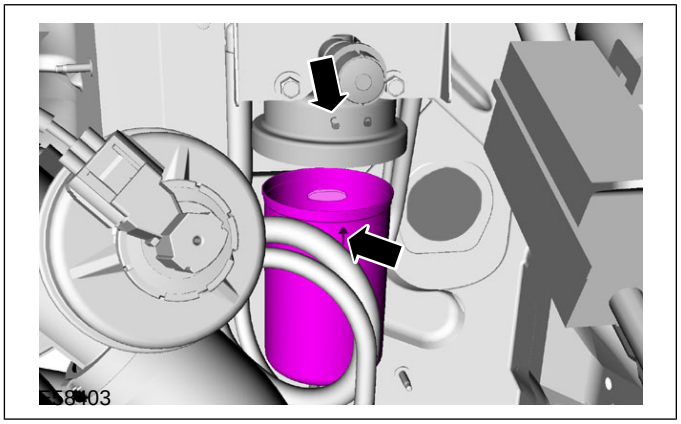
Left-hand drive vehicles

3. **CAUTION:Use lint free cloth.**

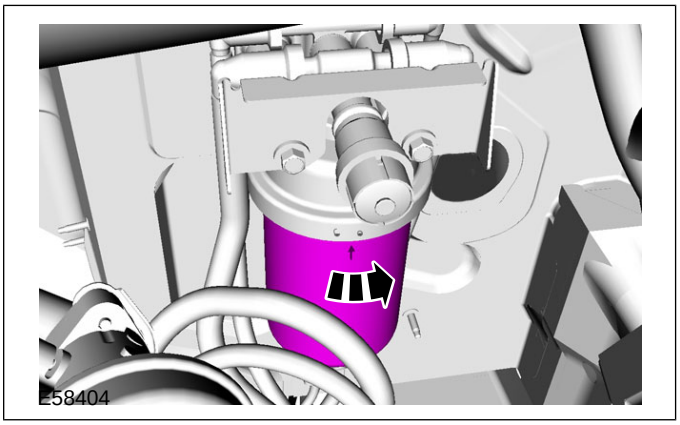
   Protect the generator with lint-free cloth to prevent contamination.

All vehicles

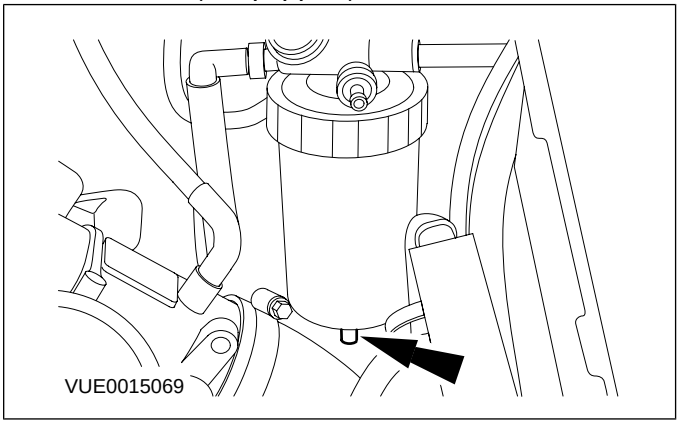
4. **CAUTION:Make sure that the installation marks are aligned.**



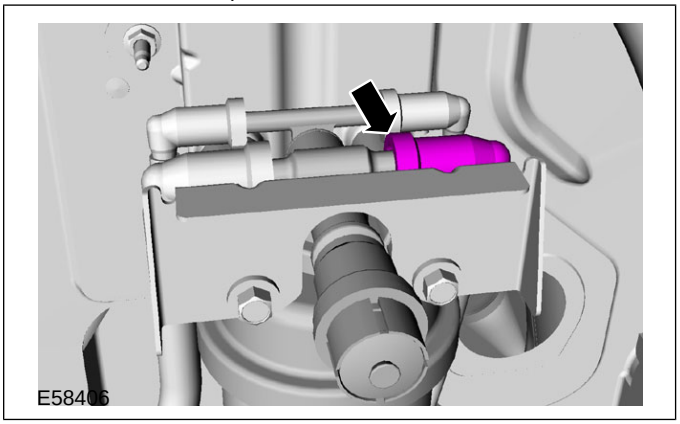
5.



6. Connect the water-in-fuel sensor electrical connector (if equipped).

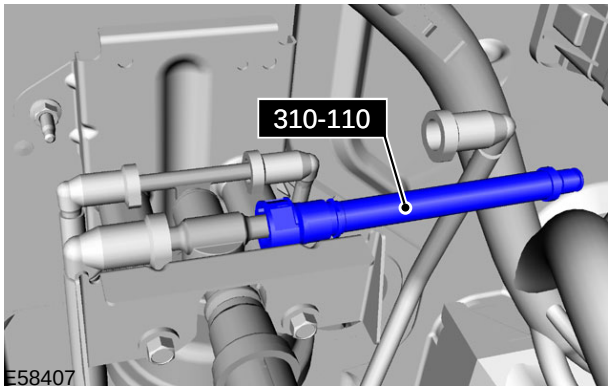


7. Refer to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).

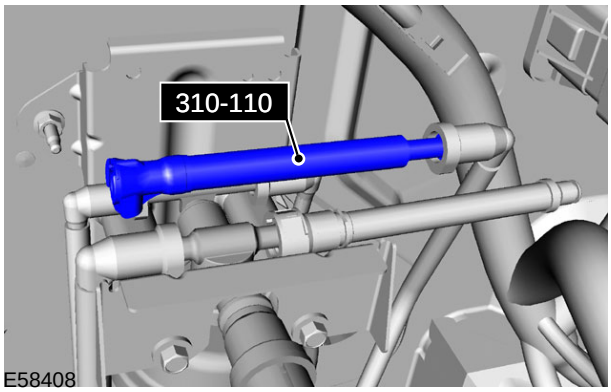


REMOVAL AND INSTALLATION

8. Special Tool(s): 310-110A

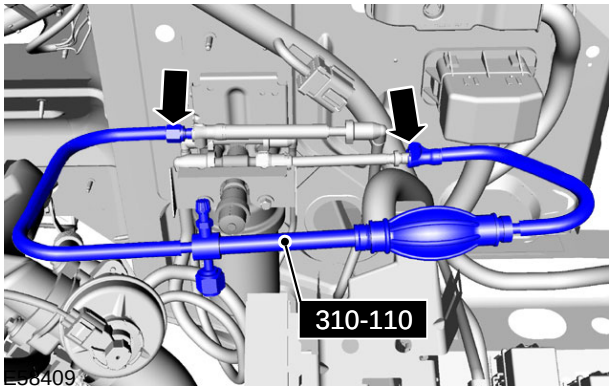


9. Special Tool(s): 310-110A



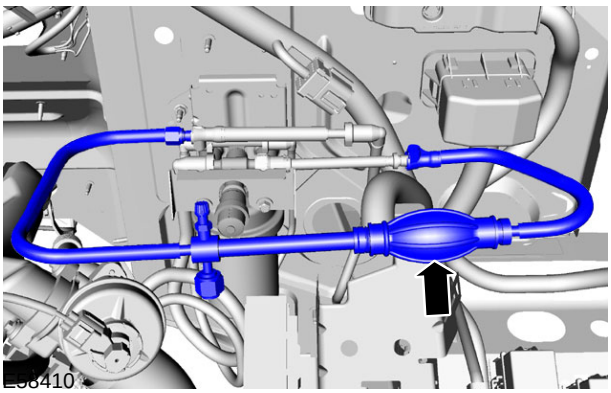
10. Install the hand pressure pump special tool to the hand pressure pump special tool adapters.

Special Tool(s): 310-110A



11. Operate the hand pressure pump special tool adapter until fuel starts to flow through the fuel filter and the special tool becomes firm.

Special Tool(s): 310-110A



Left-hand drive vehicles

12. Remove the lint-free cloth from the generator.

All vehicles

13. **CAUTION:The starter motor operation must not exceed 10 seconds at a time. After 10 seconds turn the ignition switch to position 0 and allow the starter motor to cool for 30 seconds before operating the starter motor again.**

Start the engine and allow it to idle until it reaches normal operating temperature.

14. Switch the engine off.

Left-hand drive vehicles

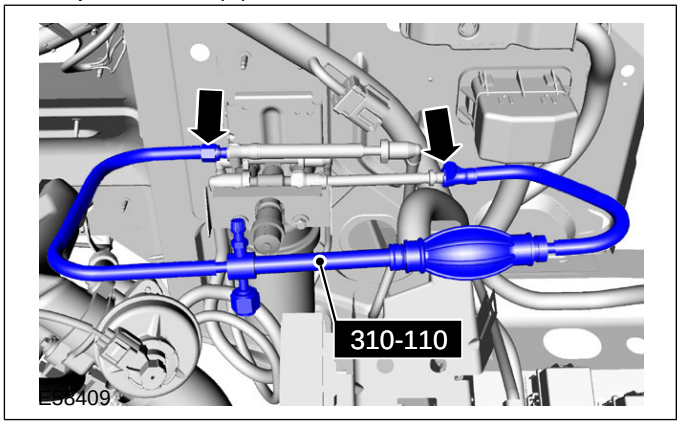
15. **CAUTION:Use lint free cloth.**

Protect the generator with lint-free cloth to prevent contamination.

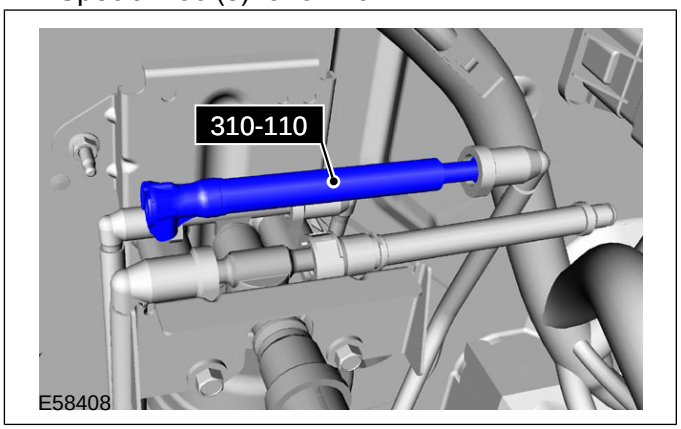
REMOVAL AND INSTALLATION

All vehicles

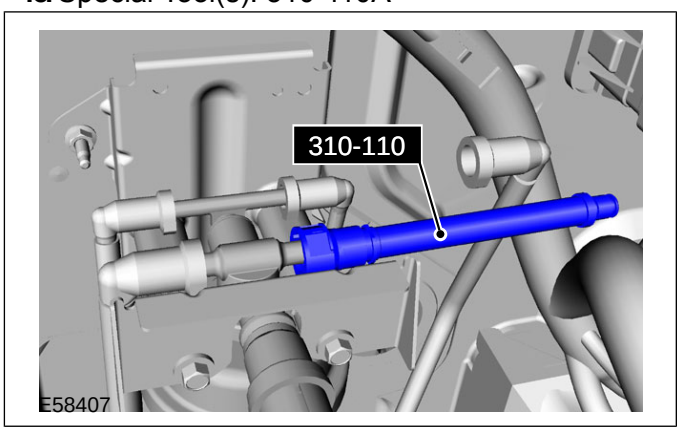
16. Special Tool(s): 310-110A



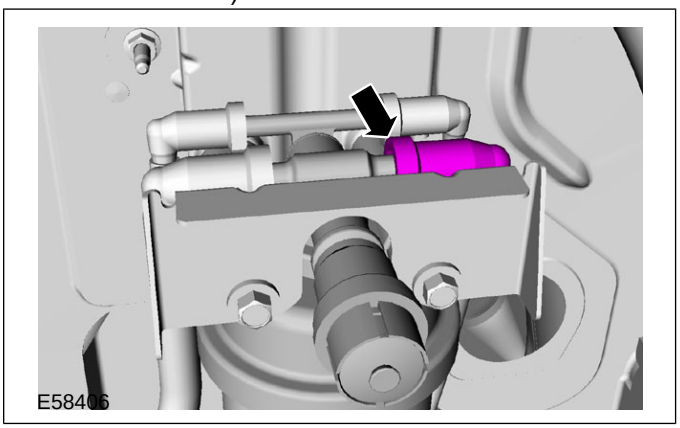
17. Special Tool(s): 310-110A



18. Special Tool(s): 310-110A



19. Refer to:Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).



Left-hand drive vehicles

20. Remove the lint-free cloth from the generator.

REMOVAL AND INSTALLATION

Water-in-Fuel Sensor

1. Information not available at this time.

SECTION 310-02A Acceleration Control — 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Acceleration Control..... 310-02A-2
Inspection and Verification..... 310-02A-2

DIAGNOSIS AND TESTING

Acceleration Control

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Accelerator pedal	• Fuse(s) • Relay(s) • Wiring harness • Electrical connector(s) • Accelerator pedal position (APP) sensor • Fuel pump • Central junction box (CJB) • Powertrain control module (PCM)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the WDS to diagnose the system.

SECTION 310-02B Acceleration Control — 2.3L Duratec-HE (MI4)

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Acceleration Control 310-02B-2
Inspection and Verification 310-02B-2
Symptom Chart 310-02B-2

DIAGNOSIS AND TESTING

Acceleration Control

General Equipment

Worldwide Diagnostic System (WDS)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Accelerator pedal – Electronic throttle body	• Fuse(s) • Wiring harness(es) • Electrical connector(s) • Accelerator pedal • Electronic throttle body • Powertrain control module (PCM)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• Accelerator pedal is hard to press or has a rough/raspy or sticky feel	• Adjacent hardware, wiring harness(s), trim(s), carpet or mat(s) incorrectly installed	• CHECK the accelerator pedal and adjacent parts for correct installation.
	• Worn or damaged accelerator pedal	• INSTALL a new accelerator pedal.
• Accelerator pedal does not return freely	• Adjacent hardware, wiring harness(s), trim(s), carpet or mat(s) incorrectly installed	• CHECK the accelerator pedal and adjacent parts for correct installation.
	• Worn or damaged accelerator pedal	• INSTALL a new accelerator pedal.
• High engine idle speed	• Damaged accelerator pedal	• REFER to the WDS to diagnose the system.
	• Electronic throttle body	• REFER to the WDS to diagnose the system.
	• PCM calibration	• REFER to the WDS to diagnose the system.
• Poor idling	• Electronic throttle body	• REFER to the WDS to diagnose the system.
	• PCM calibration	• REFER to the WDS to diagnose the system.

SECTION 310-03 Speed Control

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Speed Control..... 310-03-2
Principles of Operation..... 310-03-2
Inspection and Verification..... 310-03-2
Symptom Chart..... 310-03-2
Pinpoint Test..... 310-03-3
Component Tests - Speed Control Switch..... 310-03-7

DIAGNOSIS AND TESTING

Speed Control

Principles of Operation

The electronic speed control is restricted to vehicles with no accelerator cable. This type of speed control uses the powertrain control module (PCM), engine and transmission inputs and outputs to monitor, adjust and maintain the required vehicle speed.

The PCM receives speed control commands from the steering wheel mounted speed control switches. Vehicle speed is monitored from the vehicle speed sensor (VSS) input to the instrument cluster speedometer.

The speed control system will not be enabled until the vehicles indicated road speed is 42 km/h (26.3 mph) or above. At this speed, the operation of the speed control ON switch will put the speed control system into standby mode. The instrument cluster speed control indicator lamp will not be illuminated. Standby mode will be maintained until the speed control OFF switch has been operated or the ignition key has been turned to position 0. Standby mode will be maintained if the vehicle indicated speed decreases below 42 km/h (26.3 mph).

Speed control cruise function is disabled until the following criteria is met:

- The vehicle indicated speed is above 42 km/h (26.3 mph)
- Third gear or above must been selected
- The speed control + switch is pressed

As long as these criteria are met, the instrument cluster speed control indicator lamp will illuminate, indicating the vehicle is under speed control.

To prevent the vehicle engine working against the vehicle braking system, the brake pedal position (BPP) switch is used to monitor brake pedal movement. If the BPP switch is actuated, the speed control will disengage and normal engine operation will resume.

To prevent uncontrolled engine acceleration with no transmission load, the clutch pedal position (CPP) switch is used to monitor clutch pedal movement. If the CPP switch is actuated, the speed control will disengage.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Brake pedal – Clutch pedal	– Fuse(s) – Wiring harness – Electrical connector(s) – Clockspring – Speed control switch – BPP switch – CPP switch – PCM – Central junction box (CJB)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• The speed control is inoperative	• Fuse(s). • Circuit(s). • Speed control switch. • BPP switch. • CPP switch. • CJB • PCM.	• GO to Pinpoint Test A.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• The speed control does not disengage when the brakes are applied.	• Circuit(s). • BPP switch. • CJB	• GO to Pinpoint Test B.
• The speed control does not disengage when the clutch is applied.	• Circuit(s). • CPP switch. • CJB	• GO to Pinpoint Test C.
• The speed control switch does not operate correctly	• Speed control switch.	• CARRY OUT the speed control switch component test in this section.

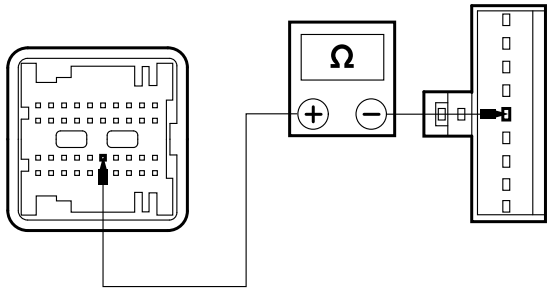
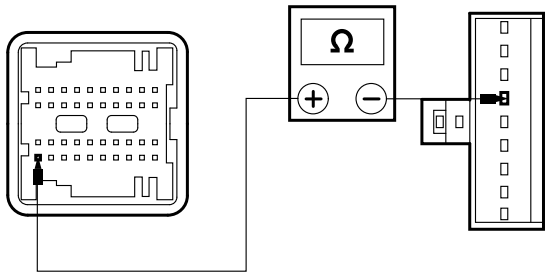
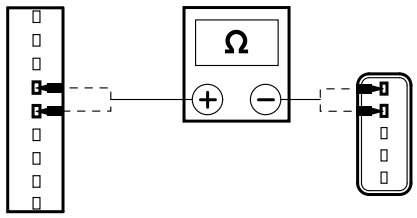
Pinpoint Test

NOTE: Use a digital multimeter for all electrical measurements.

PINPOINT TEST A : THE SPEED CONTROL IS INOPERATIVE

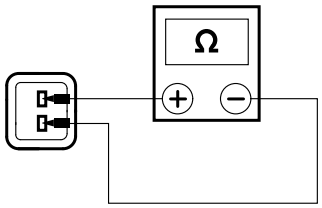
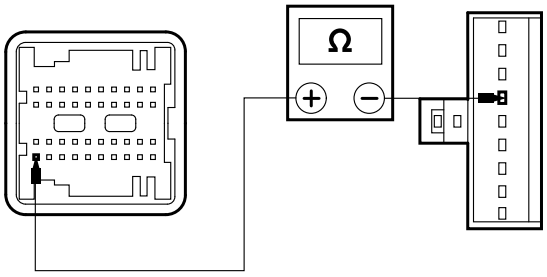
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK CIRCUIT CBB18 (GY/OG) FOR POWER	
	1 Ignition switch in position II.
	2 Disconnect CJB CBP02F.
	3 Measure the voltage between the CJB CBP02F pin 1, circuit CBB18 (GY/OG), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A2. → **No** REPAIR the circuit.
A2: CHECK CIRCUIT ZA233 (OG) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Remove the driver air bag. REFER to:Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).
	3 Disconnect Clockspring CR115A.

DIAGNOSIS AND TESTING

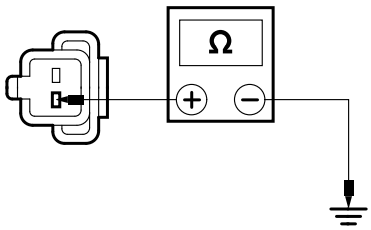
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E72027	4 Measure the resistance between the CJB CBP02F pin 26, circuit ZA233 (OG), harness side and the clockspring CR115A pin 5, circuit ZA233 (OG), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to A3. → **No** REPAIR the circuit as necessary. TEST the system for normal operation.
A3: CHECK CIRCUIT ZA232 (OG/VT) FOR OPEN CIRCUIT	
 E72028	1 Measure the resistance between the CJB CBP02F pin 40, circuit ZA232 (OG/VT), harness side and the clockspring CR115A pin 4, circuit ZA232 (OG/VT), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to A4. → **No** REPAIR the circuit. TEST the system for normal operation.
A4: CHECK THE CLOCKSPRING FOR OPEN CIRCUIT	
	1 Disconnect Clockspring CR115B.
 E72067	2 Measure the resistance between: • the clockspring CR115A pin 4, component side and the clockspring CR115B pin 2, component side. • the clockspring CR115A pin 5, component side and the clockspring CR115B pin 3, component side. • Are the resistances less than 1 ohm? → **Yes** INSTALL a new speed control switch. TEST the system for normal operation. If the concern is still apparent, REFER to the WDS to diagnose the high speed controller area network (CAN) bus. → **No** INSTALL a new clockspring. REFER to:Clockspring (501-20 Supplemental Restraint System, Removal and Installation). TEST the system for normal operation.

DIAGNOSIS AND TESTING

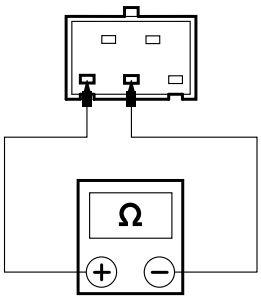
PINPOINT TEST B : THE SPEED CONTROL DOES NOT DISENGAGE WHEN THE BRAKES ARE APPLIED

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK THE BPP SWITCH OPERATION	
	1 Disconnect BPPSwitch CCB15.
	2 Press the brake pedal.
 E71828	3 Measure the resistance between the BPP switch CCB15 pin 1, component side and the BPP switch CCB15 pin 2, component side. • Is the resistance greater than 10,000 ohms with the brake pedal pressed? → **Yes** GO to B2. → **No** ADJUST the BPP switch. TEST the system for normal operation. If the concern is still evident, INSTALL a new BPP switch.
B2: CHECK CIRCUIT CCB15 (GN/RD) FOR OPEN CIRCUIT	
	1 Disconnect CJB CBP02C.
	2 Ignition switch in position II.
 E72028	3 Measure the resistance between the CJB CBP02C pin 3, circuit CCB15 (GN/RD), harness side and the brake pedal position (BPP) switch CCB15 pin 1, circuit CCB15 (GN/RD), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to B3. → **No** REPAIR the circuit. TEST the system for normal operation.

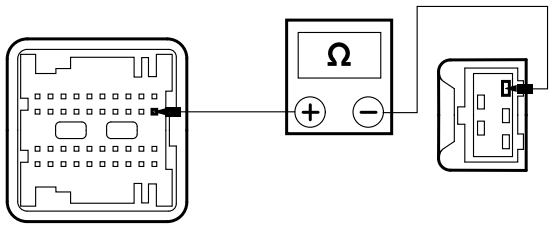
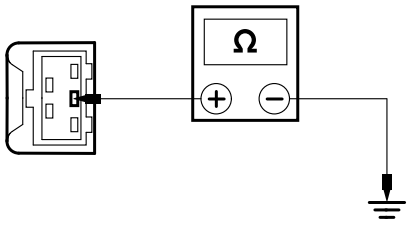
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B3: CHECK THE BPP SWITCH FOR GROUND	
 E69919	1 Measure the resistance between the brake pedal position (BPP) switch CCB15 pin 2, circuit GD138 (BK/WH), harness side and ground. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit GD138 (BK/WH). TEST the system for normal operation.

PINPOINT TEST C : THE SPEED CONTROL DOES NOT DISENGAGE WHEN THE CLUTCH IS APPLIED

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CHECK THE CPP SWITCH OPERATION	
	1 Disconnect CPP Switch CE903.
	2 Press the clutch pedal.
 E72009	3 Measure the resistance between the CPP switch CE903 pin 1, component side and the CPP switch CE903 pin 2, component side. • Is the resistance greater than 10,000 ohms with the clutch pedal pressed? → **Yes** GO to C2. → **No** INSTALL a new CPP switch. TEST the system for normal operation.
C2: CHECK CIRCUIT CE903 (BU/OG) FOR OPEN CIRCUIT	
	1 Disconnect CJB CBP02C.

DIAGNOSIS AND TESTING

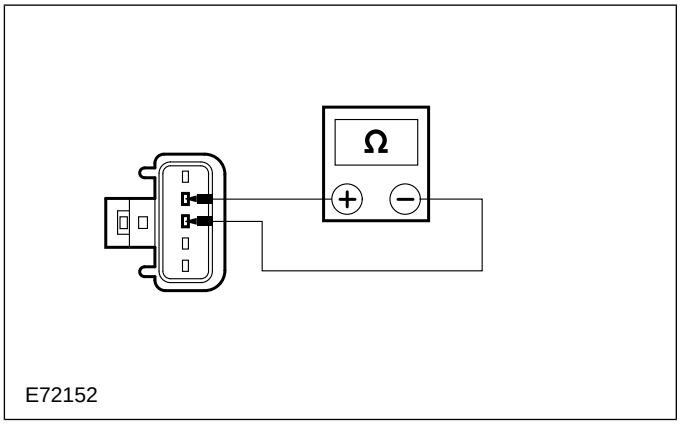
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69917	2 Measure the resistance between the CJB CBP02C pin 11, circuit CE903 (BU/OG), harness side and the CPP switch CE903 pin 1, circuit CE903 (BU/OG), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to C3. → **No** REPAIR the circuit. TEST the system for normal operation.
C3: CHECK THE CPP SWITCH FOR GROUND	
 E69916	1 Measure the resistance between the CPP switch CCB15 pin 2, circuit GD138 (BK/WH), harness side and ground. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit GD138 (BK/WH). TEST the system for normal operation.

Component Tests - Speed Control Switch

Remove the driver air bag.

REFER to:Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).

Test 1



E72152

Hold the speed control switch in the ON position.

Measure the resistance between pin 2 and pin 3.

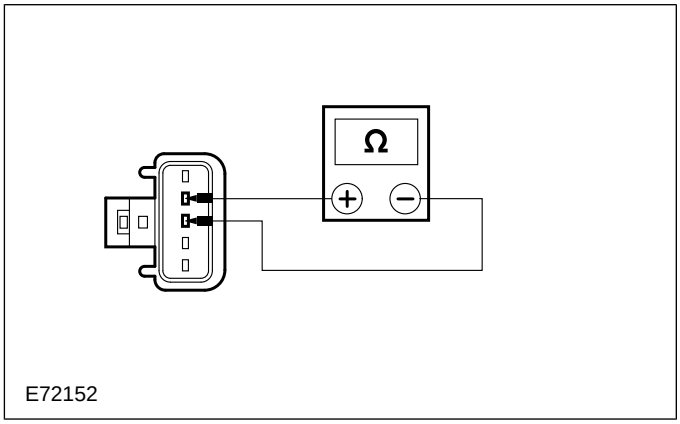
Is the resistance between 1103 ohms and 1128 ohms?

If yes, continue with Test 2.

If no, INSTALL a new speed control switch. TEST the system for normal operation.

DIAGNOSIS AND TESTING

Test 2



Hold the speed control switch in the OFF position.

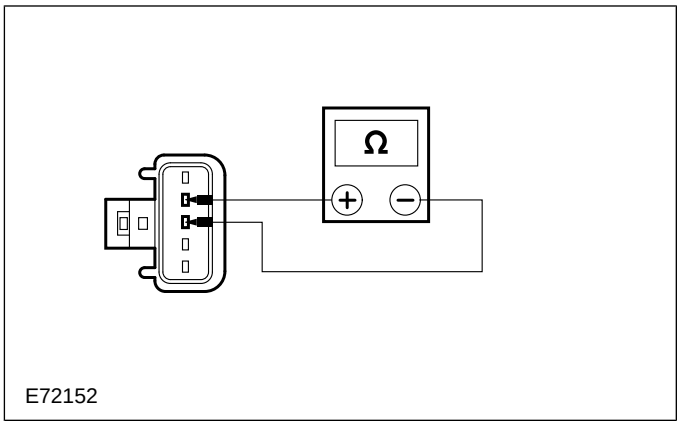
Measure the resistance between pin 2 and pin 3.

Is the resistance 0 ohms?

If yes, continue with Test 3.

If no, INSTALL a new speed control switch. TEST the system for normal operation.

Test 3



Hold the speed control switch in the SET position.

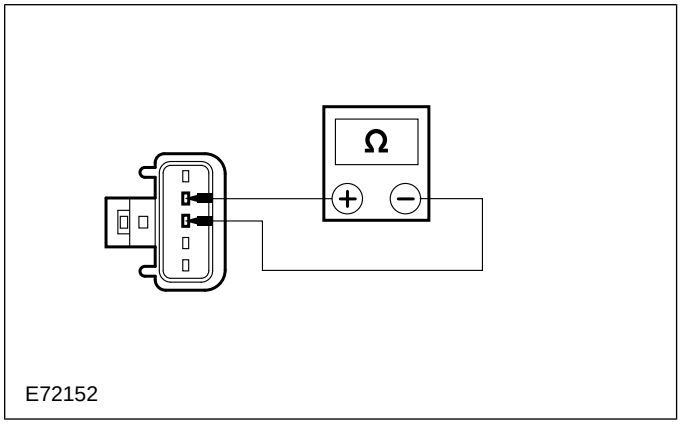
Measure the resistance between pin 2 and pin 3.

Is the resistance between 300 ohms and 307 ohms?

If yes, continue with Test 4.

If no, INSTALL a new speed control switch. TEST the system for normal operation.

Test 4



Hold the speed control switch in the RESUME position.

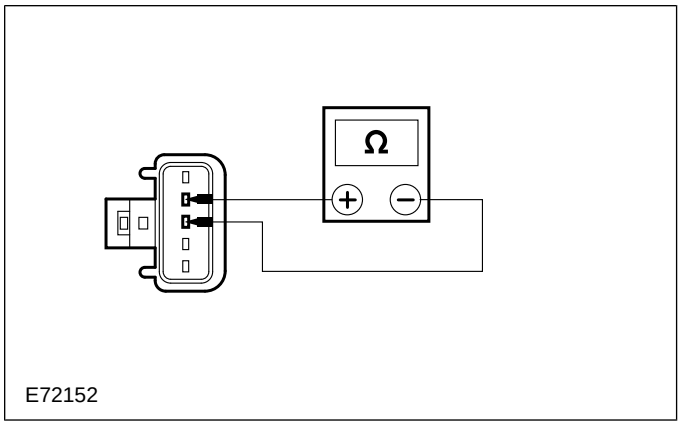
Measure the resistance between pin 2 and pin 3.

Is the resistance between 598 ohms and 611 ohms?

If yes, continue with Test 5.

If no, INSTALL a new speed control switch. TEST the system for normal operation.

Test 5



Hold the speed control switch in the DECELERATE position.

Measure the resistance between pin 2 and pin 3.

Is the resistance between 120 ohms and 123 ohms?

If yes, INSTALL a new CJB. TEST the system for normal operation.

If no, INSTALL a new speed control switch. TEST the system for normal operation.

SECTION 412-00 Climate Control System - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 412-00-2

DIAGNOSIS AND TESTING

Climate Control System..... 412-00-3
Inspection and Testing..... 412-00-3
Refrigerant Circuit - Quick Check..... 412-00-3
Symptom chart..... 412-00-4
System Checks..... 412-00-6

GENERAL PROCEDURES

Spring Lock Coupling..... 412-00-54
Air Conditioning (A/C) Clutch Air Gap Adjustment..... 412-00-56
Fluorescent Dye Leak Detection..... 412-00-57
Electronic Leak Detection..... 412-00-58
Refrigerant Oil Adding..... 412-00-59
Contaminated Refrigerant Handling..... 412-00-60
Air Conditioning (A/C) System Recovery, Evacuation and Charging..... 412-00-61
Vacuum Leak Detection..... 412-00-63

SPECIFICATIONS

Lubricants, Fluids, Sealants and Adhesives

Item	Specification
Refrigerant R134a	WSH-M17B19-A
Refrigerant oil	WSH-M1C231-B

Refrigerant Capacities (When Charging)

	Grams
A/C system	750 ± 20
A/C system with Auxiliary A/C system	1400 ± 34

Refrigerant Oil Capacities (When Charging)

	millilitres
A/C system	280
A/C system with Auxiliary A/C system	640

Addition of Refrigerant Oil (When new components are installed)

CAUTIONS:

The refrigerant oil top-up quantity must not exceed the refrigerant oil fill quantity.

If other A/C components are being renewed in addition to the A/C compressor, there is no need to top up with additional refrigerant oil, apart from filling the compressor.

	millilitres
When all lines and components are replaced.	Add 280.
When all lines and components have been renewed (vehicles with additional air conditioning).	Add 640.
Air conditioning (A/C) compressor - if the quantity of refrigerant oil drained from the faulty compressor is less than 150 ml	Drain 50 from new compressor.
Air conditioning compressor - if the amount of refrigerant oil drained from the faulty compressor is more than 150 ml	Drain 0 from new compressor.
Condenser	add 30.
Evaporator	add 30.
Accumulator/dehydrator	add 90.
Always, if refrigerant was drained.	Add the same quantity as the quantity that was collected.

Clutch air gap

	mm
Compressor clutch air gap	0.35 - 0.85

Tightening Torques

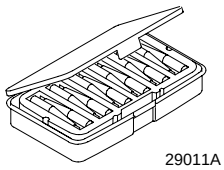
Description	Nm	lb-ft	lb-in
Compressor drive plate retaining bolt	13	10	–

DIAGNOSIS AND TESTING

Climate Control System

Refer to Wiring Diagrams Section412-00,for schematic and connector information.

Special Tool(s)

 29011A	Terminal probe kit 418-S035

General Equipment

Digital Multimeter (compatible with K-type thermo-couple)
Thermometer - Fluke 80 PK-8 (FSE number 260 4102 001 07)
Worldwide Diagnostic System (WDS)
Refrigerant center
Vacuum pump.
Vacuum gauge

Inspection and Testing

1. Check customer concern.
2. Visually CHECK for any obvious mechanical or electrical damage.

Visual Inspection

Mechanical	Electrical
• Refrigerant lines • Condenser • Drive belt • Coolant level • Coolant hoses • A/C compressor • Vacuum lines	• Fuses • Wiring harness • Connector

3. RECTIFY any obvious causes for a concern found during the visual inspection before performing any further tests. CHECK the operation of the system.
4. If the concern persists after the visual inspection, PERFORM a fault diagnosis on the electronic engine management with WDS and RECTIFY any displayed faults in accordance with the displayed fault description. CHECK the operation of the system.
5. For vehicles with no stored fault(s), PROCEED in accordance with the Symptom Chart according to the fault symptom.
6. Following checking or elimination of the fault and after completion of operations, the fault memories of all vehicle modules must be READ OUT and any stored faults must be DELETED. READ OUT all fault memories again following a road test.

Refrigerant Circuit - Quick Check

WARNING:The air conditioning system is filled with R134a refrigerant. Observe "Health and Safety Precautions". For further information

REFER to:Health and Safety Precautions (100-00 General Information, Description and Operation).

Refrigerant circuit check

WARNING:Under certain circumstances, refrigerant lines and A/C components may be extremely hot or cold. Exercising care, touch the refrigerant lines or A/C components in order to check this. Failure to observe this instruction can lead to injury.

- The refrigerant line from the refrigerant compressor to the condenser must be hot.
- The refrigerant line from the A/C condenser to the fixed orifice tube must be warm, but not so hot as the refrigerant line mentioned above.
- Determine the difference in temperature upstream and downstream of the A/C condenser by measuring the temperatures. Depending on the ambient temperature, the temperature difference should be more than 20 °C. If the temperature difference is less, check the condenser for contamination or damage to the fins as well as operation of the radiator fans.

DIAGNOSIS AND TESTING

- The refrigerant line between the fixed orifice tube and the evaporator must be cold from the point where the fixed orifice tube is installed. Depending on the weather, the refrigerant line may also have ice on its surface.
- The refrigerant line between the evaporator and the A/C compressor including the dehydrator must be cold.

Evaporator outlet temperature test

To test the power of the A/C system, the temperature of the evaporator outlet line must be measured. To do this, the following preconditions must be met:

- Open all windows.
- Set the air distribution to the defrost/dashboard position and open all the ventilation nozzles.
- DO NOT switch on recirculated air.
- Select lowest blower switch setting.
- Select lowest temperature setting.

NOTE: The temperature measurement cannot be done with a thermometer which makes no contact. False measurements may arise as a result of surface reflections.

Connect the temperature sensor (Fluke 80 PK-8) to the outlet line of the evaporator. The temperature sensor must be positioned as closely as possible to the evaporator. Connect the temperature sensor to the multimeter.

Start the engine and allow it to run at idle speed for several minutes.

Switch on the air-conditioning system.

After three minutes, measure the surface temperature of the evaporator outlet line.

If the measured temperature is 5 °C (vehicles with additional air conditioning: 2 °C) or less then the air conditioning system is OK. If the temperature is higher, the A/C system may be under-filled.

Frequent faults and their causes

If the customer expresses concern about insufficient cooling performance, ensure that the temperature control is working properly.

- No or poor cooling performance:
  - Blockage or narrowing of a refrigerant line or in the dehydrator: The location of the blockage or narrowing can easily be located by temperature comparisons at the refrigerant lines and the dehydrator. The blockage or restriction is located at the point where the temperature difference is identified. **Note: A difference in temperature in the area of the fixed orifice tube is normal.** Once you have found the location of the blockage or narrowing, check the corresponding component and replace it with a new one if required.
- Sudden drop in cooling performance (after the air conditioning has been switched off for approx. 5 minutes, the cooling performance returns to normal):
  - The cause is an iced-up fixed orifice tube because of moisture in the refrigerant circuit. In order to ensure that moisture is completely removed from the refrigerant circuit, the dehydrator should be renewed and the evacuation time should be extended to 2-3 hours. For further information

Symptom chart

Symptom chart

Symptom	Possible Sources	Action
• Blower faulty/inoperative	• Fuse(s) • Circuit(s) • Blower motor • Blower switch • Blower resistor assembly • Blower relay, programmable fuel-fired booster heater • Blower relay, air conditioning	• GO to Pinpoint Test A.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Additional blower motor faulty / inoperative	• Fuse(s) • Circuit(s) • Additional blower motor • Additional blower switch • Additional blower resistor	• GO to Pinpoint Test B.
• Air conditioning inoperative - blower function OK	• Fuse(s) • Circuit(s) • Air conditioning clutch • Air conditioning clutch relay • Refrigerant high pressure switch • Powertrain control module (PCM) • Refrigerant low pressure switch • Air conditioning control assembly	• GO to Pinpoint Test C.
• Refrigerant compressor inoperative in "defrost" air distribution setting (function of air conditioning OK)	• Circuit(s) • Mechanical actuation of the defrost switch • Defrost switch	• GO to Pinpoint Test D.
• Blower does not run automatically when the air conditioning is switched on - vehicles with air conditioning	• Circuit(s) • Blower relay, air conditioning	• GO to Pinpoint Test E.
• Temperature control inoperative - vehicles with air conditioning (function of the air conditioning OK)	• Circuit(s) • Temperature control potentiometer • Temperature control flap actuator • Temperature control flap • Air conditioning control assembly	• GO to Pinpoint Test F.
• Air distribution flap actuator for additional heater inoperative (operation of additional blower motor OK)	• Fuse(s) • Circuit(s) • Actuator – additional heater air distribution flap • Additional heater control assembly	• GO to Pinpoint Test G.
• The temperature control is inoperative when the additional heater control assembly is used.	• Fuse(s) • Circuit(s) • Additional heater control valve • Additional heater control valve module • Additional heater control assembly	• GO to Pinpoint Test H.
• Recirculated air flap inoperative	• Vacuum line(s). • Actuator – recirculated air flap • Climate control system control assembly	• GO to Pinpoint Test I.

DIAGNOSIS AND TESTING

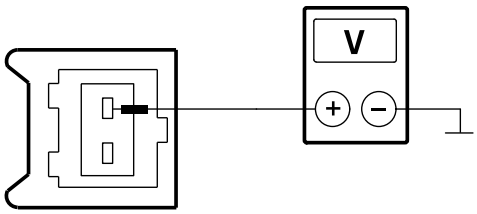
Symptom	Possible Sources	Action
• No heating power	• Cooling system • Vacuum line(s). • Circuit(s) • Coolant shut-off valve • Solenoid valve, coolant shut-off valve • Solenoid valve switch, coolant shut-off valve	• GO to Pinpoint Test J.

System Checks

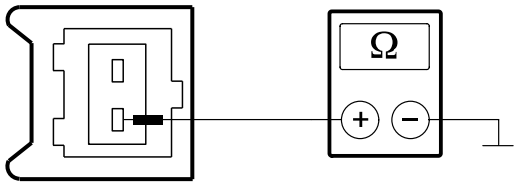
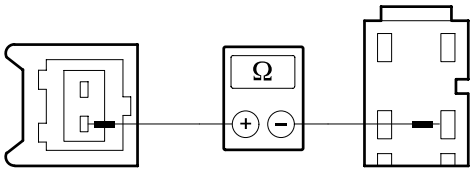
PINPOINT TEST A : BLOWER FAULTY/INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK ALL SPEED SETTINGS OF THE BLOWER MOTOR	
	1 Ignition switch in position II.
	2 Switch the blower switch through all speed settings. • Is the blower motor inoperative in all the switch positions? → **Yes** GO to A2. → **No** - The blower motor is inoperative in switch position 1 and/or 2: GO to A9. - The blower motor is only inoperative in switch position 3: GO to A8.
A2: CHECK FUSE F55	
	1 Ignition switch in position 0.
	2 CHECK Fuse F55 (standard relay box). • Is the fuse OK? → **Yes** GO to A3. → **No** INSTALL A NEW fuse F55 (40 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
A3: CHECK THE VOLTAGE AT FUSE F55	
	1 Connect Fuse F55 (standard relay box).
	2 Ignition switch in position II.

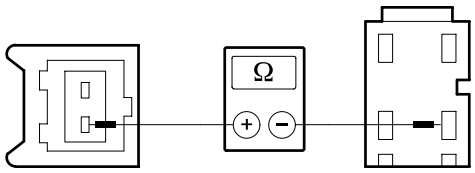
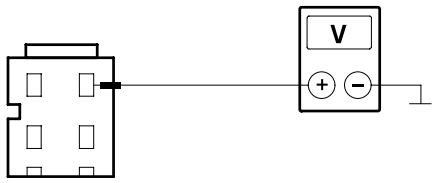
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between fuse F55 and ground. • Does the meter display battery voltage? → **Yes** GO to A4. → **No** REPAIR the voltage supply to fuse F55 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A4: CHECK VOLTAGE AT BLOWER MOTOR	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH123 from the blower motor.
	3 Ignition switch in position II.
 E54403	4 Measure the voltage between the blower motor, connector CH123, pin 1, circuit CB155J (YE/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** - All except vehicles with programmable fuel-fired booster heater: GO to A5. - Vehicles with programmable fuel-fired booster heater: GO to A19. → **No** - All except vehicles with programmable fuel-fired booster heater: LOCATE and REPAIR the break in the circuit between the blower motor and fuse F55 using the Wiring Diagrams. CHECK the operation of the system. - Vehicles with programmable fuel-fired booster heater: GO to A14.
A5: CHECK GROUND CONNECTION OF BLOWER MOTOR	
	1 Ignition switch in position 0.
	2 Set the blower switch to level 3.

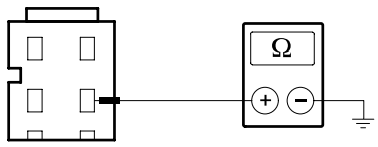
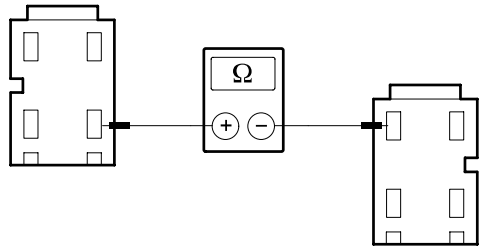
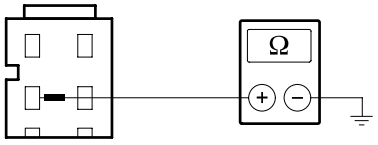
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E54404	3 Measure the resistance between the blower motor, connector CH123, pin 2, circuit VH301B (YE/BU), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the blower motor. CHECK the operation of the system. → **No** GO to A6.
A6: CHECK THE GROUND CONNECTION OF THE BLOWER SWITCH	
	1 Disconnect Connector CH101B from the blower switch.
 VFE0016022	2 Measure the resistance between the blower switch, connector CH101B, pin 4, circuit GD115F (BK/RD), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A7. → **No** LOCATE and REPAIR the break in the circuit between the blower switch and ground connection GP15 using the Wiring Diagrams. CHECK the operation of the system.
A7: CHECK CIRCUIT BETWEEN THE BLOWER MOTOR AND THE BLOWER SWITCH FOR OPEN CIRCUIT	
 VFE0033621	1 Measure the resistance between the blower motor, connector CH123, pin 2, circuit VH301B (YE/BU), wiring harness side and the blower switch, connector CH101B, pin 2, circuit VH301A (YE/BU), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the blower switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit VH301B (YE/BU) between the blower motor and soldered connection S2H301 using the Wiring Diagrams. CHECK the operation of the system.

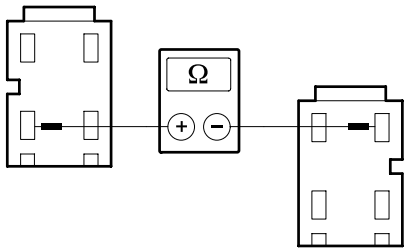
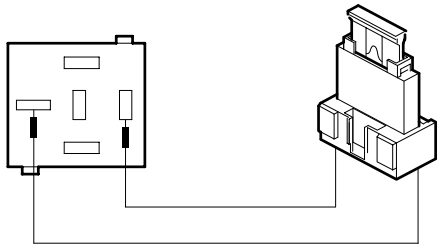
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A8: CHECK THE CIRCUIT BETWEEN THE BLOWER MOTOR AND THE BLOWER SWITCH FOR OPEN CIRCUIT - LEVEL 3 INOPERATIVE	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH123 from the blower motor.
	3 Disconnect Connector CH101B from the blower switch.
 VFE0033621	4 Measure the resistance between the blower motor, connector CH123, pin 2, circuit VH301B (YE/BU), wiring harness side and the blower switch, connector CH101B, pin 2, circuit VH301A (YE/BU), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the blower switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit VH301A (YE/BU) between soldered connection S2H301 and the blower switch using the Wiring Diagrams. CHECK the operation of the system.
A9: MEASURE THE VOLTAGE AT THE BLOWER RESISTOR ASSEMBLY	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH403 from the blower resistor assembly.
	3 Ignition switch in position II.
 VFE0023419	4 Measure the resistance between the blower resistor assembly, connector CH403, pin 1, circuit VH301C (YE/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** INSTALL a new heater blower series resistor. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit VH301C (YE/BU) between soldered connection S2H301 and the blower resistor assembly using the Wiring Diagrams. CHECK the operation of the system.
A10: CHECK THE GROUND CONNECTION OF BLOWER RESISTOR ASSEMBLY - LEVEL 1	
	1 Ignition switch in position 0.

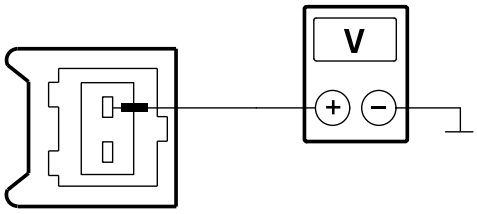
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Set the blower switch to level 1.
 VFE0008570	3 Measure the resistance between the blower resistor assembly, connector CH403, pin 2, circuit CH427C (BN), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A12. → **No** GO to A11.
A11: CHECK THE CIRCUIT BETWEEN THE BLOWER RESISTOR ASSEMBLY AND THE BLOWER SWITCH FOR OPEN CIRCUIT - LEVEL 1	
	1 Disconnect Connector CH101B from the blower switch.
 VFE0033622	2 Measure the resistance between the blower resistor assembly, connector CH403, pin 2, circuit CH427C (BN), wiring harness side and the blower switch, connector CH101B, pin 3, circuit CH427B (BN), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the blower switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the blower switch and the blower resistor assembly using the Wiring Diagrams. CHECK the operation of the system.
A12: CHECK THE GROUND CONNECTION OF BLOWER RESISTOR ASSEMBLY - LEVEL 2	
	1 Set the blower switch to level 2.
 VFE0009221	2 Measure the resistance between the blower resistor assembly, connector CH403, pin 4, circuit CH428A (GN/WH), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** INSTALL a new heater blower series resistor. CHECK the operation of the system. → **No** GO to A13.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A13: CHECK THE CIRCUIT BETWEEN THE BLOWER RESISTOR ASSEMBLY AND THE BLOWER SWITCH FOR OPEN CIRCUIT - LEVEL 2	
	1 Disconnect Connector CH101B from the blower switch.
 VFE0034284	2 Measure the resistance between the blower resistor assembly, connector CH403, pin 4, circuit CH428A (GN/WH), wiring harness side and the blower switch, connector CH101B, pin 1, circuit CH428A (GN/WH), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the blower switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit CH428A (GN/WH) between the blower switch and the blower resistor assembly using the Wiring Diagrams. CHECK the operation of the system.
A14: CHECK THE BLOWER MOTOR CIRCUIT	
	1 Ignition switch in position 0.
	2 DisconnectBlower relay for the programmable fuel-fired booster heater from socket CH402A.
 VFE0013150	3 Use a fused test cable (5 A) to bridge the blower relay of the programmable fuel-fired booster heater, socket CH402A, between pin 4, circuit CB155G (BN/BU), wiring harness side and pin 1, circuit CB155F (BN/BU), wiring harness side.
	4 Ignition switch in position II.

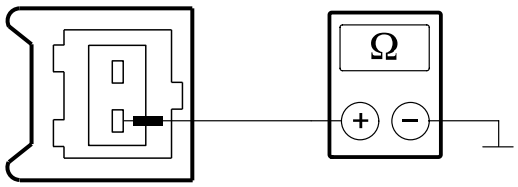
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E54403	5 Measure the voltage between the blower motor, connector CH123, pin 1, circuit CB155A (BN/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A17. → **No** GO to A15.
A15: CHECK THE VOLTAGE AT THE BLOWER RELAY OF THE PROGRAMMABLE FUEL-FIRED BOOSTER HEATER	
	1 Measure the voltage between the blower relay of the programmable fuel-fired booster heater, socket CH402A, pin 4, circuit CB154G (VT/OG) (vehicles without air conditioning: circuit CB154C (VT/OG)), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and REPAIR the break in the circuit between the blower relay for the programmable fuel-fired booster heater and the blower motor with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to A16.
A16: CHECK THE CIRCUIT BETWEEN THE BLOWER RELAY OF THE PROGRAMMABLE FUEL-FIRED BOOSTER HEATER AND THE PROGRAMMABLE FUEL-FIRED BOOSTER HEATER RELAY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Relay R16.

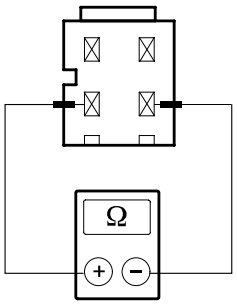
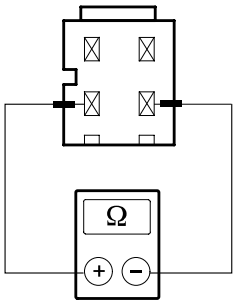
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the resistance between the blower relay of the programmable fuel-fired booster heater, socket CH402A, pin 4, circuit CB154G (VT/OG) (vehicles without air conditioning: circuit CB154C (VT/OG)), wiring harness side and the programmable fuel-fired booster heater relay, pin 5, circuit CB154A (VT/OG), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary RENEW the fuel-fired booster heater relay. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the blower relay for the programmable fuel-fired booster heater and the programmable fuel-fired booster heater relay using the Wiring Diagrams. CHECK the operation of the system.
A17: CHECK THE VOLTAGE AT THE BLOWER RELAY OF THE PROGRAMMABLE FUEL-FIRED BOOSTER HEATER	
	1 Measure the voltage between the blower relay of the programmable fuel-fired booster heater, socket CH402A, pin 3, circuit CB150P (YE/OG) (vehicles without air conditioning: circuit CB155G (BN/BU)), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A18. → **No** LOCATE and RECTIFY the break in the circuit between the blower relay of the programmable fuel-fired booster heater and soldered connection S2B150B (vehicles without air conditioning: soldered connection S2B155) using the Wiring Diagrams. CHECK the operation of the system.
A18: CHECK THE GROUND CONNECTION OF THE BLOWER RELAY FOR THE PROGRAMMABLE FUEL-FIRED BOOSTER HEATER	
	1 Ignition switch in position 0.

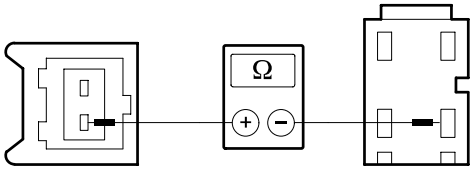
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the blower relay of the programmable fuel-fired booster heater, socket CH402A, pin 2, circuit GD115P (BK/GY) (vehicles without air conditioning: circuit GD115D (BK/GY)), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the blower relay for the programmable fuel-fired booster heater CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in circuit GD115P (BK/RD) (vehicles without air conditioning: circuit GD115D (BK/GY)) between the blower relay for the programmable fuel-fired booster heater and ground connection GP15 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A19: CHECK GROUND CONNECTION OF BLOWER MOTOR	
	1 Set the blower switch to level 3.
 E54404	2 Measure the resistance between the blower motor, connector CH123, pin 2, circuit VH301B (YE/BU), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the blower motor. CHECK the operation of the system. → **No** - Vehicles with air conditioning: GO to A20. , - Vehicles without air conditioning: GO to A21.
A20: CHECK BLOWER SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH101B from the blower switch.
	3 Set the blower switch to position 3.

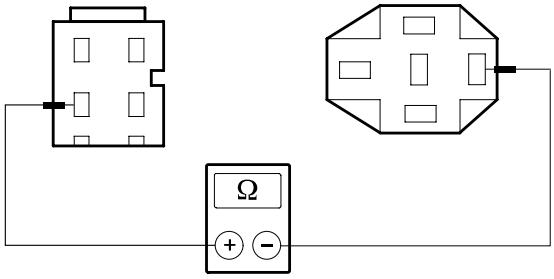
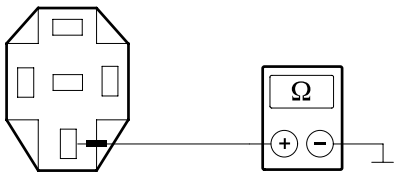
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the resistance at the blower switch, connector CH101B, between pin 2 and pin 4, component side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A22. → **No** RENEW the blower switch. CHECK the operation of the system.
A21: CHECK BLOWER SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH426B from the blower switch.
	3 Set the blower switch to position 3.
	4 Measure the resistance at the blower switch, connector CH426B, between pin 2 and pin 4, component side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A23. → **No** RENEW the blower switch. CHECK the operation of the system.
A22: CHECK CIRCUIT BETWEEN THE BLOWER MOTOR AND THE BLOWER SWITCH FOR OPEN CIRCUIT	
	1 Measure the resistance between the blower motor, connector CH123, pin 2, circuit VH301B (YE/BU), wiring harness side and the blower switch, connector CH101B, pin 2, circuit VH301A (YE/BU), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A24. → **No** LOCATE and REPAIR the break in circuit VH301B (YE/BU) between the blower motor and soldered connection S2H301 using the Wiring Diagrams. CHECK the operation of the system.

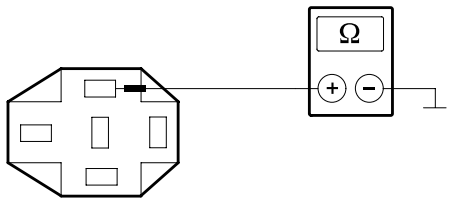
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A23: CHECK CIRCUIT BETWEEN THE BLOWER MOTOR AND THE BLOWER SWITCH FOR OPEN CIRCUIT	
 VFE0033621	1 Measure the resistance between the blower motor, connector CH123, pin 2, circuit VH301B (YE/BU), wiring harness side and the blower switch, connector CH426B, pin 2, circuit VH301A (YE/BU), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A25. → **No** LOCATE and REPAIR the break in circuit VH301B (YE/BU) between the blower motor and soldered connection S2H301 using the Wiring Diagrams. CHECK the operation of the system.
A24: CHECK CIRCUIT BETWEEN THE BLOWER MOTOR AND THE BLOWER SWITCH FOR OPEN CIRCUIT	
	1 Measure the resistance between the blower motor, connector CH123, pin 2, circuit VH301B (YE/BU), wiring harness side and the blower switch, connector CH101B, pin 2, circuit VH301A (YE/BU), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A26. → **No** LOCATE and REPAIR the break in circuit VH301B (YE/BU) between the blower motor and soldered connection S2H301 using the Wiring Diagrams. CHECK the operation of the system.
A25: CHECK THE CIRCUIT BETWEEN THE BLOWER SWITCH AND THE AIR CONDITIONING BLOWER RELAY FOR OPEN CIRCUIT	
	1 Disconnect A/C blower relay from socket CH402B.

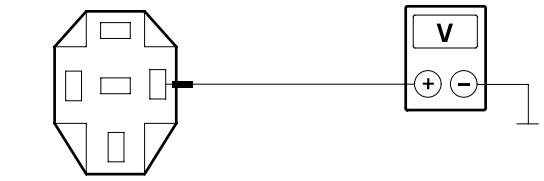
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the blower switch, connector CH426B, pin 4, circuit GD115A (BK/GY), wiring harness side and the A/C blower relay, socket CH402B, pin 5, circuit GD115A (BK/GY), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A27. → **No** LOCATE and REPAIR the break in circuit GD115A (BK/GY) between the blower switch and the A/C blower relay with the aid of the Wiring Diagrams. CHECK the operation of the system.
A26: CHECK THE CIRCUIT BETWEEN THE BLOWER SWITCH AND THE AIR CONDITIONING BLOWER RELAY FOR OPEN CIRCUIT	
	1 Disconnect A/C blower relay from socket CH402B.
	2 Measure the resistance between the blower switch, connector CH101B, pin 4, circuit GD115A (BK/GY), wiring harness side and the A/C blower relay, socket CH402B, pin 4, circuit GD115B (BK/GY), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A28. → **No** LOCATE and REPAIR the break in circuit GD115A (BK/GY) between the blower switch and the A/C blower relay with the aid of the Wiring Diagrams. CHECK the operation of the system.
A27: CHECK THE GROUND CONNECTION OF THE A/C BLOWER RELAY	
 VFE0025841	1 Measure the resistance between the A/C blower relay, socket CH405B, pin 1, circuit GD115R (BK/RD), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A29. → **No** LOCATE and REPAIR the break in circuit GD115R (BK/RD) between the air conditioning blower relay and soldered connection S2D115C with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A28: CHECK THE GROUND CONNECTION OF THE A/C BLOWER RELAY	
	1 Measure the resistance between the A/C blower relay, socket CH405B, pin 1, circuit GD115U (BK/RD), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A30. → **No** LOCATE and REPAIR the break in circuit GD115U (BK/RD) between the A/C blower relay and soldered connection S2D115C with the aid of the Wiring Diagrams. CHECK the operation of the system.
A29: CHECK THE GROUND CONNECTION OF THE A/C BLOWER RELAY	
	1 Measure the resistance between the A/C blower relay, socket CH402B, pin 2, circuit GD115Q (BK/RD), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A32. → **No** LOCATE and REPAIR the break in circuit GD115Q (BK/RD) between the air conditioning blower relay and soldered connection S2D115C with the aid of the Wiring Diagrams. CHECK the operation of the system.
A30: CHECK THE GROUND CONNECTION OF THE A/C BLOWER RELAY	
	1 Measure the resistance between the A/C blower relay, socket CH402B, pin 2, circuit GD115Q (BK/RD), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A31. → **No** LOCATE and REPAIR the break in circuit GD115Q (BK/RD) between the air conditioning blower relay and soldered connection S2D115C with the aid of the Wiring Diagrams. CHECK the operation of the system.
A31: CHECK THE VOLTAGE AT THE AIR CONDITIONING BLOWER RELAY - PIN 1	
	1 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the voltage between the A/C blower relay, socket CH402B, pin 1, circuit CB154E (VT/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the air conditioning blower relay. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit CB154E (VT/OG) between the A/C blower relay and soldered connection S2B154 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A32: CHECK THE VOLTAGE AT THE AIR CONDITIONING BLOWER RELAY - PIN 1	
	1 Ignition switch in position II.
 VFE0015922	2 Measure the voltage between the A/C blower relay, socket CH402B, pin 3, circuit CB155E (YE/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the air conditioning blower relay. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit CB155E (YE/RD) between the air conditioning blower relay and soldered connection S2B155 with the aid of the Wiring Diagrams. CHECK the operation of the system.

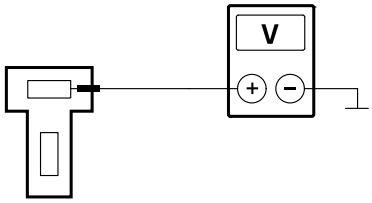
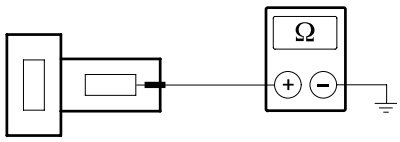
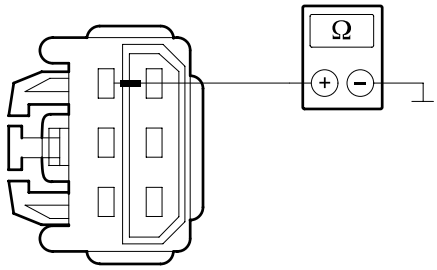
PINPOINT TEST B : ADDITIONAL BLOWER MOTOR FAULTY / INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK ALL SPEED SETTINGS OF THE ADDITIONAL BLOWER MOTOR	
	1 Ignition switch in position II.

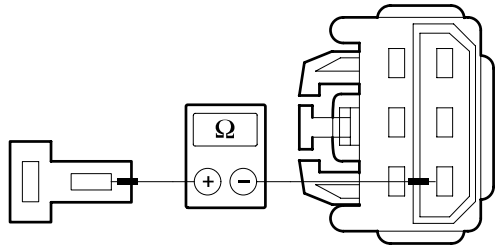
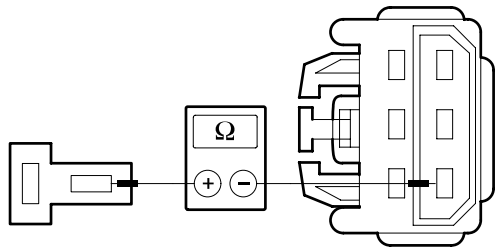
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Switch the additional blower motor switch through all settings. • Is the additional blower motor inoperative in all the switch positions? → **Yes** GO to B2. → **No** - The additional blower motor is inoperative in switch position 1, 2 and/or 3: GO to B9. - The additional blower motor is only inoperative in switch position 4: GO to B8.
B2: CHECK FUSE F57	
	1 Ignition switch in position 0.
	2 CHECK Fuse F57 (standard relay box). • Is the fuse OK? → **Yes** GO to B3. → **No** RENEW fuse F57 (30 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
B3: CHECK THE VOLTAGE AT FUSE F57	
	1 Connect Fuse F57 (standard relay box).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F57 and ground. • Does the meter display battery voltage? → **Yes** GO to B4. → **No** REPAIR the voltage supply to fuse F57 with the aid of the Wiring Diagrams. CHECK the operation of the system.
B4: CHECK THE VOLTAGE AT THE ADDITIONAL BLOWER MOTOR	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH123R from the additional blower motor.
	3 Ignition switch in position II.

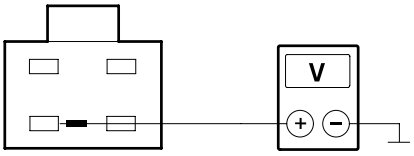
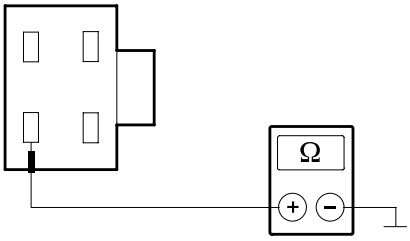
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between the additional blower motor, connector CH123R, pin 1, circuit CB157D (BN/GN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B5. → **No** LOCATE and REPAIR the break in the circuit between the additional blower motor and fuse F57 using the Wiring Diagrams. CHECK the operation of the system.
B5: CHECK THE GROUND CONNECTION OF THE ADDITIONAL BLOWER MOTOR	
	1 Ignition switch in position 0.
	2 Set the additional blower switch to position 4.
 VFE0013703	3 Measure the resistance between the additional blower motor, connector CH123R, pin 2, circuit CHA08A (GN/OG), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the additional blower motor. CHECK the operation of the system. → **No** GO to B6.
B6: CHECK THE GROUND CONNECTION OF THE ADDITIONAL BLOWER SWITCH	
	1 Disconnect Connector CHA05A from the additional blower switch.
 VFE0034286	2 Measure the resistance between the additional blower switch, connector CHA05A, pin 1, circuit GD149H (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to B7. → **No** LOCATE and RECTIFY the break in the circuit between the additional blower switch and ground connection GP49 using the Wiring Diagrams. CHECK the operation of the system.

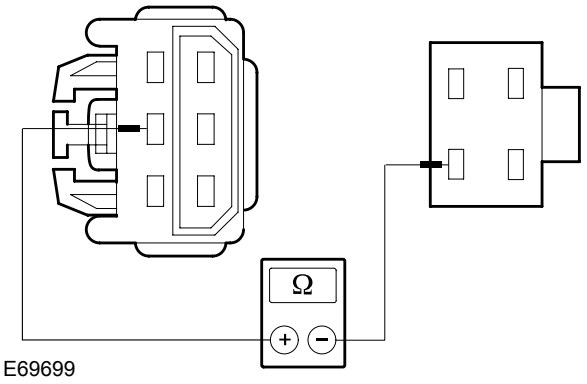
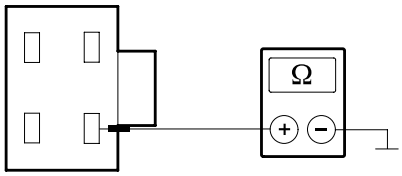
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B7: CHECK THE CIRCUIT BETWEEN THE ADDITIONAL BLOWER MOTOR AND THE ADDITIONAL BLOWER SWITCH FOR OPEN CIRCUIT	
 VFE0034285	1 Measure the resistance between the additional blower motor, connector CH123R, pin 2, circuit CHA08A (GN/OG), wiring harness side and the additional blower switch, connector CHA05A, pin 6, circuit CHA08F (GN/OG), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the additional blower switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the additional blower motor and soldered connection S4HA08 with the aid of the Wiring Diagrams. CHECK the operation of the system.
B8: CHECK THE CIRCUIT BETWEEN THE ADDITIONAL BLOWER MOTOR AND THE ADDITIONAL BLOWER SWITCH FOR OPEN CIRCUIT - LEVEL 4 INOPERATIVE	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH123R from the additional blower motor.
	3 Disconnect Connector CHA05A from the additional blower switch.
 VFE0034285	4 Measure the resistance between the additional blower motor, connector CH123R, pin 2, circuit CHA08A (GN/OG), wiring harness side and the additional blower switch, connector CHA05A, pin 6, circuit CHA08F (GN/OG), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the additional blower switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between soldered connection S4HA08 and the additional blower switch with the aid of the Wiring Diagrams. CHECK the operation of the system.
B9: CHECK THE VOLTAGE AT THE ADDITIONAL BLOWER RESISTOR	
	1 Ignition switch in position 0.

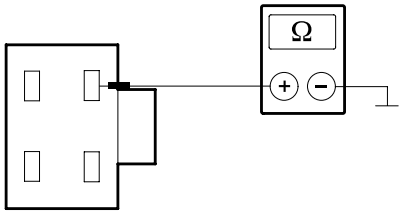
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Connector CHA04 from the additional blower resistor.
	3 Ignition switch in position II.
 VFE0034288	4 Measure the voltage between the additional blower resistor, connector CHA04, pin 4, circuit CHA08B (GN/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B10. → **No** LOCATE and REPAIR the break in the circuit between soldered connection S4HA08 and the additional blower resistor with the aid of the Wiring Diagrams. CHECK the operation of the system.
B10: CHECK THE GROUND CONNECTION OF THE ADDITIONAL BLOWER RESISTOR - LEVEL 1	
	1 Ignition switch in position 0.
	2 Set the additional blower switch to level 1.
	3 Measure the resistance between the additional blower resistor, connector CHA04, pin 3, circuit CHA06D (YE/VT), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to B12. → **No** GO to B11.
B11: CHECK THE CIRCUIT BETWEEN THE ADDITIONAL BLOWER SWITCH AND THE ADDITIONAL BLOWER RESISTOR FOR OPEN CIRCUIT	
	1 Disconnect Connector CHA05A from the additional blower switch.

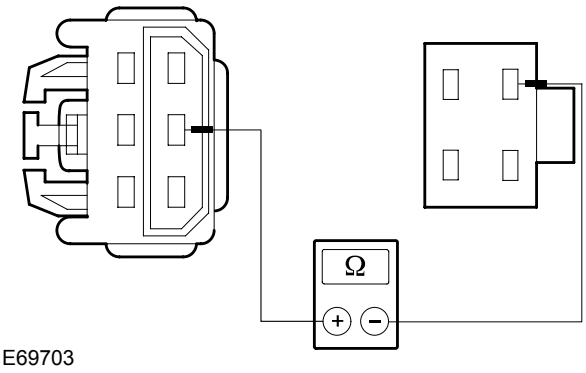
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69699	2 Measure the resistance between the additional blower switch, connector CHA05A, pin 2, circuit CHA06A (YE/VT), wiring harness side and the additional blower resistor, connector CHA04, pin 3, circuit CHA06D (YE/VT), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the additional blower switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the additional blower switch and the additional blower resistor with the aid of the Wiring Diagrams. CHECK the operation of the system.
B12: CHECK THE GROUND CONNECTION OF THE ADDITIONAL BLOWER RESISTOR - LEVEL 2	
	1 Set the additional blower switch to level 2.
	2 Measure the resistance between the additional blower resistor, connector CHA04, pin 1, circuit ZA345A (OG/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to B14. → **No** GO to B13.
B13: CHECK THE CIRCUIT BETWEEN THE ADDITIONAL BLOWER SWITCH AND THE ADDITIONAL BLOWER RESISTOR FOR OPEN CIRCUIT	
	1 Disconnect Connector CHA05A from the additional blower switch.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the additional blower switch, connector CHA05A, pin 3, circuit ZA345D (OG/GY), wiring harness side and the additional blower resistor, connector CHA04, pin 1, circuit ZA345A (OG/GY), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the additional blower switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the additional blower switch and the additional blower resistor with the aid of the Wiring Diagrams. CHECK the operation of the system.
B14: CHECK THE GROUND CONNECTION OF THE ADDITIONAL BLOWER RESISTOR - LEVEL 3	
	1 Set the additional blower switch to level 3.
	2 Measure the resistance between the additional blower resistor, connector CHA04, pin 2, circuit CHA07D (BU/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the additional blower resistor. CHECK the operation of the system. → **No** GO to B15.
B15: CHECK THE CIRCUIT BETWEEN THE ADDITIONAL BLOWER SWITCH AND THE ADDITIONAL BLOWER RESISTOR FOR OPEN CIRCUIT	
	1 Disconnect Connector CHA05A from the additional blower switch.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69703	2 Measure the resistance between the additional blower switch, connector CHA05A, pin 5, circuit CHA07A (BU/GY), wiring harness side and the additional blower resistor, connector CHA04, pin 2, circuit CHA07D (BU/GY), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the additional blower switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the additional blower switch and the additional blower resistor with the aid of the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST C : AIR CONDITIONING INOPERATIVE - BLOWER FUNCTION OK

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: DETERMINE THE CONDITIONS UNDER WHICH THE FAULT OCCURS	
	1 Ignition switch in position III. 2 Run the engine at idle speed.
	3 Switch on the air-conditioning system. • Does the A/C clutch work, and is the A/C indicator lamp on? → **Yes** PERFORM the Refrigerant Circuit Quick Check. → **No** - The A/C indicator lamp is on, but the A/C clutch is not working: GO to C2. - The A/C indicator lamp is not on, but the A/C clutch is working: RENEW the blower switch. CHECK the operation of the system. - The A/C indicator lamp is not on, and the A/C clutch is not working: GO to C21.
C2: CHECK FUSE F36	
	1 Ignition switch in position 0.

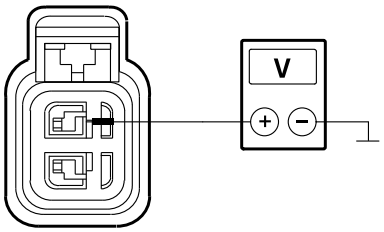
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK FuseF36 (BJB). • Is the fuse OK? → **Yes** GO to C3. → **No** RENEW fuse F36 (10 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
C3: CHECK THE VOLTAGE AT FUSE F36	
	1 Connect Fuse F36 (BJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F36 (10 A) and ground. • Does the meter display battery voltage? → **Yes** GO to C4. → **No** REPAIR the voltage supply to fuse F36 with the aid of the Wiring Diagrams. CHECK the operation of the system.
C4: CHECK FUSE F29	
	1 Ignition switch in position 0.
	2 CHECK FuseF29 (BJB). • Is the fuse OK? → **Yes** GO to C5. → **No** RENEW fuse F29 (5 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
C5: CHECK THE VOLTAGE AT FUSE F29	
	1 Connect Fuse F29 (BJB).
	2 Ignition switch in position II.

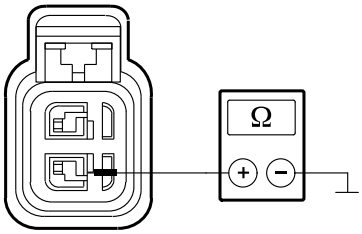
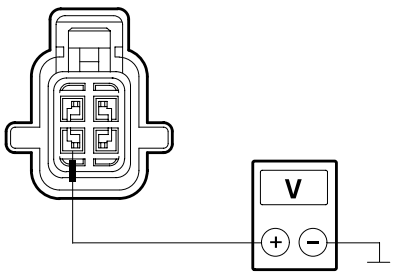
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between fuse F29 (5 A) and ground. • Does the meter display battery voltage? → **Yes** GO to C6. → **No** REPAIR the voltage supply to fuse F29 with the aid of the Wiring Diagrams. CHECK the operation of the system.
C6: CHECK THE CONTROL VOLTAGE AT THE A/C CLUTCH RELAY	
	1 Ignition switch in position 0.
	2 Disconnect A/C clutch relay from socket C1010.
	3 Ignition switch in position II.
	4 Measure the voltage between the A/C clutch relay, socket C1010, pin 1, circuit CBB29A (WH/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to C7. → **No** LOCATE and RECTIFY the break in circuit CBB29A (WH/VT) between the A/C relay and fuse F29 with the aid of the Wiring Diagrams. CHECK the operation of the system.
C7: CHECK THE VOLTAGE AT THE A/C CLUTCH RELAY	
	1 Measure the voltage between the A/C clutch relay, socket C1010, pin 3, circuit CBB36A (BU/BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to C8. → **No** LOCATE and RECTIFY the break in circuit CBB36A (BU/BN) between the A/C relay and fuse F36 with the aid of the Wiring Diagrams. CHECK the operation of the system.
C8: CHECK THE CIRCUIT OF THE A/C CLUTCH	
	1 Ignition switch in position 0.

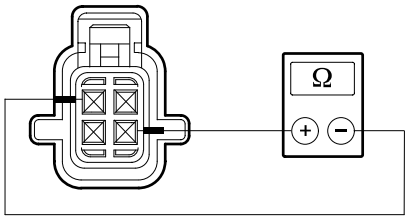
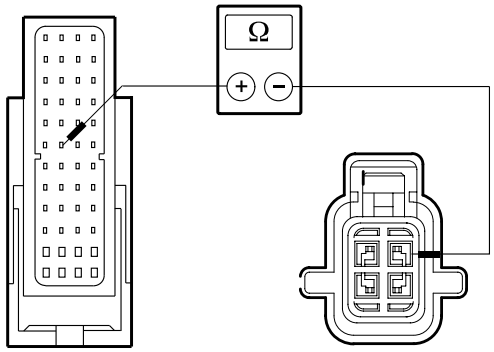
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Using a fused test cable ((10 A), bridge between the relay of the A/C clutch, socket C1010, pin 3, circuit CBB36A (BU/BN), wiring harness side and pin 5, circuit CH109A (WH/OG), wiring harness side.
	3 Ignition switch in position II. • Does the air conditioning clutch work? → **Yes** GO to C11. → **No** GO to C9.
C9: CHECK THE VOLTAGE AT THE A/C CLUTCH	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH302 from the A/C clutch.
	3 Using a fused test cable ((10 A), bridge between the relay of the A/C clutch, socket C1010, pin 3, circuit CBB36A (BU/BN), wiring harness side and pin 5, circuit CH109A (WH/OG), wiring harness side.
	4 Ignition switch in position II.
	5 Measure the voltage between the A/C clutch, connector CH302, pin 1, circuit CH109D (WH/OG) (vehicles with a diesel engine: circuit CH109B (WH/OG)), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to C10. → **No** LOCATE and REPAIR the open circuit between the A/C relay and the A/C clutch using the Wiring Diagrams. CHECK the operation of the system.
C10: CHECK THE GROUND CONNECTION OF THE A/C CLUTCH	
	1 Ignition switch in position 0.

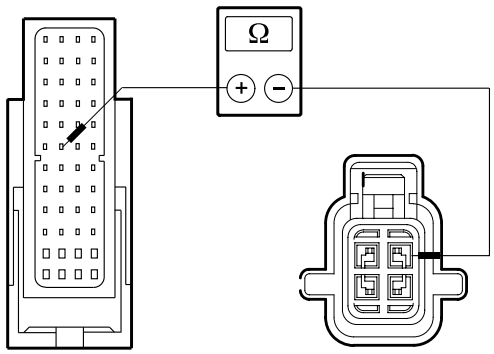
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E57637	2 Measure the resistance between the A/C clutch, connector CH302, pin 2, circuit GD122Q (BK) (vehicles with a diesel engine: circuit GD122G (BK)), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the air conditioning clutch. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the air conditioning clutch and ground connection GP22 with the aid of the Wiring Diagrams. CHECK the operation of the system.
C11: CHECK AIR CONDITIONING CLUTCH RELAY	
	1 Check the A/C clutch relay according to the component test at the end of this section. • Is the air conditioning clutch relay OK? → **Yes** GO to C12. → **No** RENEW the air conditioning clutch relay. CHECK the operation of the system.
C12: CHECK THE VOLTAGE AT THE REFRIGERANT HIGH PRESSURE SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH433 from the refrigerant high pressure switch.
	3 Ignition switch in position II.
	4 Switch on the air-conditioning system.
	5 Measure the voltage at the refrigerant high pressure switch, between connector CH433, pin 4, circuit CH421A (GY), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to C13. → **No** GO to C18.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C13: CHECK THE A/C HIGH PRESSURE SWITCH	
NOTE: Make sure that the refrigerant pressure is in the range between 3.0 and 10.5 bar (temperature dependent). If the pressure is higher, perform a refrigerant circuit Quick Check. If the pressure is lower, check the refrigerant circuit for leaks.	
	1 Ignition switch in position 0.
 E54593	2 Measure the resistance at the refrigerant high pressure switch, connector CH433, between pin 1 and pin 4, component side. • Is a resistance of less than 2 Ohms registered? → **Yes** - Vehicles with diesel engine: GO to C14. - All except vehicles with diesel engines: GO to C16. → **No** RENEW the refrigerant high pressure switch. CHECK the operation of the system.
C14: CHECK THE CIRCUIT BETWEEN THE POWERTRAIN CONTROL MODULE (PCM) AND THE REFRIGERANT HIGH PRESSURE SWITCH FOR OPEN CIRCUIT - VEHICLES WITH A DIESEL ENGINE	
	1 Disconnect Connector CE104B from the PCM.
	2 Measure the resistance between the PCM, connector CE104B, pin F2, circuit CH423A (YE), wiring harness side and the refrigerant high pressure switch, connector CH433, pin 1, circuit CH423A (YE), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to C15. → **No** LOCATE and RECTIFY the break in circuit CH423A (YE) between the PCM and the refrigerant high pressure switch with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C15: CHECK THE CIRCUIT BETWEEN THE POWERTRAIN CONTROL MODULE (PCM) AND THE A/C CLUTCH RELAY FOR OPEN CIRCUIT - VEHICLES WITH A DIESEL ENGINE	
	1 Measure the resistance between the PCM, connector CE104B, pin B2, circuit CH401A (VT/WH), wiring harness side and the A/C clutch relay, socket C1010, pin 2, circuit CH401A (VT/WH), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK the PCM and RENEW if necessary. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in circuit CH401A (VT/WH) between PCM and the A/C clutch relay with the aid of the Wiring Diagrams. CHECK the operation of the system.
C16: CHECK THE CIRCUIT BETWEEN THE POWERTRAIN CONTROL MODULE (PCM) AND THE REFRIGERANT HIGH PRESSURE SWITCH FOR OPEN CIRCUIT - ALL VEHICLES EXCEPT VEHICLES WITH A DIESEL ENGINE	
	1 Disconnect Connector CE512B from the PCM.
	2 Measure the resistance between the PCM, connector CE512B, pin F2, circuit CH423A (YE), wiring harness side and the refrigerant high pressure switch, connector CH433, pin 1, circuit CH423A (YE), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to C17. → **No** LOCATE and RECTIFY the break in circuit CH423A (YE) between the PCM and the refrigerant high pressure switch with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C17: CHECK THE CIRCUIT BETWEEN THE POWERTRAIN CONTROL MODULE (PCM) AND THE A/C CLUTCH RELAY FOR OPEN CIRCUIT - ALL VEHICLES EXCEPT VEHICLES WITH A DIESEL ENGINE	
	1 Measure the resistance between the PCM, connector CE512B, pin B2, circuit CH401A (VT/WH), wiring harness side and the A/C clutch relay, socket C1010, pin 2, circuit CH401A (VT/WH), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK the PCM and RENEW if necessary. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in circuit CH401A (VT/WH) between PCM and the A/C clutch relay with the aid of the Wiring Diagrams. CHECK the operation of the system.
C18: CHECK THE VOLTAGE AT THE REFRIGERANT LOW PRESSURE SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH421 from the refrigerant low pressure switch.
	3 Ignition switch in position II.
	4 Switch on the air-conditioning system.
	5 Measure the voltage between the refrigerant low pressure switch, connector CH421, pin 1, circuit CH422A (VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to C19. → **No** GO to C20.
C19: CHECK REFRIGERANT LOW PRESSURE SWITCH	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance at the refrigerant low pressure switch, connector CH421, between pin 1 and pin 4, component side. • Is a resistance of less than 2 Ohms registered? → **Yes** LOCATE and RECTIFY the break in circuit CH421A (GY) between the refrigerant low pressure switch and the refrigerant high pressure switch with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the refrigerant low pressure switch. CHECK the operation of the system.
C20: CHECK THE CIRCUIT BETWEEN THE REFRIGERANT LOW PRESSURE SWITCH AND THE A/C CONTROL ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH101C from the A/C control assembly.
	3 Measure the resistance between the A/C control assembly, connector CH101C, pin 4, circuit CH422F (VT), wiring harness side and the refrigerant low pressure switch, connector CH421, pin 1, circuit CH422A (VT), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the A/C control assembly. CHECK the operation of the system. → **No** LOCATE and RECTIFY the open circuit between the air conditioning control assembly and the refrigerant low pressure switch with the aid of the Wiring Diagrams. CHECK the operation of the system.
C21: CHECK THE FUNCTION OF THE DEFROST SWITCH	
	1 Set the air distribution to defrost. • Does the A/C clutch work, and is the A/C indicator lamp on? → **Yes** GO to C24. → **No** GO to C22.

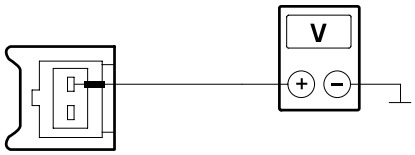
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C22: CHECK FUSE F50	
	1 Ignition switch in position 0.
	2 CHECKFuse F50 (standard relay box). • Is the fuse OK? → **Yes** GO to C23. → **No** RENEW fuse F50 (10 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
C23: CHECK THE VOLTAGE AT FUSE F50	
	1 Connect Fuse F50 (standard relay box).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F50 (10 A) and ground. • Does the meter display battery voltage? → **Yes** GO to C24. → **No** REPAIR the voltage supply to fuse F50 with the aid of the Wiring Diagrams. CHECK the operation of the system.
C24: CHECK THE VOLTAGE AT THE AIR CONDITIONING CONTROL PANEL	
	1 Ignition switch in position 0.
	2 Disconnect Connector C101C from the A/C control assembly.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0013997	4 Measure the voltage between the A/C control assembly, connector C101C, pin 3, circuit CB150N (YE/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the A/C control assembly. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit CB150N (YE/OG) between the A/C control assembly and soldered connection S2B150B with the aid of the Wiring Diagrams. CHECK the operation of the system.

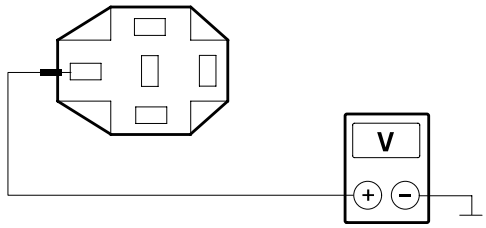
PINPOINT TEST D : REFRIGERANT COMPRESSOR INOPERATIVE IN "DEFROST" AIR DISTRIBUTION SETTING (FUNCTION OF AIR CONDITIONING OK)

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Before carrying out the check, make sure that the ambient temperature is above 4°C.	
D1: MEASURE THE VOLTAGE AT THE DEFROST SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH227 from the defrost switch.
	3 Ignition switch in position II.
 VFE0024544	4 Measure the voltage between the defrost switch, connector CH227, pin 2, circuit CB150M (YE/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to D2. → **No** LOCATE and REPAIR the break in circuit CB150M (YE/OG) between the defrost switch and soldered connection S2B150B with the aid of the Wiring Diagrams. CHECK the operation of the system.
D2: CHECK THE CIRCUIT BETWEEN THE DEFROST SWITCH AND THE REFRIGERANT LOW PRESSURE SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH421 from the refrigerant low pressure switch.

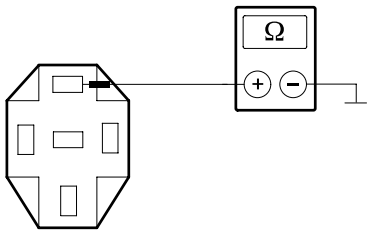
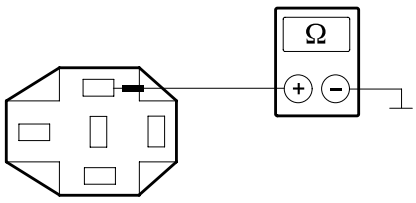
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the resistance between the defrost switch, connector CH227, pin 1, circuit CH422E (VT), wiring harness side and the refrigerant low pressure switch, connector CH421, pin 1, circuit CH422A (VT), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** TEST the mechanical actuation of the defrost switch and REPAIR if necessary. If the mechanical actuation is OK, RENEW the defrost switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit CH422E (VT) between the defrost switch and soldered connection S2H422 with the aid of the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST E : BLOWER DOES NOT RUN AUTOMATICALLY WHEN THE AIR CONDITIONING IS SWITCHED ON - VEHICLES WITH AIR CONDITIONING

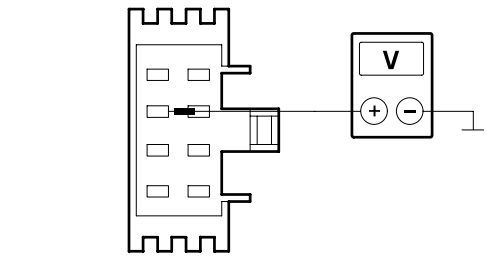
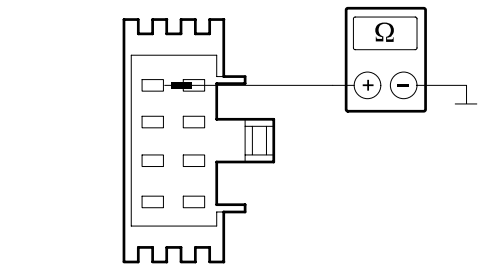
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: CHECK THE VOLTAGE AT THE AIR CONDITIONING BLOWER RELAY (PIN 3)	
	1 Ignition switch in position 0.
	2 Disconnect A/C blower relay from socket CH402B.
	3 Ignition switch in position II.
	4 Set the blower switch to position 0.
	5 Measure the voltage between the A/C blower relay, socket CH402B, pin 3, circuit CH427D (BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to E2. → **No** LOCATE and REPAIR the break in circuit CH427D (BN) between the A/C blower relay and soldered connection S2H427 with the aid of the Wiring Diagrams. CHECK the operation of the system.
E2: CHECK THE VOLTAGE AT THE AIR CONDITIONING BLOWER RELAY (PIN 1)	
	1 Switch on the air-conditioning system.

DIAGNOSIS AND TESTING

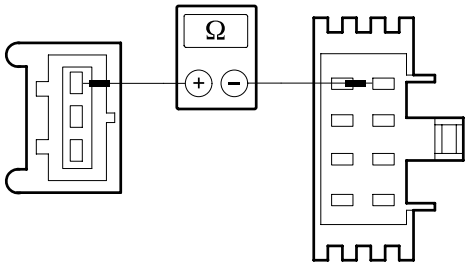
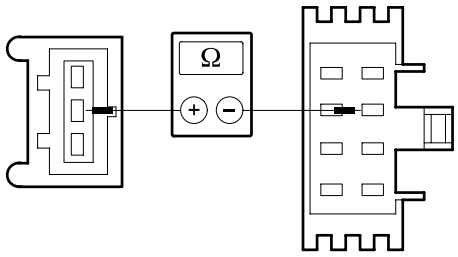
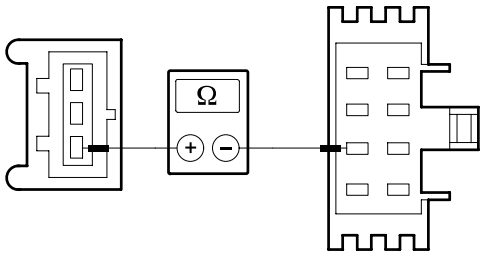
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0015922	2 Measure the voltage between the A/C blower relay, socket CH402B, pin 1, circuit CH422G (VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to E3. → **No** LOCATE and REPAIR the break in circuit CH422G (VT) between the A/C blower relay and soldered connection S2H422 with the aid of the Wiring Diagrams. CHECK the operation of the system.
E3: CHECK THE GROUND CONNECTION OF THE A/C BLOWER RELAY (PIN 5)	
	1 Ignition switch in position 0.
 VFE0031062	2 Measure the resistance between the air conditioning blower relay, socket CH402B, pin 5, circuit GD115H (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to E4. → **No** LOCATE and REPAIR the break in circuit GD115H (BK/GY) between the A/C blower relay and soldered connection S2D115C with the aid of the Wiring Diagrams. CHECK the operation of the system.
E4: CHECK THE GROUND CONNECTION OF THE A/C BLOWER RELAY (PIN 2)	
 E69708	1 Measure the resistance between the A/C blower relay, socket CH402B, pin 2, circuit GD115G (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the air conditioning blower relay. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit GD115G (BK/GY) between the A/C blower relay and soldered connection S2D115C with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

PINPOINT TEST F : TEMPERATURE CONTROL INOPERATIVE - VEHICLES WITH AIR CONDITIONING (FUNCTION OF THE AIR CONDITIONING OK)

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Before carrying out the check, make sure that the air distribution flap is mechanically OK.	
F1: CHECK THE VOLTAGE AT THE TEMPERATURE CONTROL FLAP ACTUATOR	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH232 from the temperature control flap actuator.
	3 Ignition switch in position II.
 VFE0034298	4 Measure the voltage between the temperature control flap actuator, connector CH232, pin 7, circuit CB150J (YE/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to F2. → **No** LOCATE and RECTIFY the open circuit between the temperature control flap actuator and soldered connection S2B150B with the aid of the Wiring Diagrams. CHECK the operation of the system.
F2: CHECK THE GROUND CONNECTION OF THE TEMPERATURE CONTROL FLAP ACTUATOR	
	1 Ignition switch in position 0.
 VFE0034299	2 Measure the resistance between the temperature control flap actuator, connector CH232, pin 8, circuit GD115D (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to F3. → **No** LOCATE and RECTIFY the open circuit between the temperature control flap actuator and soldered connection S2D115C with the aid of the Wiring Diagrams. CHECK the operation of the system.
F3: CHECK THE CIRCUITS BETWEEN THE TEMPERATURE CONTROL FLAP ACTUATOR AND THE A/C CONTROL ASSEMBLY FOR OPEN CIRCUIT	
	1 Disconnect Connector CH101D from the A/C control assembly.

DIAGNOSIS AND TESTING

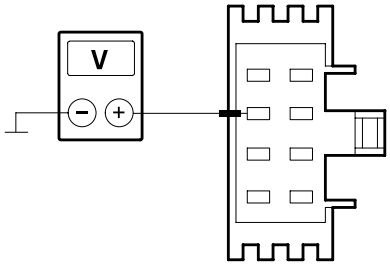
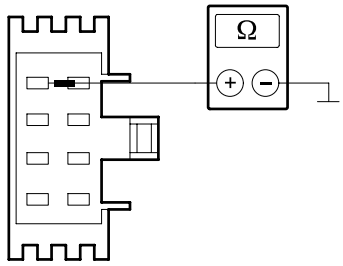
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0034302	2 Measure the resistance between the temperature control flap actuator, connector CH232, pin 4, circuit ZA337A (OG/GY), wiring harness side and the A/C control assembly, connector CH101D, pin 3, circuit ZA337A (OG/GY), wiring harness side.
 VFE0034301	3 Measure the resistance between the temperature control flap actuator, connector CH232, pin 3, circuit ZA338A (OG/WH), wiring harness side and the A/C control assembly, connector CH101D, pin 2, circuit ZA338A (OG/WH), wiring harness side.
 VFE0034300	4 Measure the resistance between the temperature control flap actuator, connector CH232, pin 6, circuit ZA339A (OG/BN), wiring harness side and the A/C control assembly, connector CH101D, pin 1, circuit ZA339A (OG/BN), wiring harness side. • Is a resistance of less than 2 Ohms measured in all of the cases? → **Yes** RENEW the temperature control potentiometer. CHECK the operation of the system. If the system is still inoperative, RENEW the temperature control flap actuator. → **No** LOCATE and REPAIR the break in the relevant circuit between the temperature control flap actuator and the A/C control assembly with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

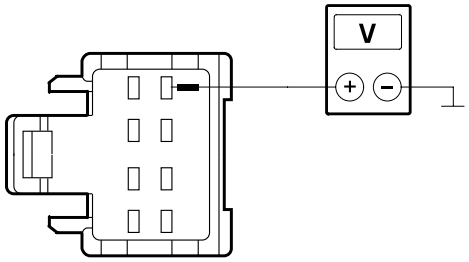
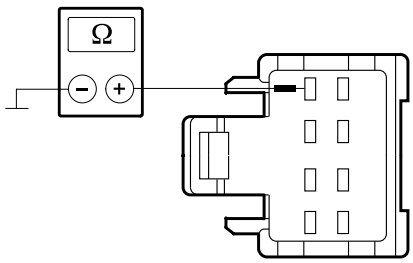
PINPOINT TEST G : AIR DISTRIBUTION FLAP ACTUATOR FOR ADDITIONAL HEATER INOPERATIVE (OPERATION OF ADDITIONAL BLOWER MOTOR OK)

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Before carrying out the check, make sure that the air distribution flap is mechanically OK.	
G1: CHECK FUSE F50	
	1 Ignition switch in position 0.
	2 CHECK Fuse F50 (standard relay box). • Is the fuse OK? → **Yes** GO to G2. → **No** RENEW fuse F50. CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
G2: CHECK THE VOLTAGE AT FUSE F50	
	1 Connect Fuse F50 (standard relay box).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F50 (10 A) and ground. • Does the meter display battery voltage? → **Yes** GO to G3. → **No** REPAIR the voltage supply to fuse F50 with the aid of the Wiring Diagrams. CHECK the operation of the system.
G3: CHECK THE VOLTAGE AT THE ACTUATOR FOR THE ADDITIONAL HEATER AIR DISTRIBUTION FLAP	
	1 Ignition switch in position 0.
	2 Disconnect Connector CHA09 from the actuator for the additional heater air distribution flap.
	3 Ignition switch in position II.

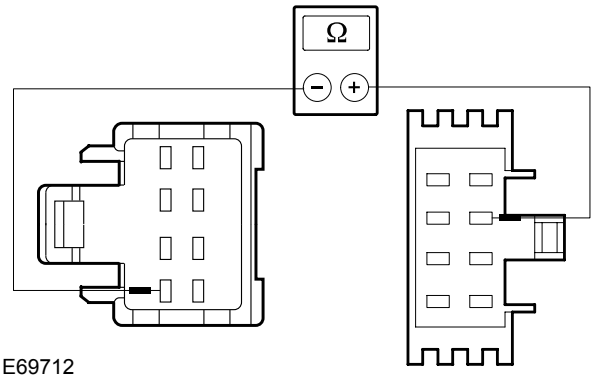
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between the actuator for the additional heater air distribution flap, connector CHA09, pin 7, circuit CB150U (YE/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to G4. → **No** LOCATE and REPAIR the break in the circuit between the actuator for the additional heater air distribution flap and fuse F50 with the aid of the Wiring Diagrams. CHECK the operation of the system.
G4: CHECK THE GROUND CONNECTION OF THE ACTUATOR FOR THE ADDITIONAL HEATER AIR DISTRIBUTION FLAP	
	1 Ignition switch in position 0.
 E0034311	2 Measure the resistance between the actuator for the additional heater air distribution flap, connector CHA09, pin 8, circuit GD149AC (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to G5. → **No** LOCATE and REPAIR the break in the circuit between the actuator for the additional heater air distribution flap and ground connection GP49 with the aid of the Wiring Diagrams. CHECK the operation of the system.
G5: CHECK THE VOLTAGE AT THE ADDITIONAL HEATER CONTROL ASSEMBLY	
	1 Disconnect Connector CHA05B from the additional heater control assembly.
	2 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between the additional heater control assembly, connector CHA05B, pin 4, circuit CB150G (YE/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to G6. → **No** LOCATE and RECTIFY the open circuit between the additional heater control assembly and soldered connection S2B150D with the aid of the Wiring Diagrams. CHECK the operation of the system.
G6: CHECK THE GROUND CONNECTION OF THE ADDITIONAL HEATER CONTROL ASSEMBLY	
	1 Ignition switch in position 0.
 1	2 Measure the resistance between the additional heater control assembly, connector CHA05B, pin 8, circuit GD149P (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to G7. → **No** LOCATE and RECTIFY the open circuit between the additional heater control assembly and soldered connection S4D149F with the aid of the Wiring Diagrams. CHECK the operation of the system.

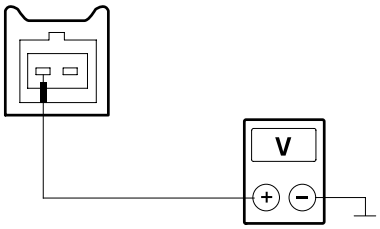
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G7: CHECK THE CIRCUIT BETWEEN THE ADDITIONAL HEATER CONTROL ASSEMBLY AND THE ACTUATOR FOR THE ADDITIONAL HEATER AIR DISTRIBUTION FLAP FOR OPEN CIRCUIT	
	1 Measure the resistance between the additional heater control assembly, connector CHA05B, pin 5, circuit VHA09A (VT/BN), wiring harness side and the actuator for the additional heater air distribution flap, connector CHA09, pin 3, circuit VHA09D (VT/BN), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the actuator for the additional heater air distribution flap CHECK the operation of the system. If the system is still inoperative, RENEW the additional heater control assembly. → **No** LOCATE and REPAIR the break in the circuit between the additional heater control assembly and the actuator for the additional heater air distribution flap with the aid of the Wiring Diagrams. CHECK the operation of the system.

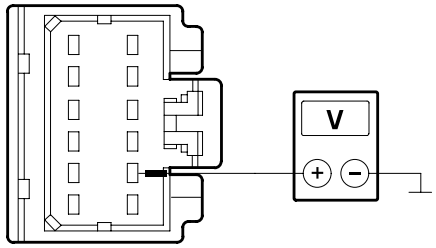
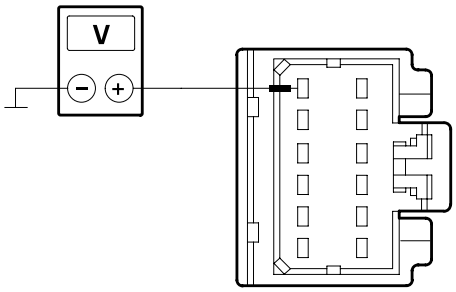
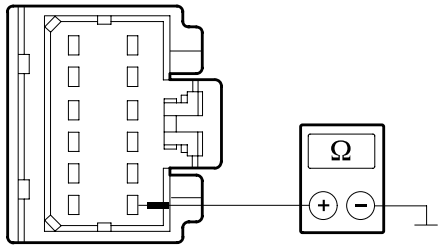
PINPOINT TEST H : THE TEMPERATURE CONTROL IS INOPERATIVE WHEN THE ADDITIONAL HEATER CONTROL ASSEMBLY IS USED.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
H1: CHECK FUSE F50	
	1 Ignition switch in position 0.
	2 CHECK Fuse F50 (standard relay box). • Is the fuse OK? → **Yes** GO to H2. → **No** RENEW fuse F50. CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
H2: CHECK THE VOLTAGE AT FUSE F50	
	1 Connect Fuse F50 (standard relay box).
	2 Ignition switch in position II.

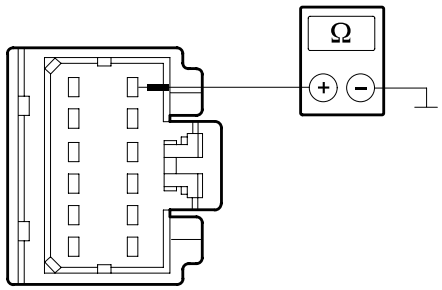
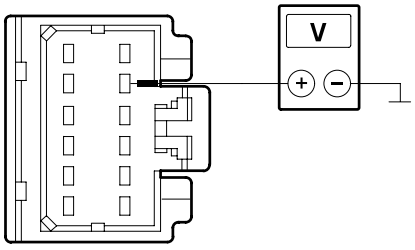
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between fuse F50 (10 A) and ground. • Does the meter display battery voltage? → **Yes** GO to H3. → **No** REPAIR the voltage supply to fuse F50 with the aid of the Wiring Diagrams. CHECK the operation of the system.
H3: CHECK THE VOLTAGE AT THE ADDITIONAL HEATER CONTROL VALVE	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH431 from the additional heater control valve.
	3 Ignition switch in position II.
 VFE0018156	4 Measure the voltage between the additional heater control valve, connector CH431, pin 1, circuit CB150X (YE/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to H4. → **No** LOCATE and REPAIR the open circuit between the additional heater control valve and actuator fuse F50 using the Wiring Diagrams. CHECK the operation of the system.
H4: MEASURE THE VOLTAGE AT THE ADDITIONAL HEATER CONTROL VALVE MODULE	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH107 from the additional heater control valve module.
	3 Ignition switch in position II.

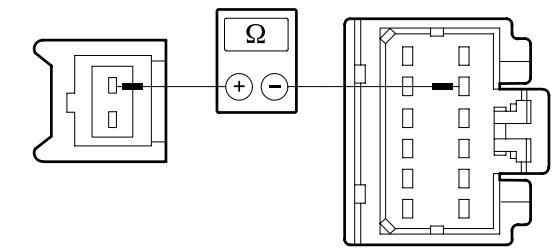
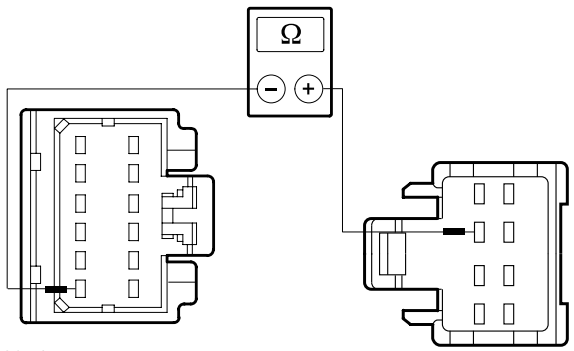
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69713	4 Measure the voltage between the additional heater control valve module, connector CH107, pin 2, circuit CB150V (YE/OG), wiring harness side and ground.
	5 Measure the voltage between the additional heater control valve module, connector CH107, pin 12, circuit CB150W (YE/OG), wiring harness side and ground. • Is battery voltage measured in both cases? → **Yes** GO to H5. → **No** LOCATE and REPAIR the break in the relevant circuit between the additional heater control valve module and soldered connection S4B150E for the additional heater with the aid of the Wiring Diagrams. CHECK the operation of the system.
H5: CHECK THE GROUND CONNECTION OF THE ADDITIONAL HEATER CONTROL VALVE MODULE	
	1 Ignition switch in position 0.
 E69715	2 Measure the resistance between the additional heater control valve module, connector CH107, pin 1, circuit GD149AD (BK/GY), wiring harness side and ground.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the resistance between the additional heater control valve module, connector CH107, pin 6, circuit GD149AB (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms measured in both cases? → **Yes** GO to H6. → **No** LOCATE and REPAIR the break in the relevant circuit between the additional heater control valve module and soldered connection S4D149E with the aid of the Wiring Diagrams. CHECK the operation of the system.
H6: CHECK THE CIRCUIT OF THE ADDITIONAL HEATER CONTROL VALVE	
	1 Connect Connector CH431 to the additional heater control valve.
	2 Ignition switch in position II.
 VFE0034304	3 Measure the voltage between the additional heater control valve module, connector CH107, pin 5, circuit ZA346A (OG/WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to H8. → **No** GO to H7.
H7: CHECK THE CIRCUIT BETWEEN THE ADDITIONAL HEATER CONTROL VALVE AND THE ADDITIONAL HEATER CONTROL VALVE MODULE FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH431 from the additional heater control valve.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0034305	3 Measure the resistance between the additional heater control valve, connector CH431, pin 2, circuit ZA346A (OG/WH), wiring harness side and the additional heater control valve module, connector CH107, pin 5, circuit ZA346A (OG/WH), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the additional heater control valve. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit ZA346A (OG/WH) between the additional heater control valve and the additional heater control valve module with the aid of the Wiring Diagrams. CHECK the operation of the system.
H8: CHECK THE CIRCUIT BETWEEN THE ADDITIONAL HEATER CONTROL VALVE MODULE AND THE ADDITIONAL HEATER CONTROL ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Connector CHA05B from the additional heater control assembly.
 E69717	3 Measure the resistance between the additional heater control valve module, connector CH107, pin 7, circuit CHA04D (GN/WH), wiring harness side and the additional heater control assembly, connector CHA05B, pin 6, circuit CHA04A (GN/WH), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the additional heater control valve module. CHECK the operation of the system. If the system is still inoperative, RENEW the additional heater control assembly. → **No** LOCATE and RECTIFY the open circuit between the additional heater control valve module and the additional heater control assembly with the aid of the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST I : RECIRCULATED AIR FLAP INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I1: CHECK THE VACUUM SUPPLY AT THE RECIRCULATED AIR FLAP ACTUATOR	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Vacuum hose from the recirculated air flap actuator.
	3 Connect a vacuum pressure gauge to the vacuum hose of the air recirculation flap actuator.
	4 Ignition switch in position III. 5 Run the engine at idle speed.
	6 Set the air distribution control switch to "FOOTWELL".
	7 Switch on recirculating air mode.
	8 Check the vacuum at the vacuum hose of the air recirculation flap actuator. • Is there a vacuum? → **Yes** GO to I2. → **No** GO to I3.
I2: CHECK THE AIR RECIRCULATION FLAP ACTUATOR FOR LEAK-TIGHTNESS AND OPERATION	
	1 Ignition switch in position 0.
	2 Apply a vacuum with a vacuum pump to the air recirculation flap actuator.
	3 Check the operation and leak-tightness of the air recirculation flap actuator. • Is the air recirculation flap actuator OK? → **Yes** CHECK the mechanical operation of the air recirculation flap and REPAIR as necessary. CHECK the operation of the system. → **No** RENEW the recirculated air flap actuator. CHECK the operation of the system.
I3: CHECK THE VACUUM SUPPLY AT THE CONTROL ASSEMBLY FOR THE CLIMATE CONTROL SYSTEM	
	1 Ignition switch in position 0.
	2 Disconnect Vacuum hose from the control assembly for the climate control system.
	3 Vacuum pressure gauge to the vacuum hose of the climate control system control assembly, connect a vacuum supply.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Ignition switch in position III. 5 Run the engine at idle speed.
	6 Vacuum at the control assembly for the climate control system, check the vacuum supply. • Is there a vacuum? → **Yes** CHECK and REPAIR the vacuum line between the control assembly for the climate control system and the air recirculation flap actuator. CHECK the operation of the system. If the vacuum line is OK, CHECK the control assembly for the climate control system and RENEW it if necessary. → **No** CHECK and REPAIR the vacuum line between the control assembly for the climate control system and the engine. CHECK the operation of the system.

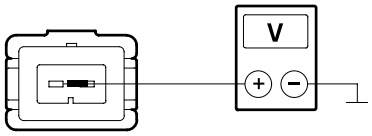
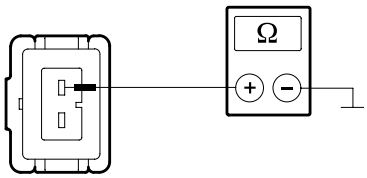
PINPOINT TEST J : NO HEATING POWER

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
J1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position III.
	2 Run the engine until the temperature gauge indicates "NORMAL".
	3 Check the operation of the heater. • Is the heater permanently cold? → **Yes** GO to J2. → **No** CHECK whether the coolant hoses are routed correctly. BLEED the cooling system if necessary. If the cooling system is OK, RENEW the coolant shut-off valve. CHECK the operation of the system.
J2: CHECK THE VACUUM SUPPLY AT THE COOLANT SHUT-OFF VALVE	
	1 Ignition switch in position 0.
	2 Disconnect Vacuum hose from the coolant shut-off valve.
	3 Vacuum pressure gauge to the vacuum hose of the coolant shut-off valve, connect a vacuum supply.

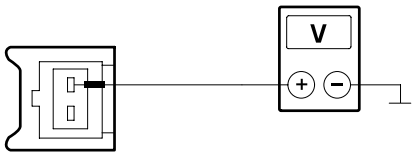
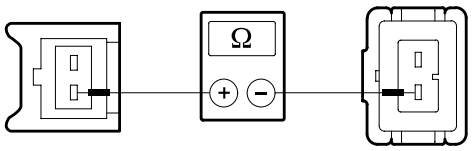
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Ignition switch in position III. 5 Run the engine at idle speed.
	6 Slowly alter the setting of the temperature controller from full cold to full heat and back again several times.
	7 Vacuum at the coolant shut-off valve, check the vacuum supply. • Does the display alternate between vacuum and normal pressure? → **Yes** CHECK whether the coolant hoses are routed correctly. BLEED the cooling system if necessary. If the cooling system is OK, RENEW the coolant shut-off valve. CHECK the operation of the system. → **No** GO to J3.
J3: CHECK THE VACUUM SUPPLY TO THE SOLENOID VALVE OF THE COOLANT SHUT-OFF VALVE	
	1 Ignition switch in position 0.
	2 Disconnect Vacuum hose from the solenoid valve of the coolant shut-off valve.
	3 Vacuum pressure gauge to the vacuum hose of the solenoid valve of the coolant shut-off valve, connect a vacuum supply.
	4 Ignition switch in position III. 5 Run the engine at idle speed.
	6 Vacuum at the solenoid valve of the coolant shut-off valve, check the vacuum supply. • Is there a vacuum? → **Yes** CHECK and REPAIR the vacuum line between the solenoid valve of the coolant shut-off valve and the coolant shut-off valve. CHECK the operation of the system. If the vacuum line is OK,GO to J4. → **No** CHECK and REPAIR the vacuum line between the solenoid valve of the coolant shut-off valve and the engine. CHECK the operation of the system.
J4: CHECK THE VOLTAGE AT THE SOLENOID VALVE OF THE COOLANT SHUT-OFF VALVE	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Connector CH226 from the solenoid valve of the coolant shut-off valve .
	3 Ignition switch in position II.
	4 Set the temperature control to maximum cold.
 VFE0016297	5 Measure the voltage between the coolant shut-off valve, connector CH226, pin 2, circuit ZA340A (OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to J5. → **No** GO to J6.
J5: CHECK THE GROUND CONNECTION OF THE SOLENOID VALVE OF THE COOLANT SHUT-OFF VALVE	
	1 Ignition switch in position 0.
 E69926	2 Measure the resistance between the solenoid valve of the coolant shut-off valve, connector CH226, pin 1, circuit GD122D (BK), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the solenoid valve of the coolant shut-off valve CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the solenoid valve of the coolant shut-off valve and ground connection GP22 with the aid of the Wiring Diagrams. CHECK the operation of the system.
J6: CHECK THE VOLTAGE AT THE SWITCH OF THE SOLENOID VALVE OF THE COOLANT SHUT-OFF VALVE	
	1 Ignition switch in position 0.
	2 Disconnect Connector CH422 from the switch of the solenoid valve of the coolant shut-off valve .
	3 Ignition switch in position II.

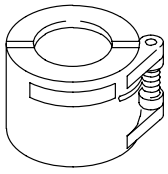
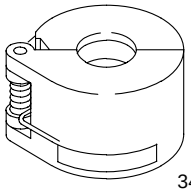
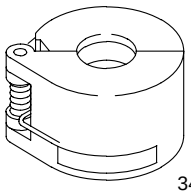
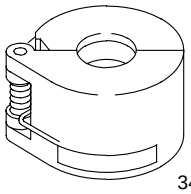
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0024544	4 Measure the voltage between the switch of the solenoid valve of the coolant shut-off valve, connector CH422, pin 2, circuit CB150L (YE/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to J7. → **No** LOCATE and REPAIR the break in circuit CB150L (YE/OG) between the switch of the solenoid valve of the coolant shut-off valve and soldered connection S2B150B with the aid of the Wiring Diagrams. CHECK the operation of the system.
J7: CHECK THE CIRCUIT BETWEEN THE SWITCH OF THE SOLENOID VALVE OF THE COOLANT SHUT-OFF VALVE AND THE SOLENOID VALVE OF THE COOLANT SHUT-OFF VALVE FOR OPEN CIRCUIT.	
	1 Ignition switch in position 0.
 E69927	2 Measure the resistance between the switch of the solenoid valve of the coolant shut-off valve, connector CH422, pin 1, circuit ZA340D (OG), wiring harness side and the solenoid valve of the coolant shut-off valve, connector CH226, pin 2, circuit ZA340A (OG), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK the mechanical actuation of the switch of the solenoid valve of the coolant shut-off valve and REPAIR it if necessary. If the mechanical actuation is OK, RENEW the switch of the solenoid valve of the coolant shut-off valve. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the switch of the solenoid valve of the coolant shut-off valve and the solenoid valve of the coolant shut-off valve with the aid of the Wiring Diagrams. CHECK the operation of the system.

GENERAL PROCEDURES

Spring Lock Coupling

Special Tool(s)

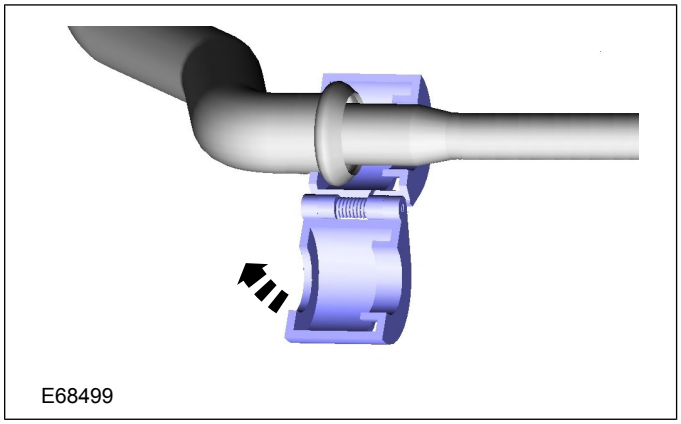
 23023A	Disconnect Tool, Spring Lock Coupling (3/8" red) 412-026
 34001	Disconnect Tool, Spring Lock Coupling (1/2" blue) 412-027
 34003	Disconnect Tool, Spring Lock Coupling (5/8" black) 412-038
 34002	Disconnect Tool, Spring Lock Coupling (3/4" white) 412-069

Materials

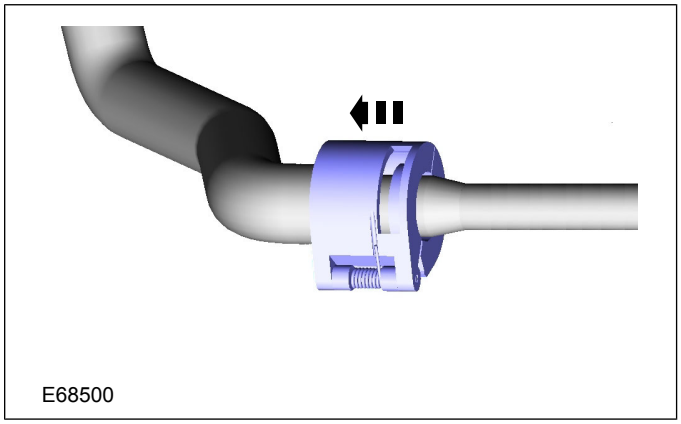
Name	Specification
Refrigerant Oil	WSH-M1C231-B

1. Refer to: Klimaanlage - Gesundheits- und Sicherheitshinweise (100-00, Description and Operation).
2. **NOTE:**Choose the special tool according to the line diameter.

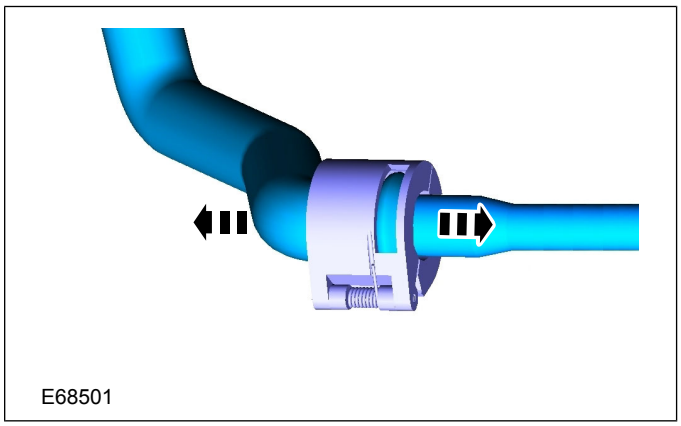
   Special Tool(s): 412-026, 412-027, 412-038, 412-069


E68499

3.

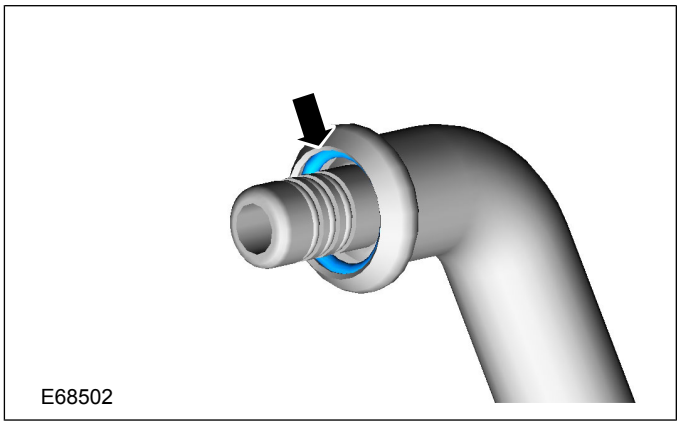

E68500

4. ⚠ **CAUTION:Make sure that all openings are sealed.**

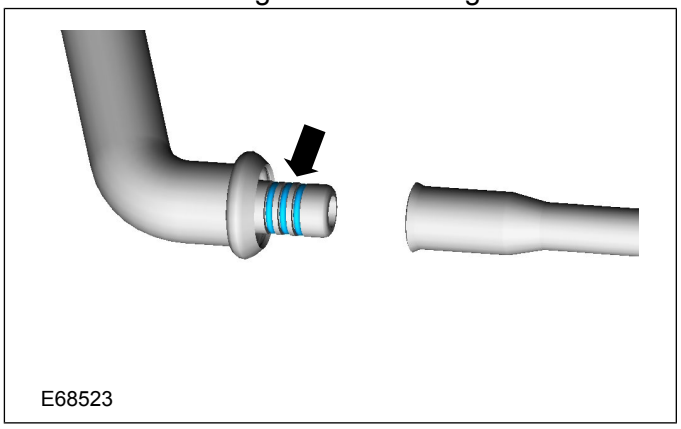

E68501

GENERAL PROCEDURES

5. **CAUTION:Make sure that all openings are sealed.**
   - Check the locking spring for damage.
   - Carefully remove damaged locking springs with a thin wire, and renew them.


E68502

6. Install new refrigerant line O-rings.

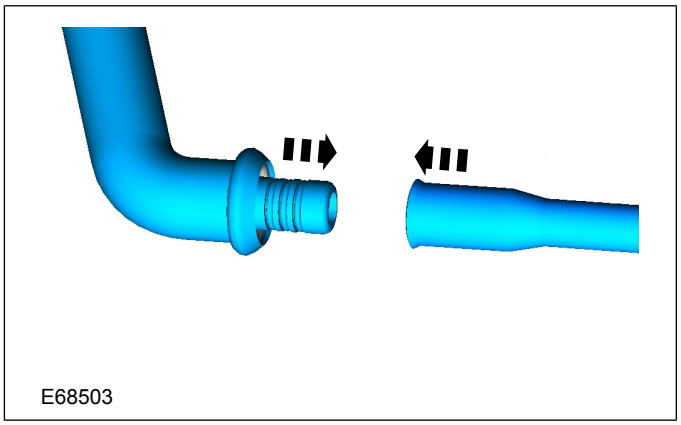

E68523

7. **CAUTION:Never lubricate connections and O-rings with mineral oil.**

   Coat the O-rings for the refrigerant line with clean refrigerant oil.

   Material: Refrigerant Oil

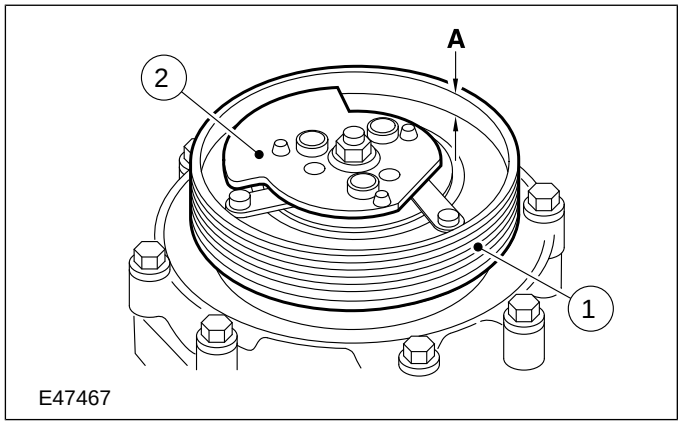
8.


E68503

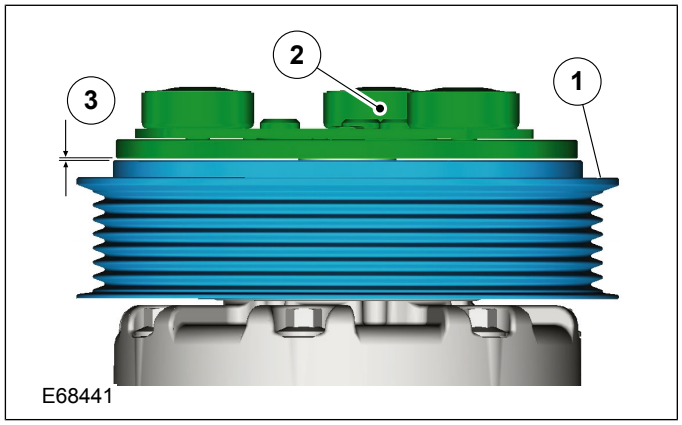
GENERAL PROCEDURES

Air Conditioning (A/C) Clutch Air Gap Adjustment

1. **NOTE:**Dimensions for reset pulley.
   1. Pulley.
   2. Drive plate
   3. Check the air gap A between the drive plate and the pulley at 60 degrees intervals around the circumference of the pulley. When doing this, actuate the air conditioning system clutch several times using a 5A fused cable connected between the battery positive terminal, the air conditioning system clutch and the battery ground cable.



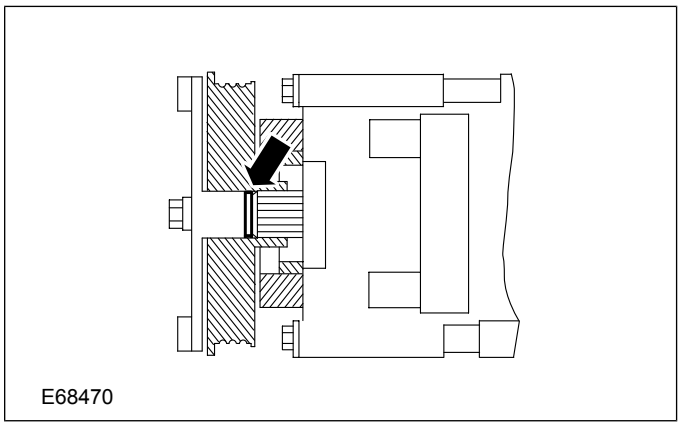
2. **NOTE:**Dimensions for pulley (not reset).
   1. Pulley.
   2. Drive plate
   3. Check the air gap A between the drive plate and the pulley at 60 degrees intervals around the circumference. See: Specifications (412-00 Heating, Ventilation, Air-Conditioning - General information, Specifications).



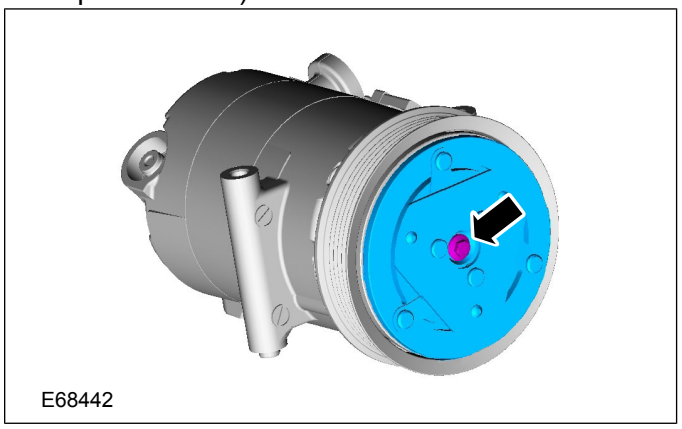
3.



4. Correct air gap A as necessary using spacer washers.



5. See: Specifications (412-00 Heating, Ventilation, Air-Conditioning - General information, Specifications).



6. Check air gap A as described in step 1 or step 2. If necessary, repeat steps 2-4.

GENERAL PROCEDURES

Fluorescent Dye Leak Detection

General Equipment

UV leak detector

All vehicles

1. Refer to: Klimaanlage - Gesundheits- und Sicherheitshinweise (100-00, Description and Operation).

Vehicles built up to 07/1999 inclusive

2. Add 7.4 ml of fluorescent tracer dye.

All vehicles

3. **NOTE:**Some vehicles may have signs of refrigerant oil at the spring lock couplers. The cause of this may be a procedure used in production before installation of the fittings in order to assist their assembly. When a spring lock coupler is suspected of leaking, always wipe the fitting clean and verify the leak with R-134a Automatic Calibration Halogen Leak Detector.

   NOTE: The exact location of leaks can be pinpointed by the bright yellow - green glow of the tracer dye. Since more than one leak can exist, always inspect each component.

   - Locate the leaks. Check all components, fittings and lines of the A/C system for leaks.

     General Equipment: UV leak detector

4. After the leak is found and rectified, remove any traces of dye with a general purpose solvent.
5. Check the repair by operating the system for some minutes and inspecting with the UV lamp again.

GENERAL PROCEDURES

Electronic Leak Detection

1. Refer to: Air Conditioning (A/C) System Health and Safety Precautions (100-00, Description and Operation).
2. **WARNINGS:**

   Before starting leak detection, make sure that the area where it is to be done is well ventilated. If the surrounding air is contaminated with refrigerant gas, the leak detector will indicate this gas all the time. Odors from other chemicals such as antifreeze, diesel fuel, disc brake cleaner, or other cleaning solvents can cause the same problem. Prevent air movement while performing leak detection.

   The refrigerant identification equipment must be used before attaching the manifold gauge set. Otherwise the manifold gauge set may become contaminated. Contaminated refrigerant must be disposed of as special waste. Follow the manufacturer's instructions when working with the service unit.

   NOTE: At 24°C with the engine switched off, both manifold gauges should show 4.1 to 5.5 bar.

   Attach the manifold gauge set to the service gauge port valves.
3. For the leak test, close the manual valves on the gauge set.
4. If little or no pressure is indicated, charge the system with approx. 300g of refrigerant. Refer to: Air Conditioning System - Evacuate and Refill.
5. Use the R-134a Automatic Calibration Halogen Leak Detector to leak test the refrigerant system. Follow the instructions included with leak detector for handling and operation techniques.
6. If any leak is found, extract the refrigerant under suction. Refer to: Air Conditioning System - Evacuate and Refill.

GENERAL PROCEDURES

Refrigerant Oil Adding

CAUTION:Collect the refrigerant oil in a clean measuring cylinder.

1. **NOTE:**This step only needs to be carried out when removing the A/C compressor.

   NOTE: Rotate the compressor shaft at least 6 to 8 turns when draining the refrigerant oil.

   Drain the refrigerant oil from the defective A/C compressor and dispose of it.

2. **CAUTIONS:**

   The refrigerant oil top-up quantity must not exceed the refrigerant oil fill quantity.

   If other A/C components are being renewed in addition to the A/C compressor, there is no need to top up with additional refrigerant oil, apart from filling the compressor.

   Top up with the calculated quantity of new refrigerant oil. See: Specifications (412-00 Heating, Ventilation, Air-Conditioning - General information, Specifications).

GENERAL PROCEDURES

Contaminated Refrigerant Handling

1. ⚠ **CAUTION:Any R134a or R12 refrigerant which is contaminated with unsuitable refrigerant should be extracted only by means of a suitable servicing unit designed for the purpose of collecting and storing contaminated refrigerant, so that the spread to other vehicles can be prevented.**

   Use refrigerant identification equipment to check that there is contaminated refrigerant in the air conditioning system.

2. Inform the customer about the additional costs involved to repair the system because of the contamination.

3. Extract the contaminated refrigerant.

GENERAL PROCEDURES

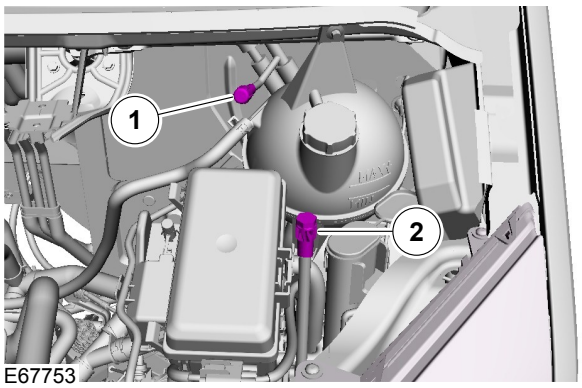
Air Conditioning (A/C) System Recovery, Evacuation and Charging

1. Refer to:Air Conditioning (A/C) System Health and Safety Precautions (100-00 General Information, Description and Operation).

2. **CAUTION:The refrigerant identification equipment must be used before the system is emptied, otherwise the service unit may become contaminated. All contaminated A/C refrigerant must be disposed of as hazardous waste. Always follow the manufacturer's instructions when using the service units.**

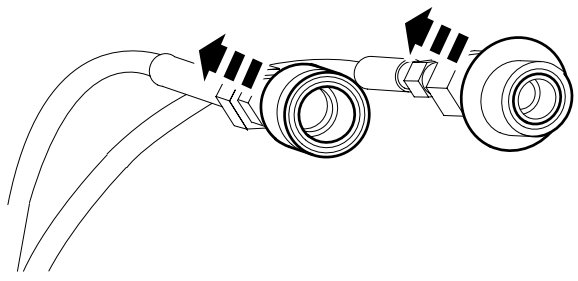
   Unscrew and remove the protective caps from the A/C charging connections.

3. 1. Low pressure charging connection
   2. High pressure charging connection



E67753

4. Pull back the catch of the quick-fit union on the line of the service unit.


VFE0031288

5. **NOTE:**Larger inner diameter for high-pressure side. Smaller inner diameter for low-pressure side.

   Connect the service unit line to the charging connection of the air conditioning system.

6. **WARNING:When draining the refrigerant do not allow it to enter the atmosphere under any circumstances.**

   NOTE: When removing components of the air conditioning system, calculate the residual quantity of refrigerant oil.

   Drain the air conditioning system via the low-pressure port in accordance with the service unit manufacturer instructions.

   Refer to:Refrigerant Oil Adding (412-00 Climate Control System - General Information, General Procedures).

7. **CAUTIONS:**

   The air conditioning system must be evacuated for about 30 minutes before recharging it, to ensure that it operates correctly.

   If moisture has entered the open system over an extended period of time (several hours), renew the accumulator/dryer and extend the evacuation time to 2-3 hours.

   Evacuate the air conditioning system in accordance with the service unit manufacturer instructions.

8. **NOTE:**If an air conditioning system is evacuated before the refrigerant has been drained, some of the refrigerant will remain in the compressor refrigerant oil. This remaining refrigerant may evaporate, causing a slight pressure increase during the leak test. The air conditioning system is not leaking if the pressure increases by not more than 20 mbar (2 kPa, 0.29 psi).

   Perform the leak test, by closing the hand valves on the gauge set, switching off the service unit vacuum pump and observing the low pressure gauge.

9. **NOTE:**This step is only necessary if the pressure has increased by more than 20 mbar (2 kPa, 0.29 psi).

   Locate any leaks in the A/C refrigerant circuit using a leak tester.

   Refer to:Electronic Leak Detection (412-00 Climate Control System - General Information, General Procedures).
   Refer to:Fluorescent Dye Leak Detection (412-00 Climate Control System - General Information, General Procedures).

GENERAL PROCEDURES

10. Add refrigerant oil to the air conditioning system.

    Refer to:Refrigerant Oil Adding (412-00 Climate Control System - General Information, General Procedures).

11. **CAUTIONS:**

    Fill the air conditioning system with gas only through the low-pressure connection.

    The air conditioning system must always be evacuated before filling.

    NOTE: Depending on the service unit and equipment (with or without heatable filler cylinder), the air conditioning system can be filled in liquid form through the high-pressure port or in gaseous form through the low-pressure port.

    NOTE: The fill quantity is indicated on a sticker in the engine compartment.

    Fill the air conditioning system with liquid through the high-pressure connection.

12. 1. Open the shut-off valve on the high-pressure side.
    2. Switch the service unit to "Fill" mode and fill the system with the specified quantity of liquid refrigerant (R134a).

13. Fill the air conditioning system with gas through the low-pressure connection.

14. 1. Open the shut-off valve on the low-pressure side.
    2. Switch the service unit to "Fill" mode and fill the system with the specified quantity of gaseous refrigerant.
    3. Add the remaining amount of refrigerant with the air conditioning switched on. To do so run the engine at about 1200-1500 rev/min. Set the air conditioning system to full cooling power and fresh air mode. Set the blower to the highest setting. Fill with the remainder of the specified fill capacity.

15. **CAUTION:Do not detach the high-pressure hose when the air conditioning is switched on.**

    Disconnect the service unit.

16. 1. Close the shut-off valve.
    2. Switch off the service unit.
    3. Disconnect the service unit line from the charging connection of the air conditioning system.
    4. Screw the protective caps onto the charging connections.

GENERAL PROCEDURES

Vacuum Leak Detection

1. Drain the air conditioning system.

   Refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00, General Procedures).

SECTION 412-01 Air Distribution and Filtering

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Air Distribution and Filtering..... 412-01-2
Air distribution..... 412-01-2
Pollen filter..... 412-01-2

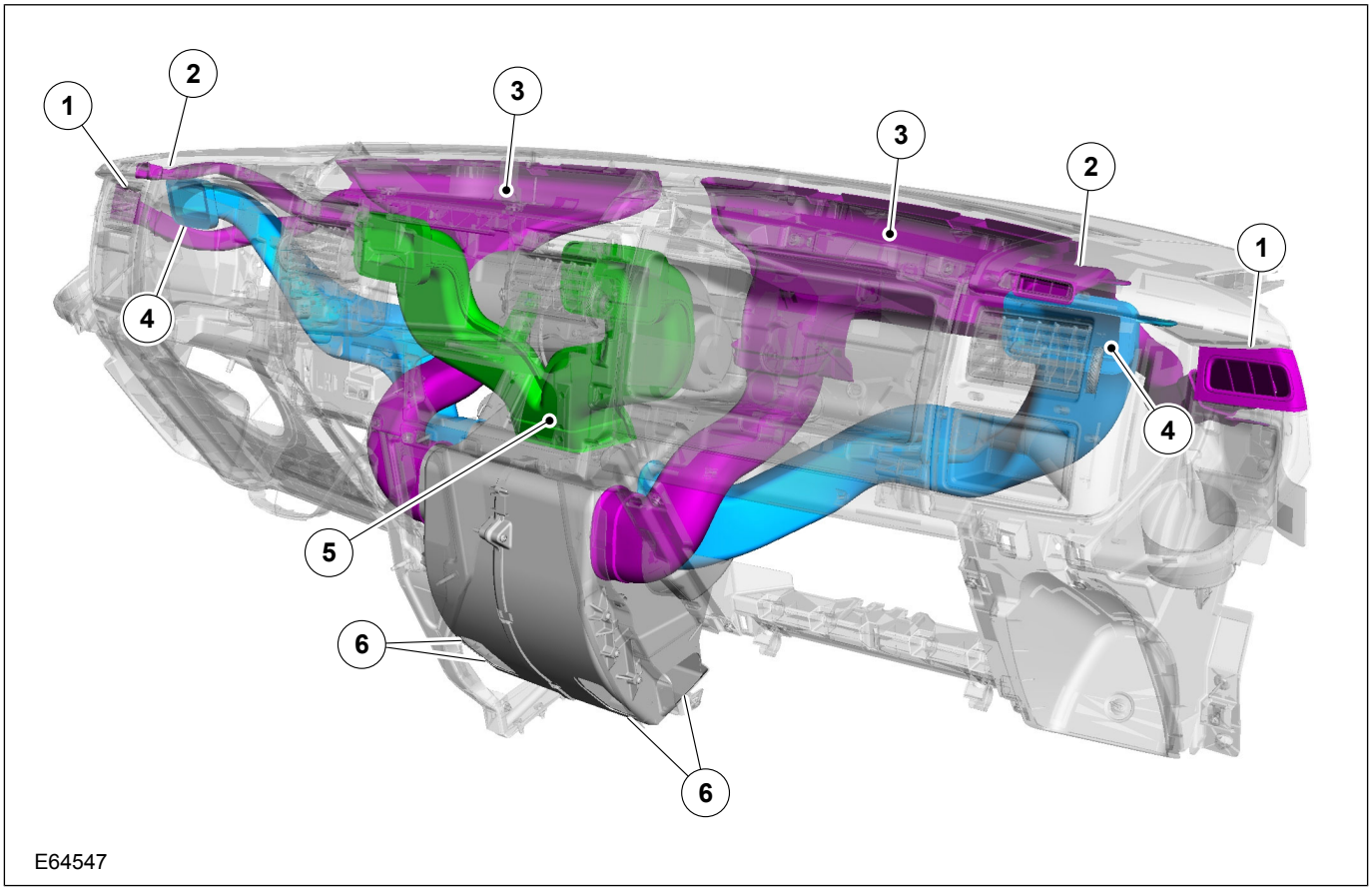
DIAGNOSIS AND TESTING

Air Distribution and Filtering..... 412-01-3

DESCRIPTION AND OPERATION

Air Distribution and Filtering

Air distribution



E64547

Item	Description
1	Air passages - side window defroster vents
2	Air passages - side vents
3	Air passages – defroster vents
4	Air passages - side vents (adjustable)
5	Air passage - center vents
6	Air passages – footwell

Pollen filter

The standard equipment of the vehicle does not include a pollen filter. A service pollen filter is also not available.

DIAGNOSIS AND TESTING

Air Distribution and Filtering

REFER to: Climate Control System (412-00, Diagnosis and Testing).

SECTION 412-02 Heating and Ventilation

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Heating and Ventilation 412-02-2
Overview of the heater housing 412-02-2
Overview of the heater/evaporator housing 412-02-2

DIAGNOSIS AND TESTING

Heating and Ventilation 412-02-4

REMOVAL AND INSTALLATION

Heater Core and Evaporator Core Housing 412-02-5
Blower Motor 412-02-14
Heater Core — Vehicles Without: Air Conditioning 412-02-23
Heater Core — Vehicles With: Air Conditioning 412-02-24

DISASSEMBLY AND ASSEMBLY

Heater Core Housing — Vehicles With: Air Conditioning 412-02-25
Heater Core Housing — Vehicles Without: Air Conditioning 412-02-27

DESCRIPTION AND OPERATION

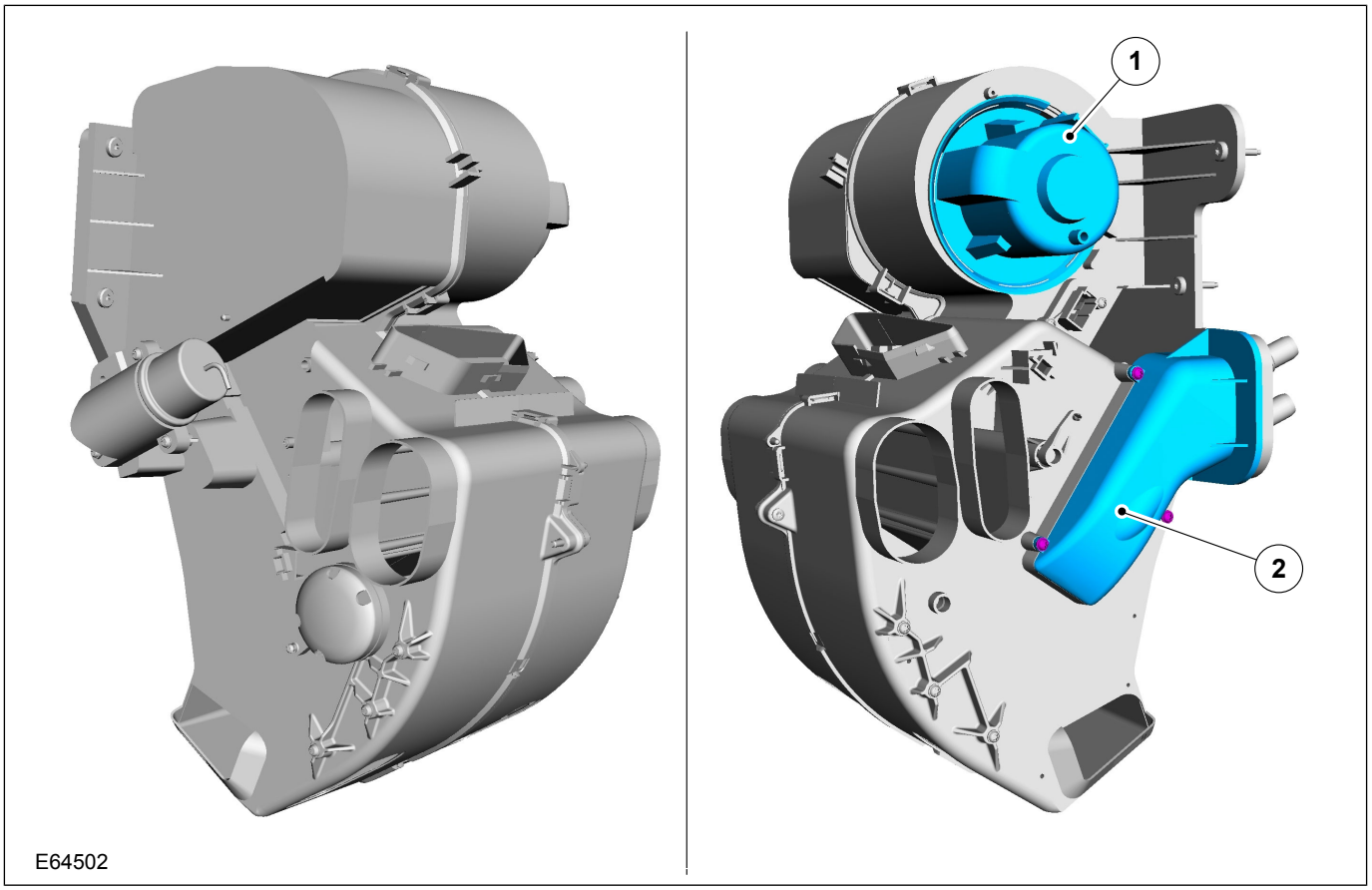
Heating and Ventilation

Overview of the heater housing

The heater housing contains the blower motor, the heat exchanger and various deflection flaps.

The heat exchanger is located on the right-hand side of the heater housing (LHD and RHD). During servicing, it can only be removed with the heater housing removed.

The blower motor is located on the right-hand side of the heater housing (LHD and RHD). During servicing, it can only be removed with the instrument panel removed.



Item	Description
1	Blower motor
2	Heat exchanger

Overview of the heater/evaporator housing

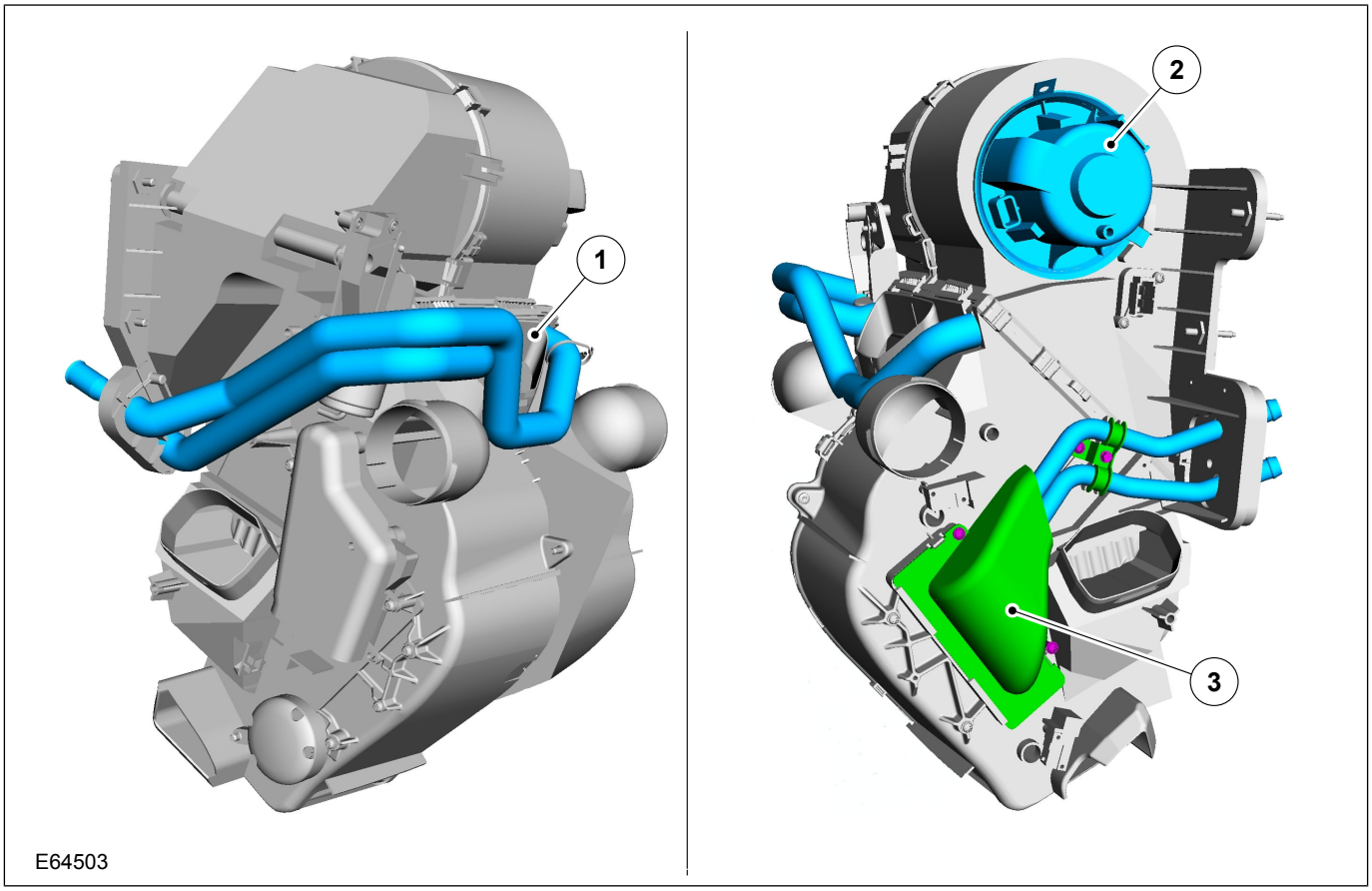
The heater/evaporator housing contains the blower motor, the heat exchanger, the evaporator and various deflection flaps.

The evaporator is located on the rear side of the heater/evaporator housing (LHD and RHD). During servicing, it can only be removed with the heater/evaporator housing removed.

The heat exchanger is located on the right-hand side of the heater housing (LHD and RHD). During servicing, it can also only be removed and installed with the heater/evaporator housing removed.

The blower motor is located on the right-hand side of the heater housing (LHD and RHD). During servicing, it can only be removed with the instrument panel removed.

DESCRIPTION AND OPERATION



Item	Description
1	Evaporator
2	Blower motor
3	Heat exchanger

DIAGNOSIS AND TESTING

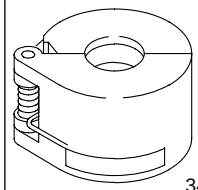
Heating and Ventilation

REFER to: Climate Control System (412-00, Diagnosis and Testing).

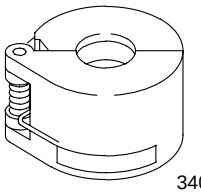
REMOVAL AND INSTALLATION

Heater Core and Evaporator Core Housing

Special Tool(s)

 34001	Disconnect Tool, Spring Lock Coupling (1/2" blue) 412-027

Special Tool(s)

 34003	Disconnect Tool, Spring Lock Coupling (5/8" black) 412-038

Materials	
Name	**Specification**
Refrigerant Oil	WSH-M1C231-B

Removal

All vehicles

NOTE: Removal steps in this procedure may contain installation details.

1. Refer to:Supplemental Restraint System (SRS) Health and Safety Precautions (100-00 General Information, Description and Operation).

2. Disconnect the battery negative lead.

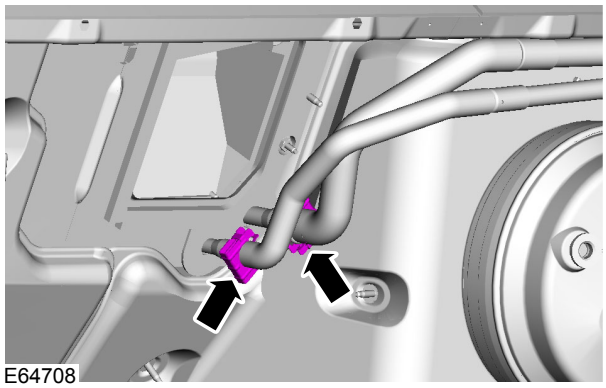
Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

Vehicles with air conditioning

3. Drain the air conditioning system.

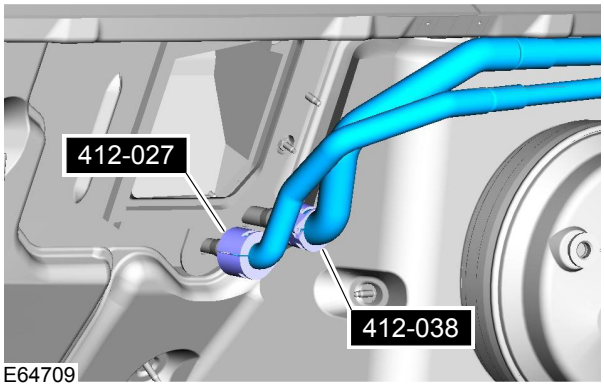
Refer to:Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).

4.



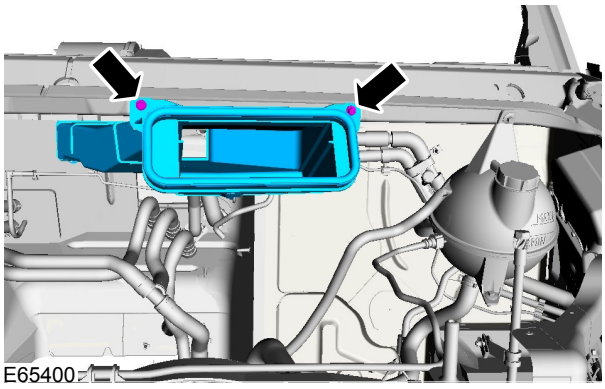
5. ⚠ **CAUTION:Make sure that all openings are sealed.**

1. Special Tool(s): 412-027, 412-038



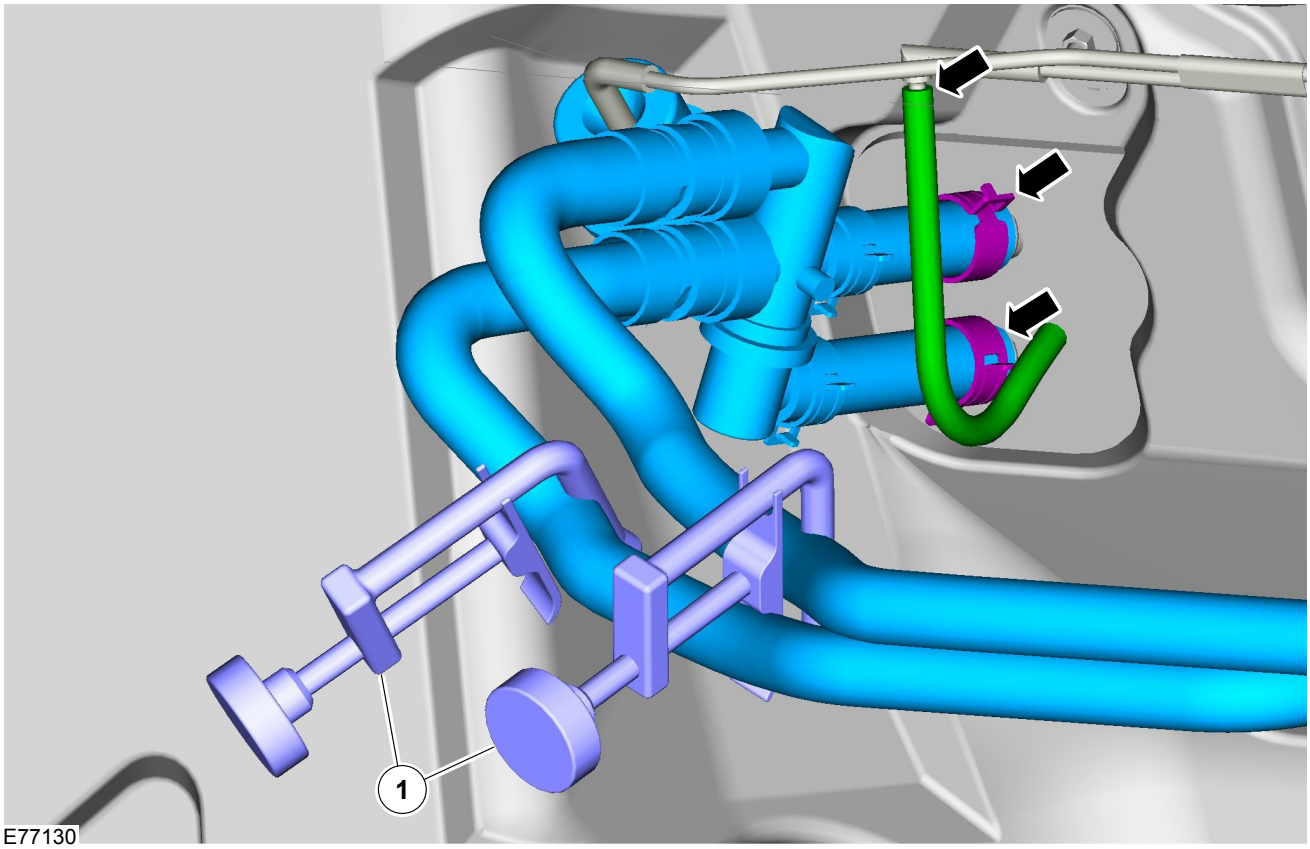
All vehicles

6.

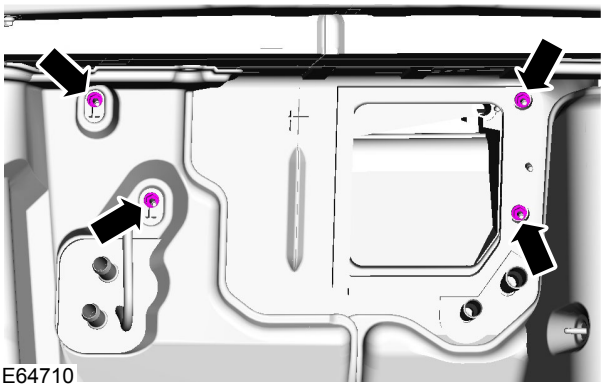


7.

REMOVAL AND INSTALLATION



8. Torque: 8 Nm



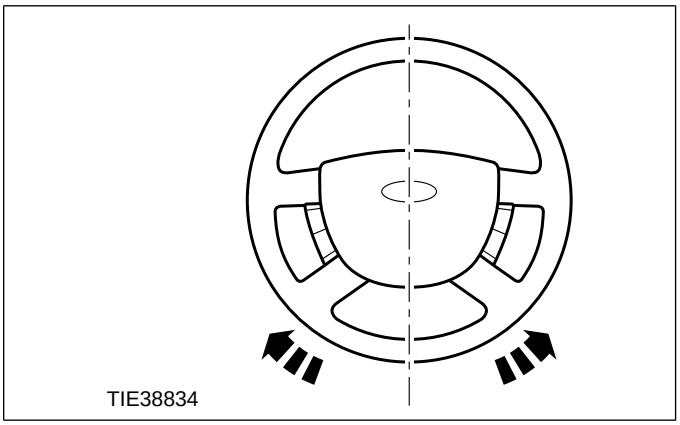
9. Remove the audio unit.

   Refer to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation).

10. Remove the A-pillar trim on the right and left-hand sides.

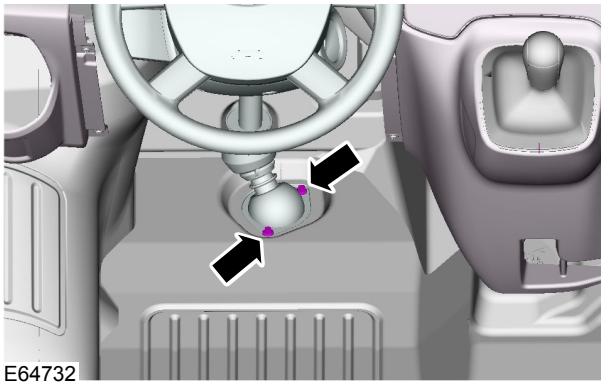
    Refer to:A-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

11. **NOTE:**Make sure the wheels are in the straight-ahead position.



REMOVAL AND INSTALLATION

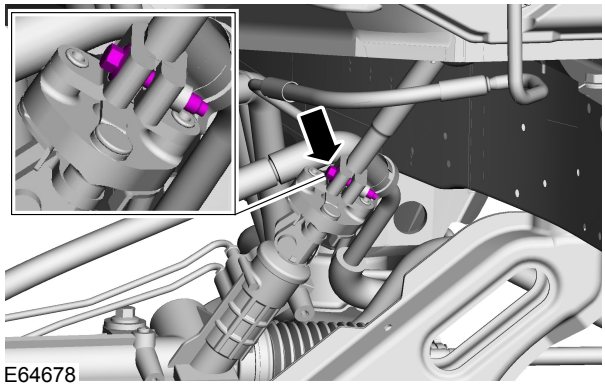
12. • Pull the footwell carpet to one side.
    • Torque: 12 Nm



13. Raise the vehicle for access

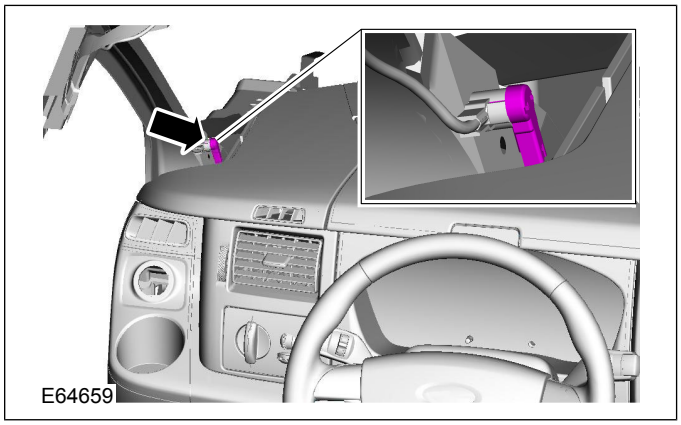
    Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

14. ⚠ **CAUTION:Make sure that new bolts are installed.**
    • Detach the steering column shaft joint from the steering column shaft.
    • Torque: 28 Nm

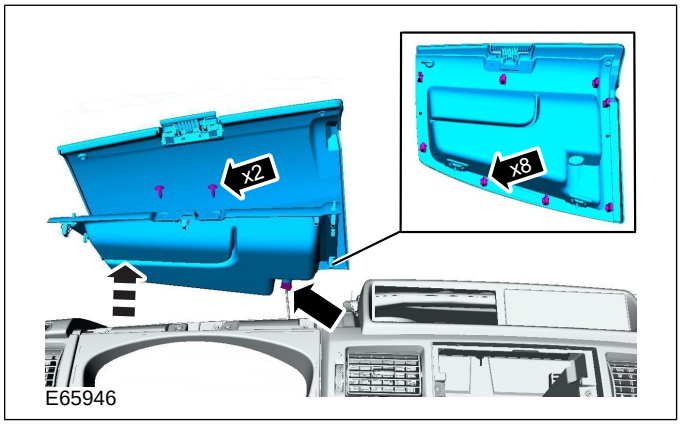


15. Lower the vehicle.

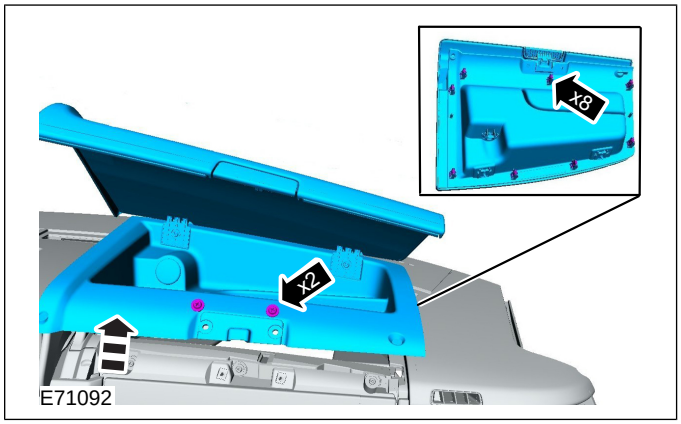
16.



17.



18.

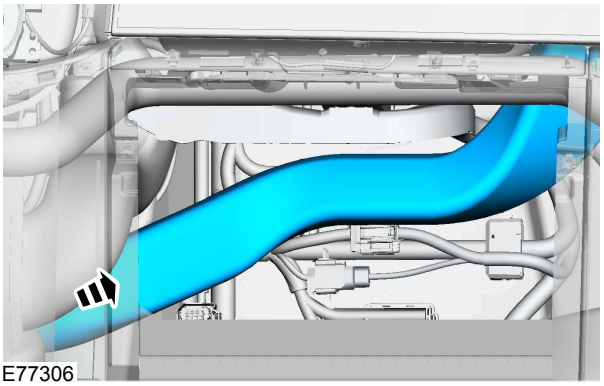


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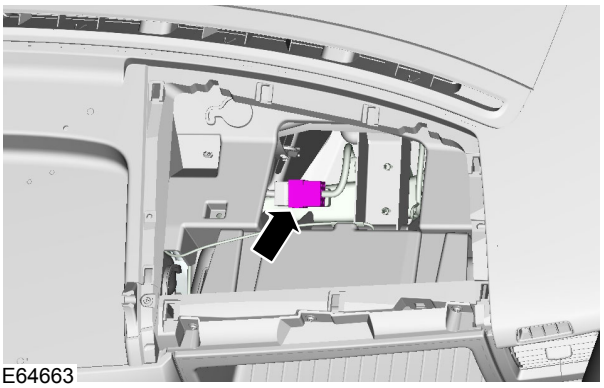
REMOVAL AND INSTALLATION


E76865

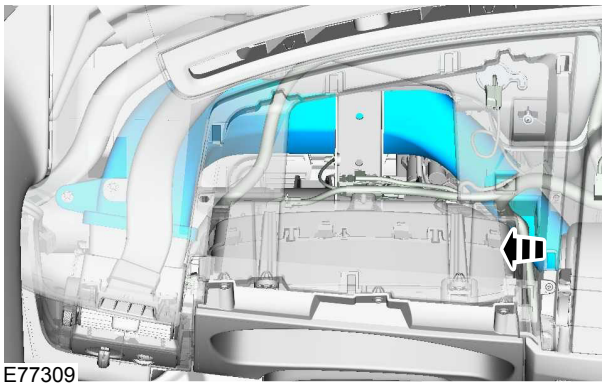
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E77306

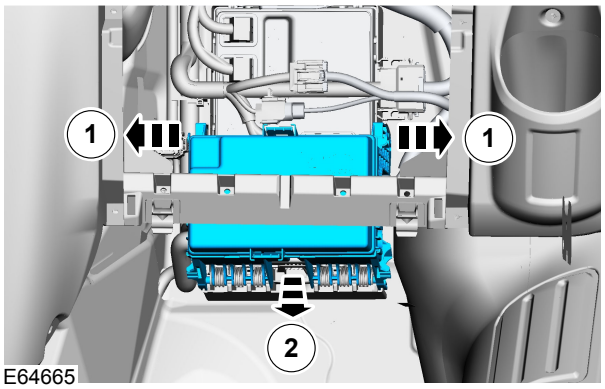
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E64663

22.


E77309

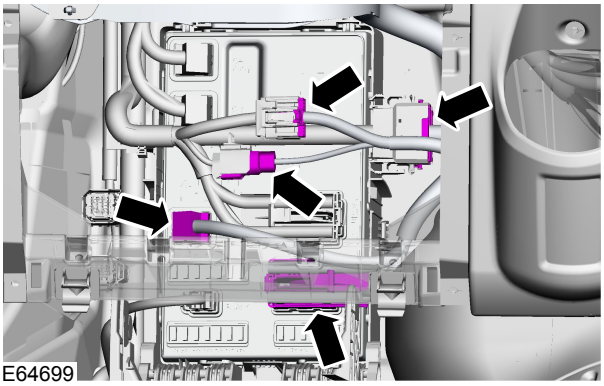
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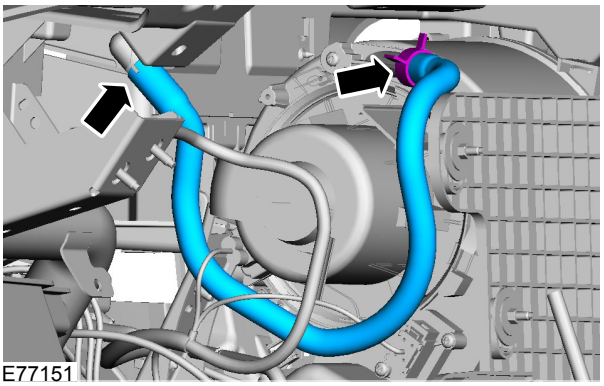
E64665

REMOVAL AND INSTALLATION

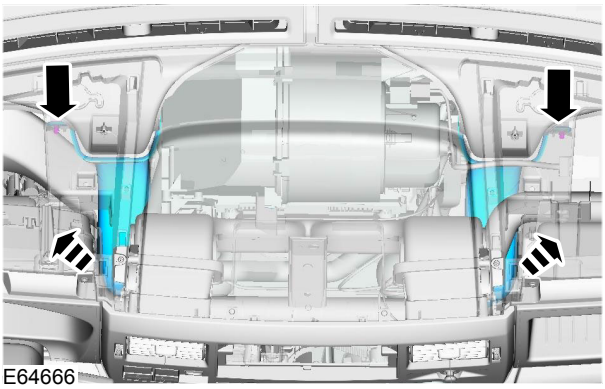
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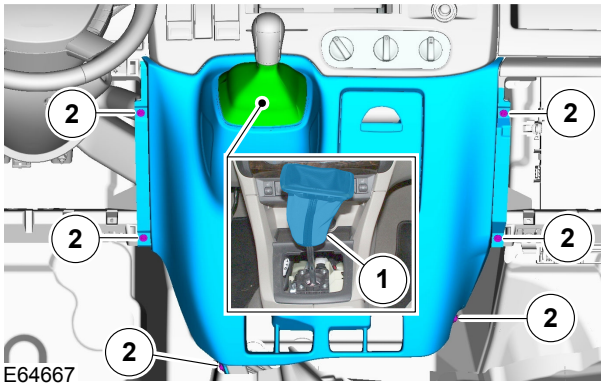
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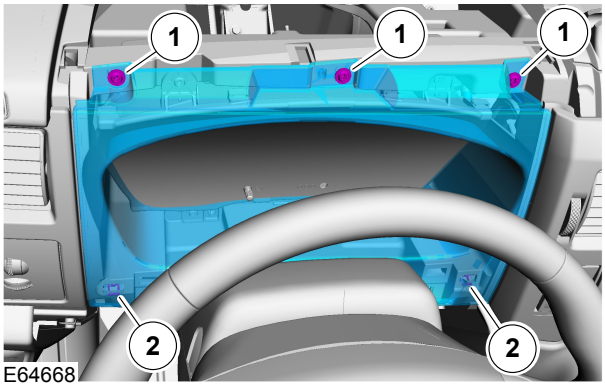
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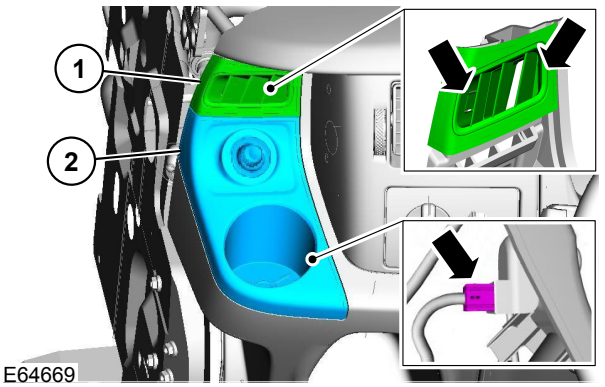
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28.

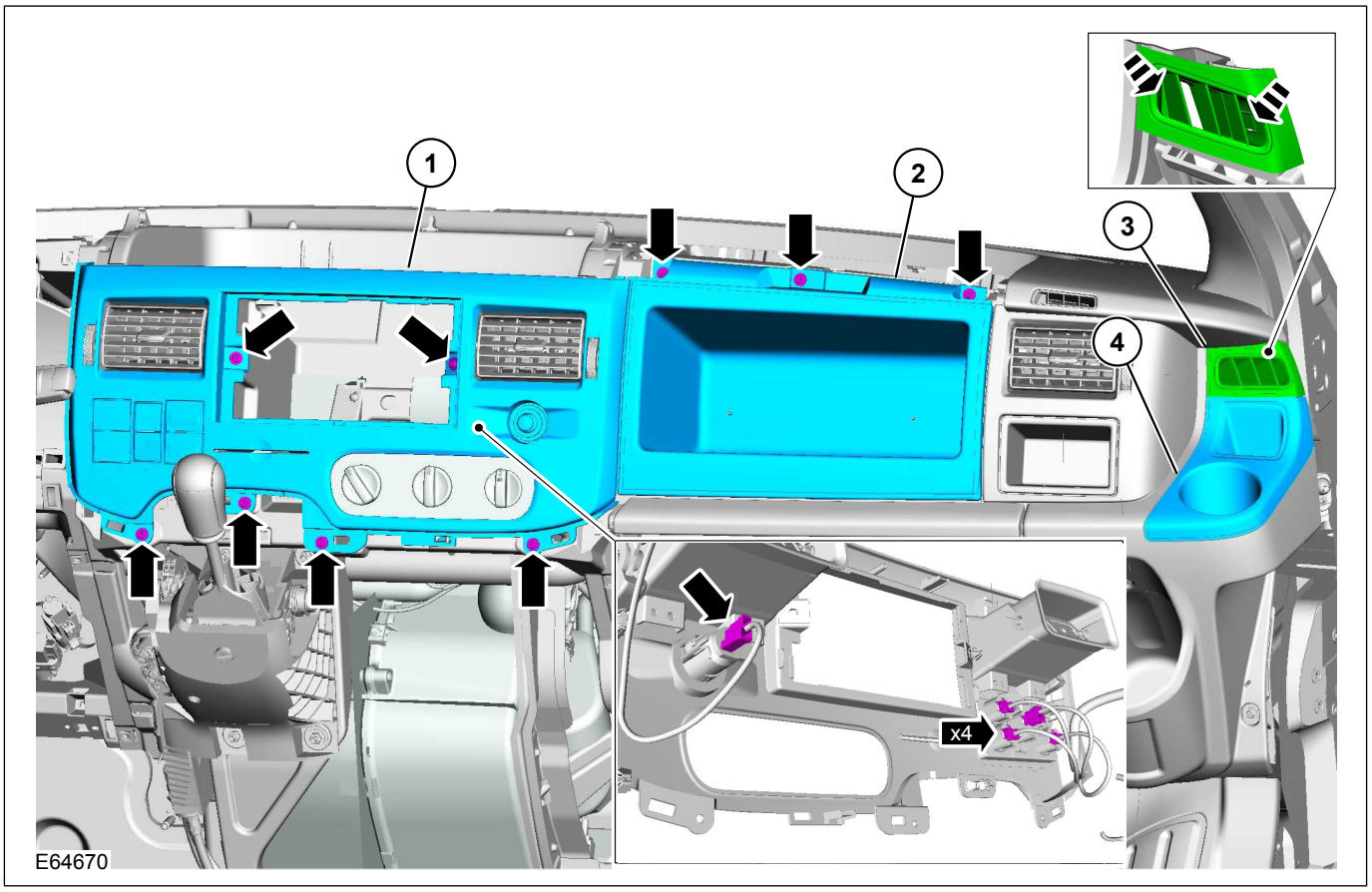


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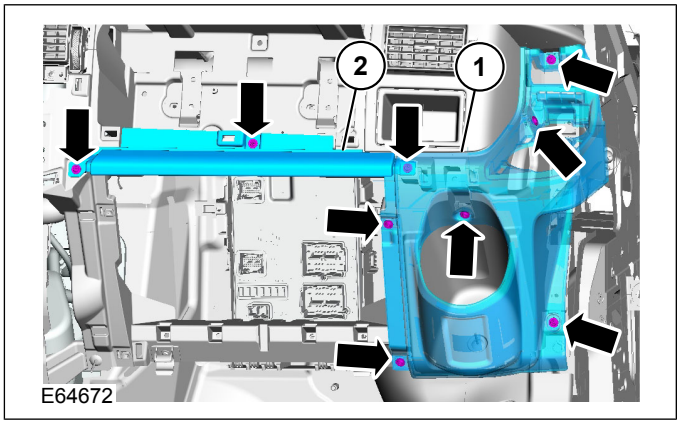


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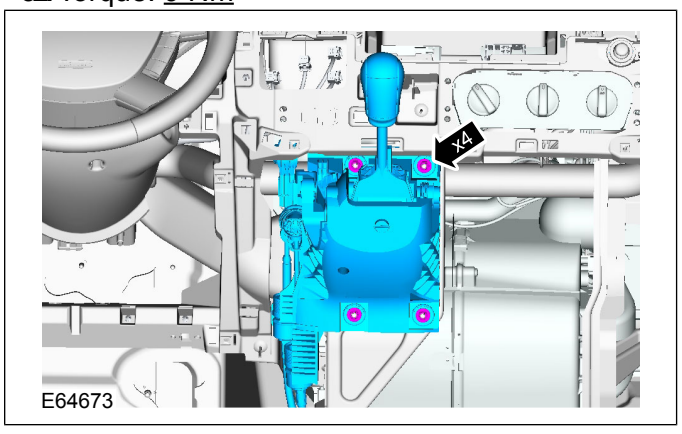
REMOVAL AND INSTALLATION



31.



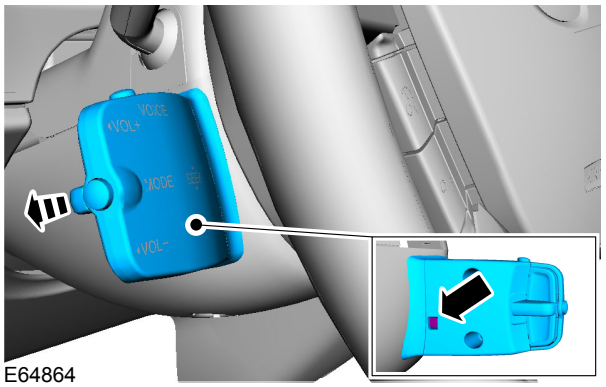
32. Torque: 9 Nm



REMOVAL AND INSTALLATION

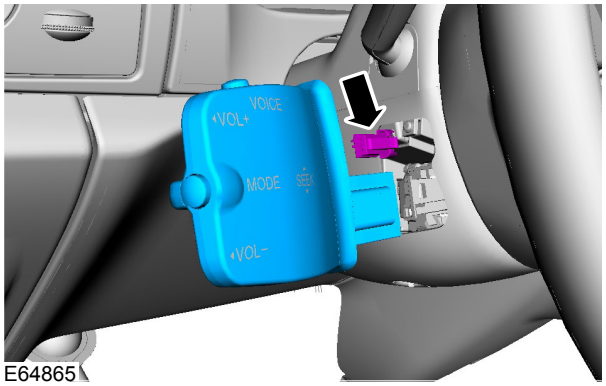
Vehicles with remote control for the audio unit

33.



E64864

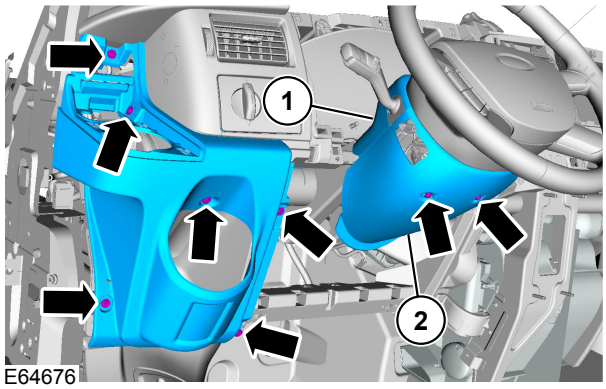
34.



E64865

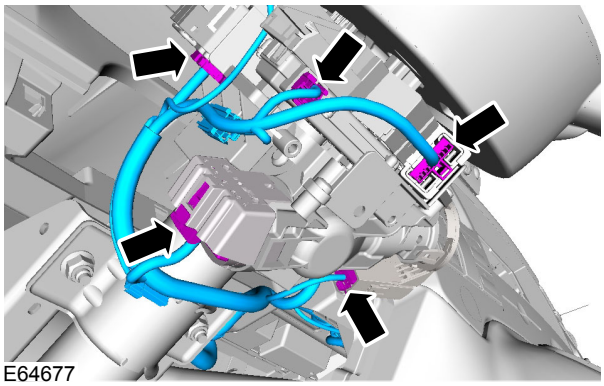
All vehicles

35.

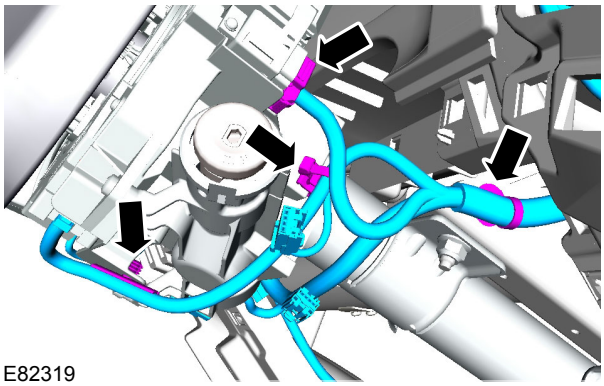


E64676

36.


E64677

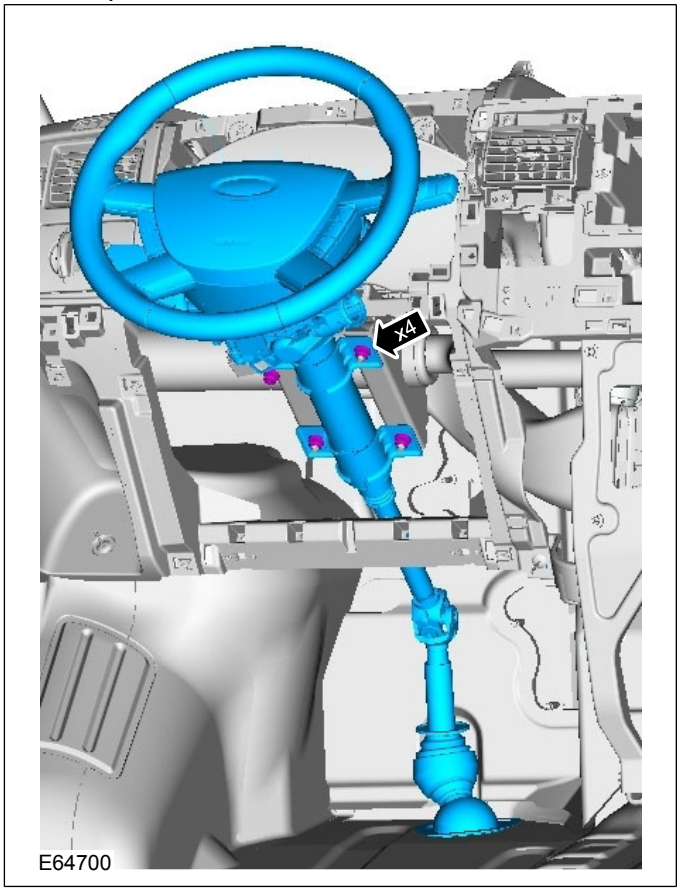
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E82319

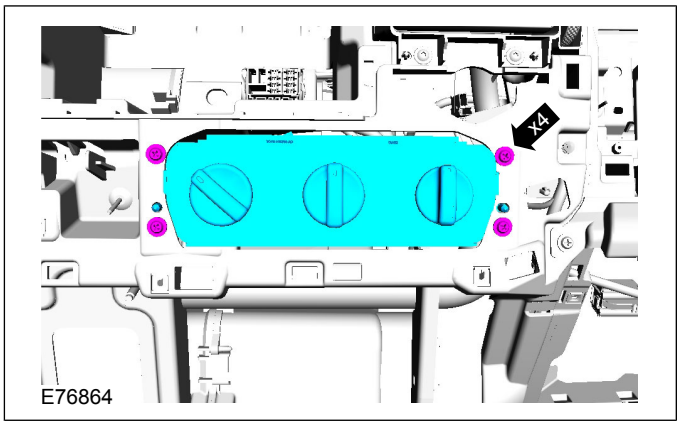
REMOVAL AND INSTALLATION

38. ⚠ **WARNING:Make sure that new self-locking nuts are installed.**

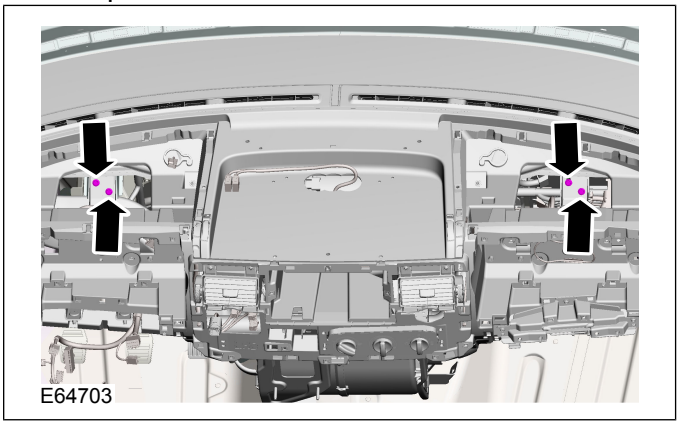
Torque: 20 Nm



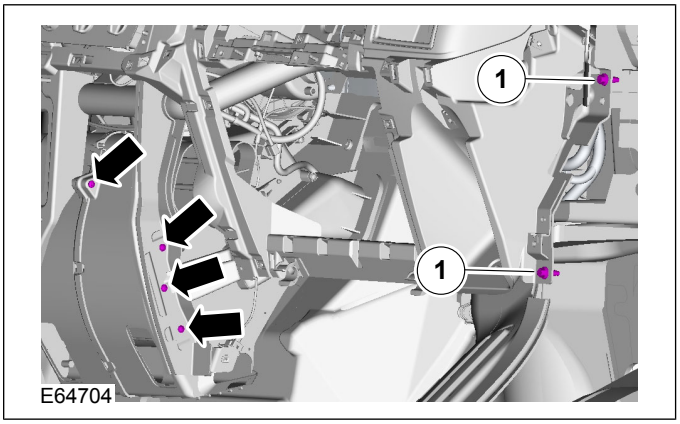
39.



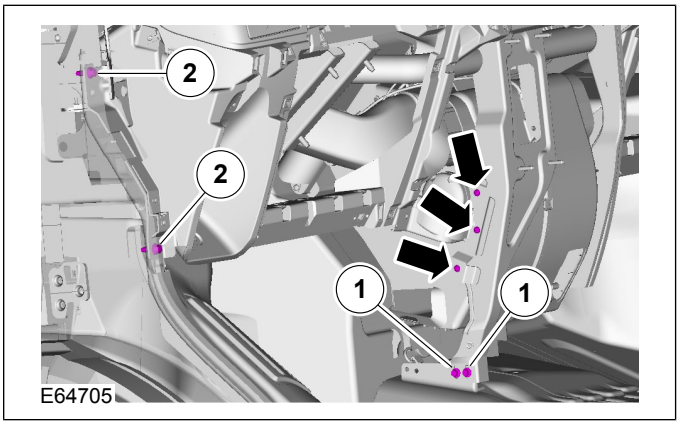
40. Torque: 20 Nm



41. 1. Torque: 25 Nm

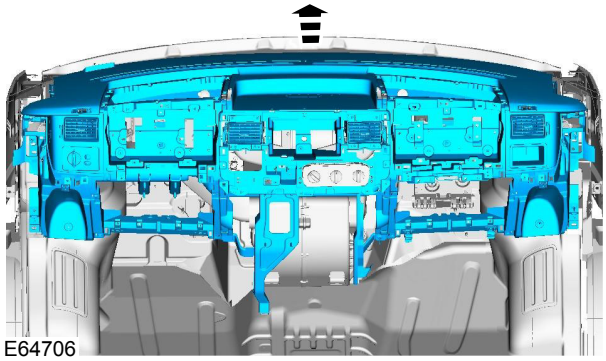


42. 1. Torque: 20 Nm
2. Torque: 25 Nm

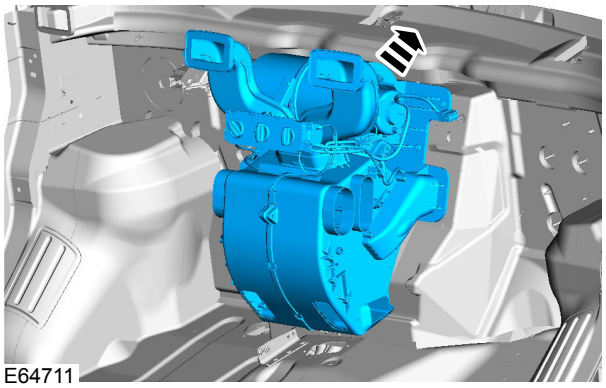


REMOVAL AND INSTALLATION

43.



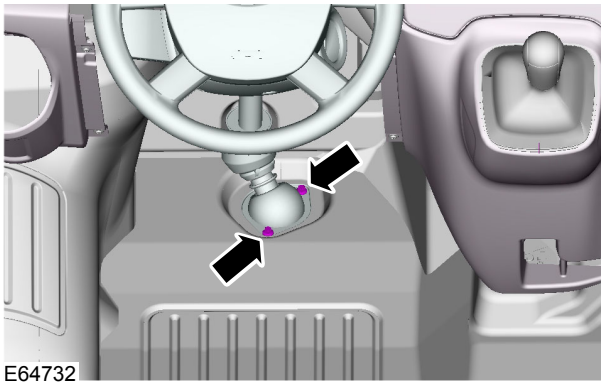
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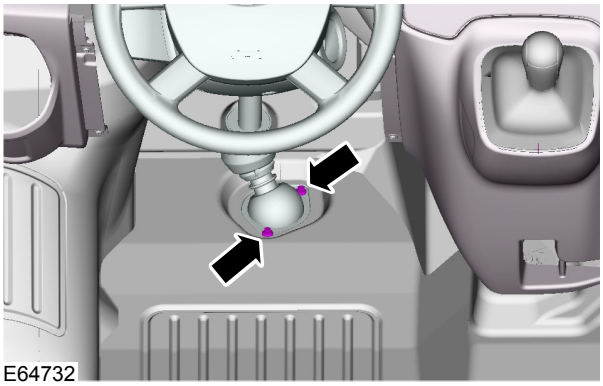
Installation

1. To install, reverse the removal procedure.
2. Coat the O-rings for the refrigerant line with clean refrigerant oil.

   Material: Refrigerant Oil
3. Loosen the bolts four turns.



4. Start the engine, turn the steering wheel from lock to lock.
5. Torque: 12 Nm



6. Inspect the coolant level.

   Refer to:Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to:Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to:Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to:Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

REMOVAL AND INSTALLATION

Blower Motor

Removal

All Vehicles

NOTE: Removal steps in this procedure may contain installation details.

1. Refer to:Supplemental Restraint System (SRS) Health and Safety Precautions (100-00 General Information, Description and Operation).
2. Disconnect the battery ground cable.

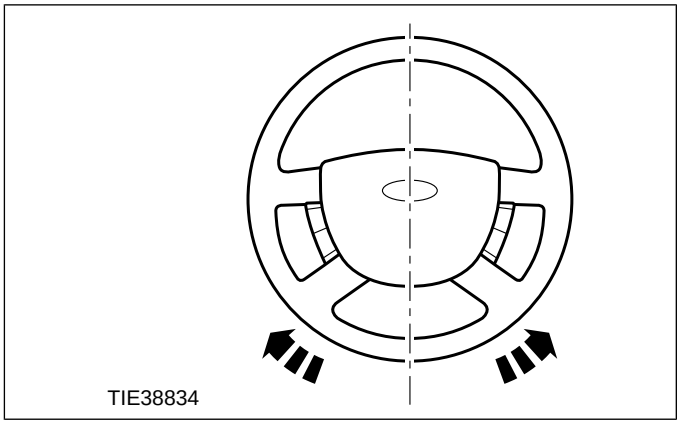
   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

All Vehicles

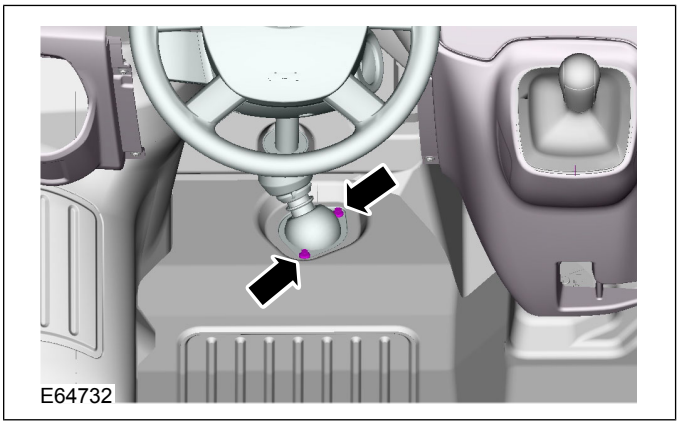
3. Remove the audio unit.

   Refer to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation).
4. Remove the left and right-hand A-pillar trim.

   Refer to:A-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
5. **NOTE:**Make sure that the road wheels are in the straight ahead position.

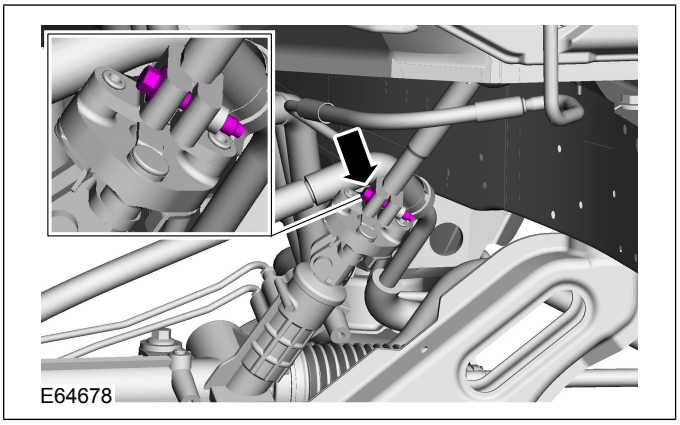


6. • Pull the footwell carpet to one side.
   • Torque: 12 Nm



7. Raise the vehicle.

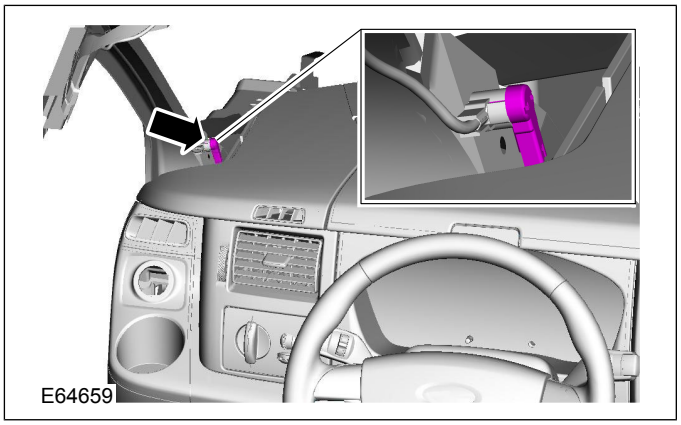
   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).
8. ⚠ **CAUTION:Make sure that new bolts are installed.**
   • Detach the steering column shaft joint from the steering column shaft.
   • Torque: 28 Nm



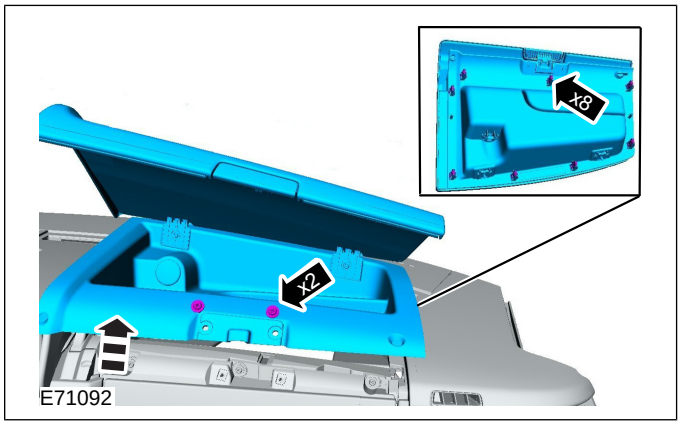
9. Lower the vehicle.

REMOVAL AND INSTALLATION

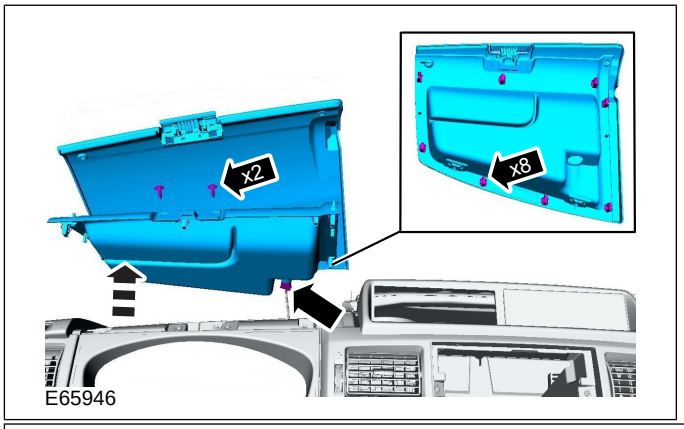
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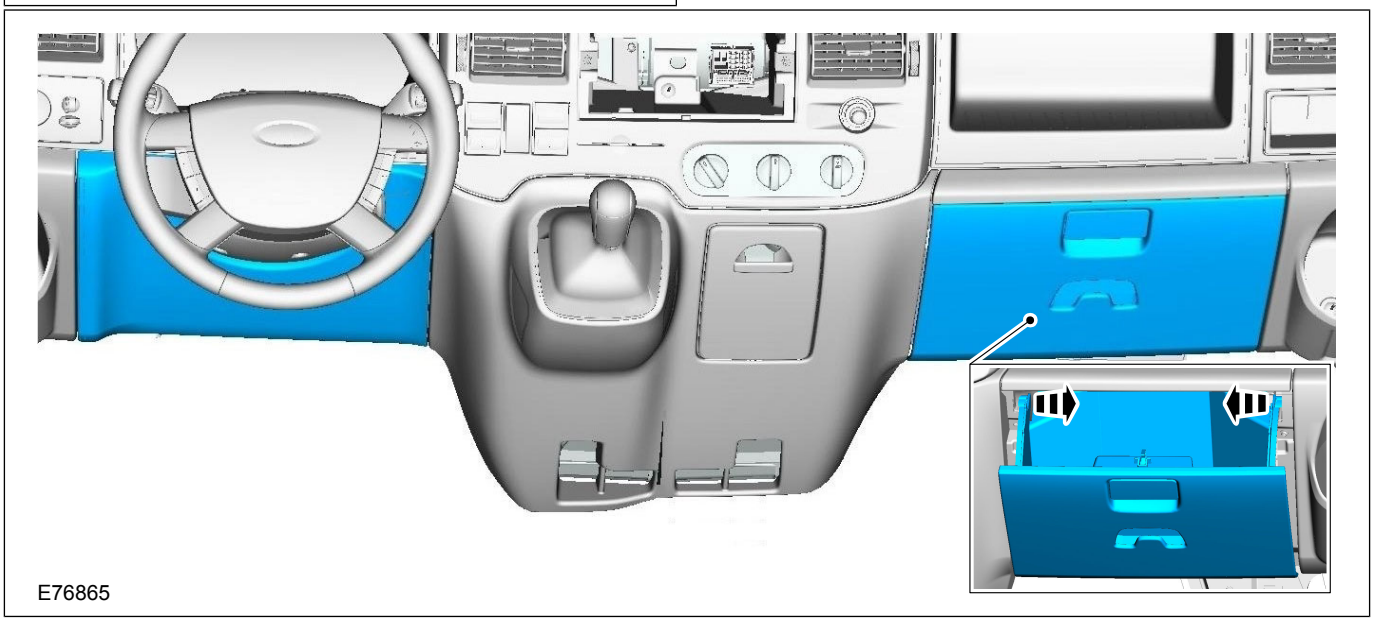
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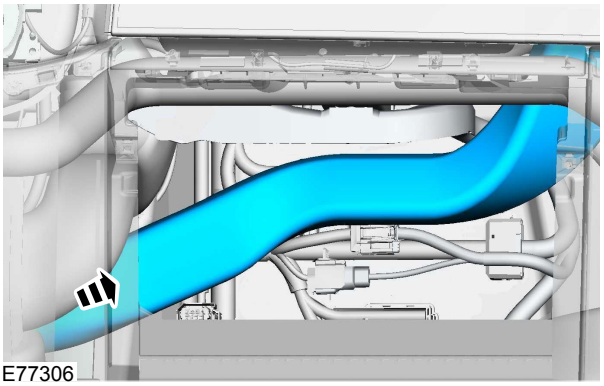


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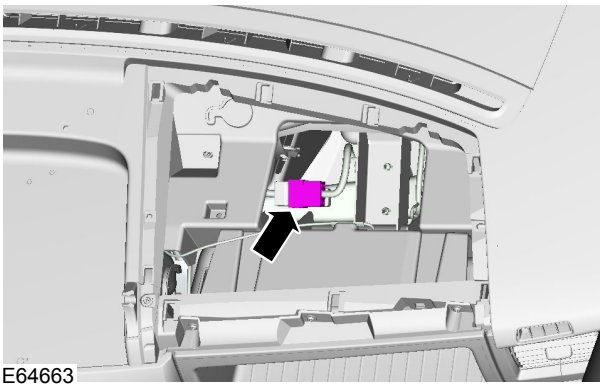


REMOVAL AND INSTALLATION

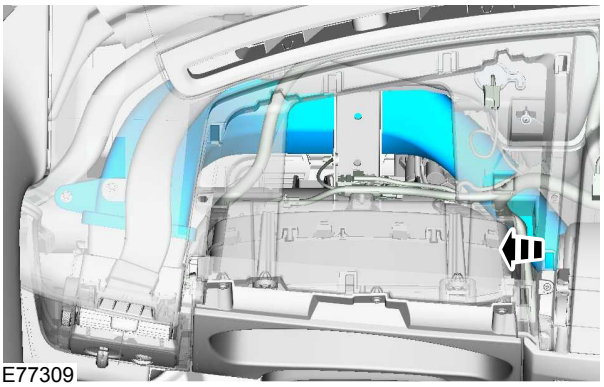
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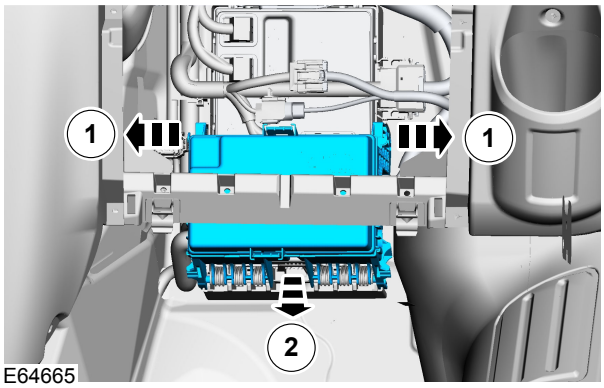
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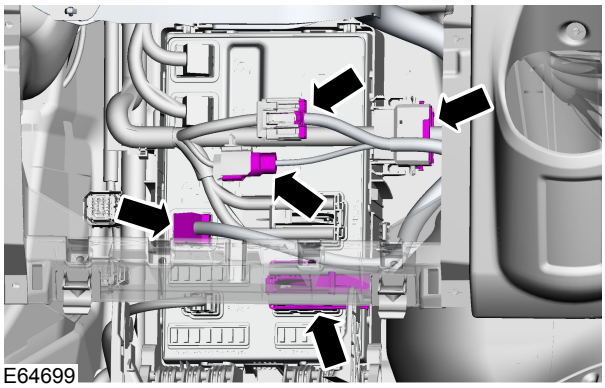
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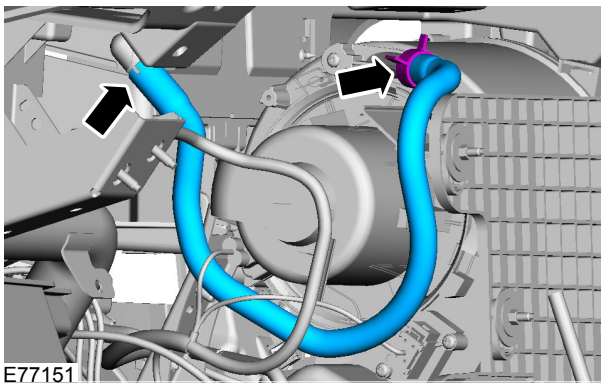
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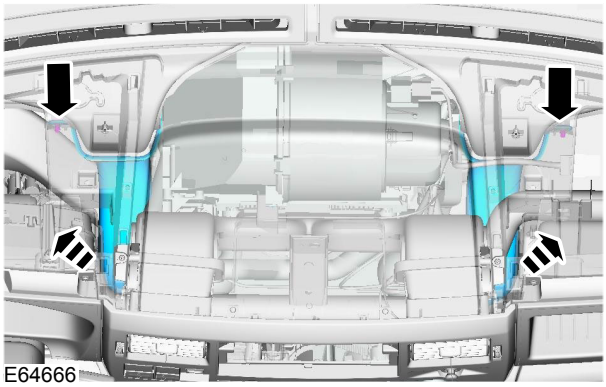


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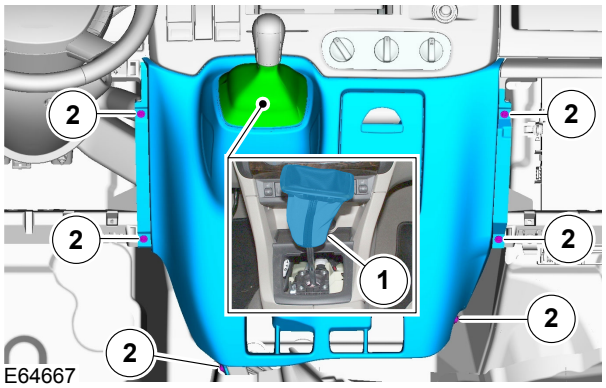


REMOVAL AND INSTALLATION

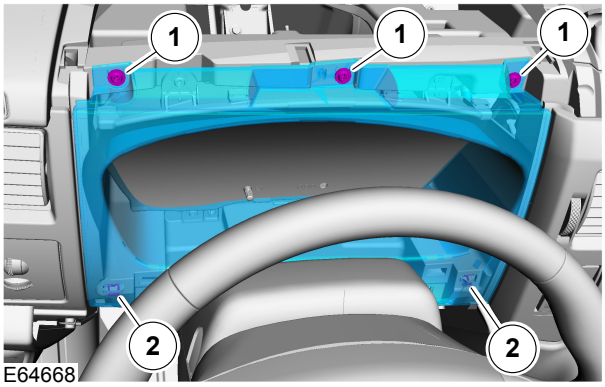
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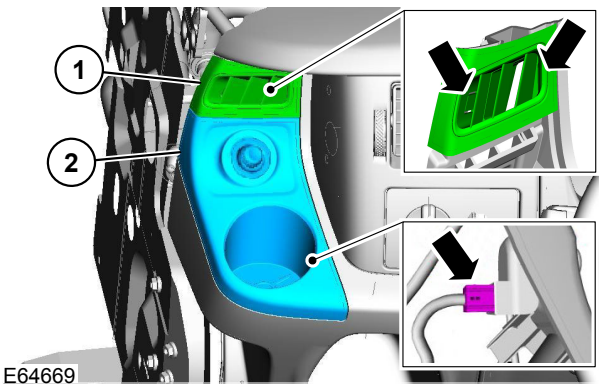
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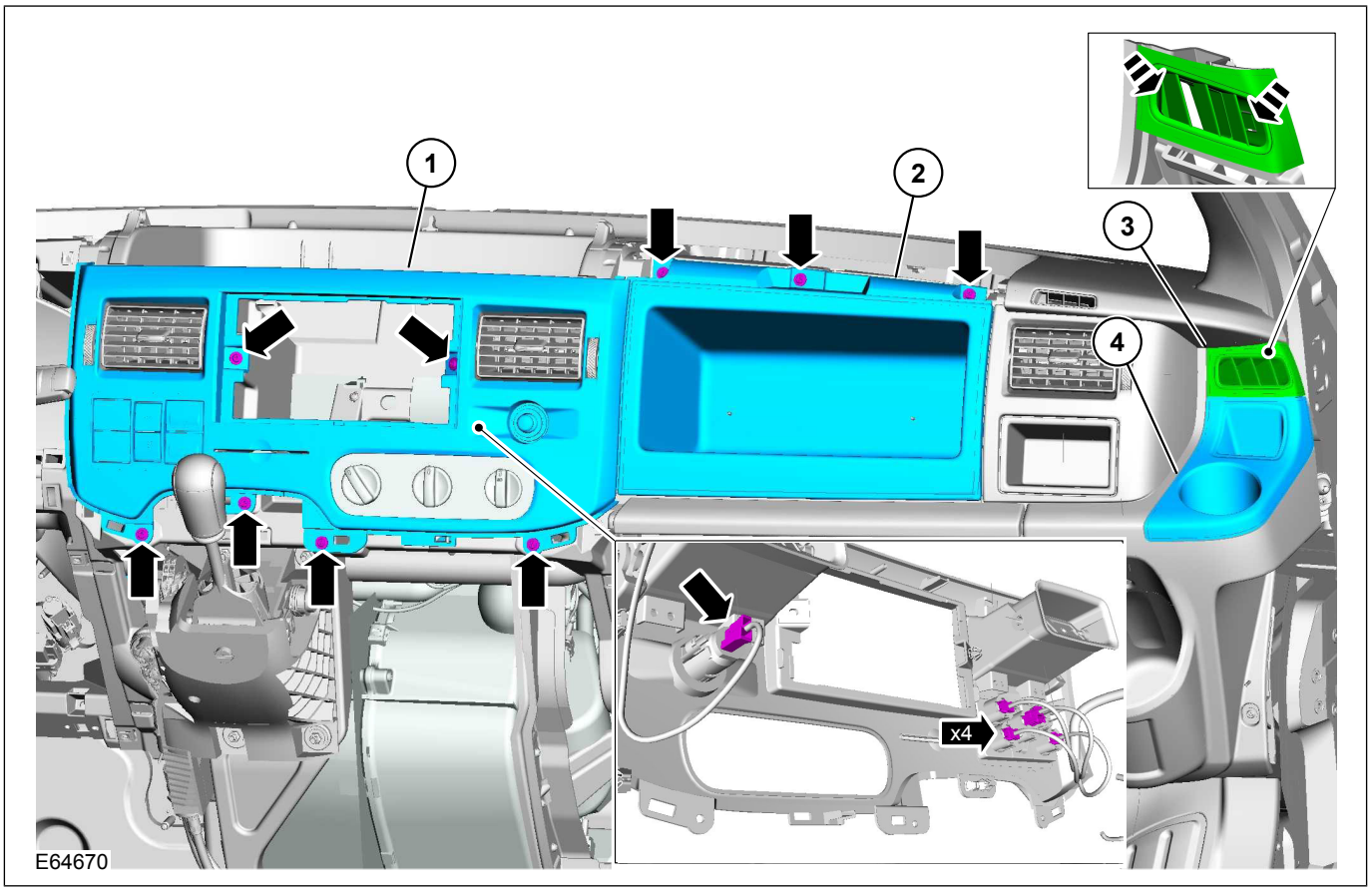


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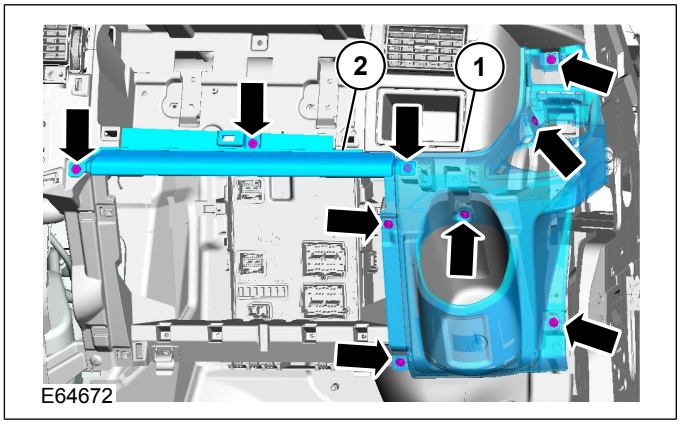


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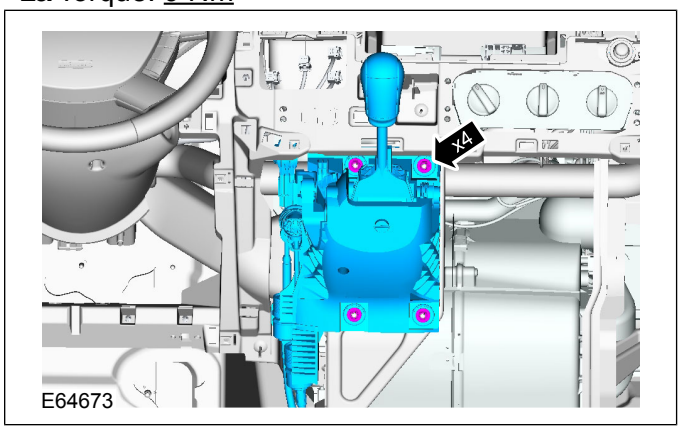
REMOVAL AND INSTALLATION



25.



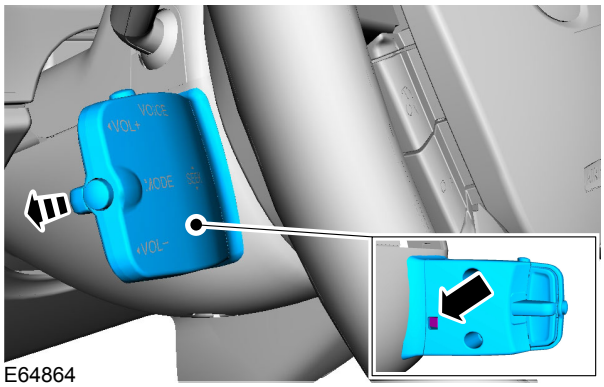
26. Torque: 9 Nm



REMOVAL AND INSTALLATION

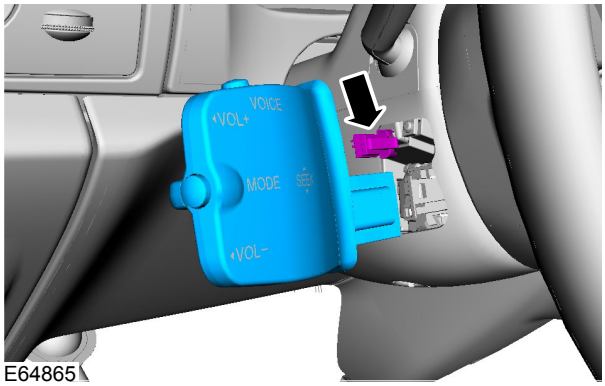
Vehicles with remote control for the audio unit

27.



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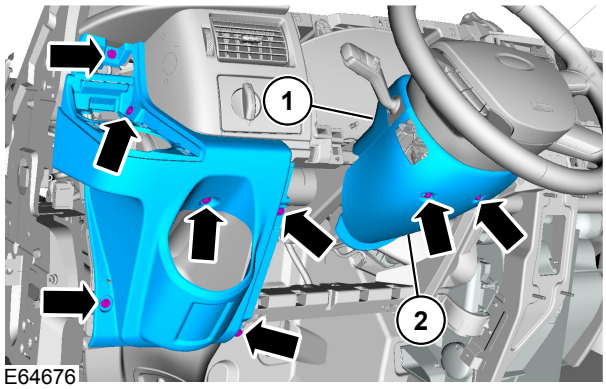
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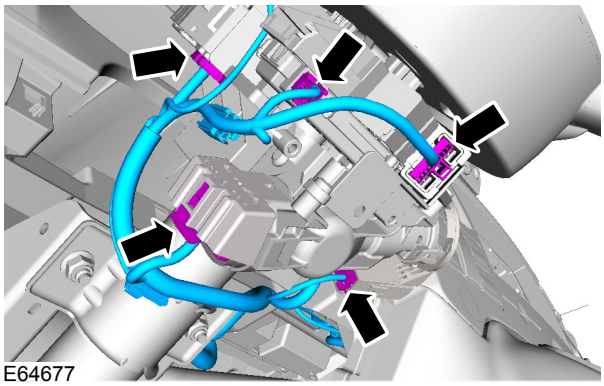
All Vehicles

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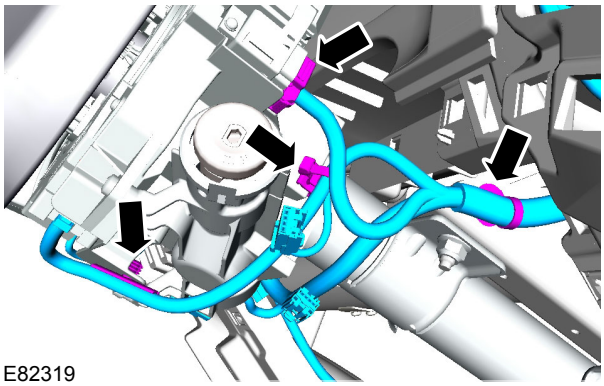


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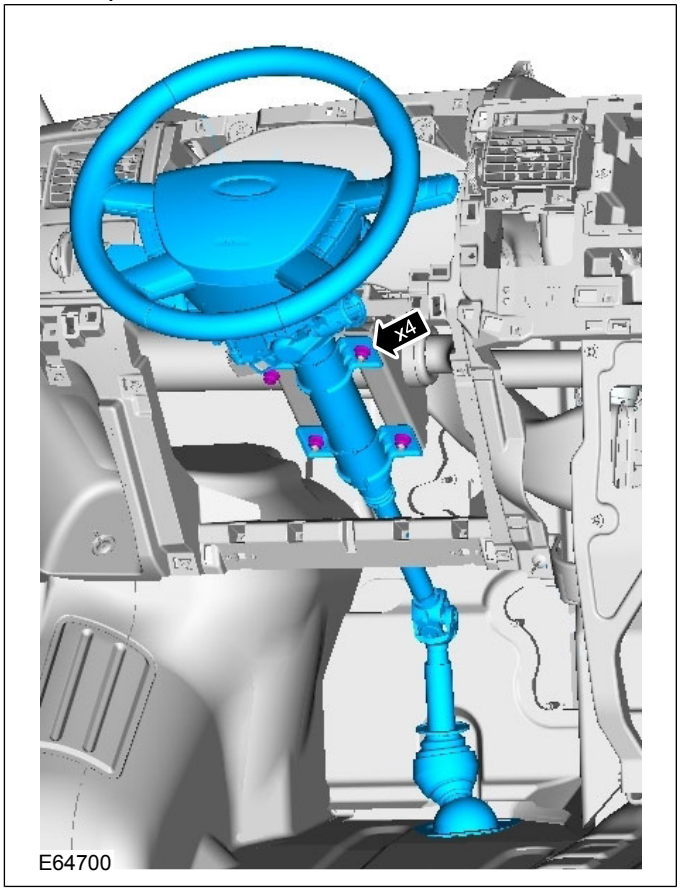

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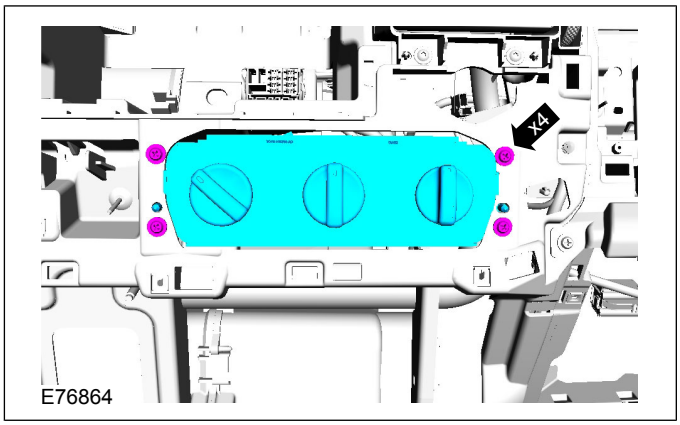

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REMOVAL AND INSTALLATION

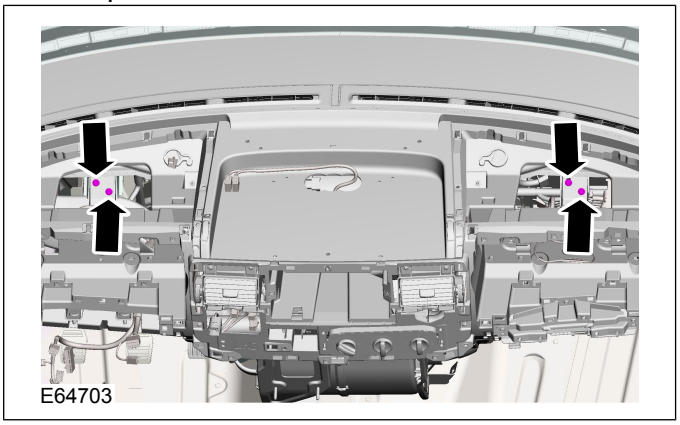
32. **WARNING:Make sure that new self-locking nuts are installed.**
Torque: 20 Nm



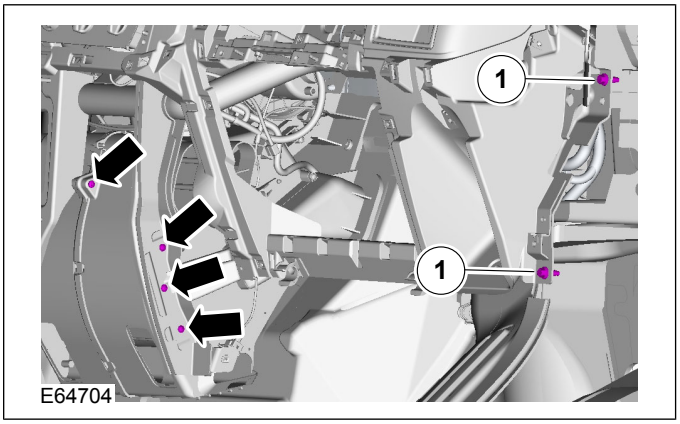
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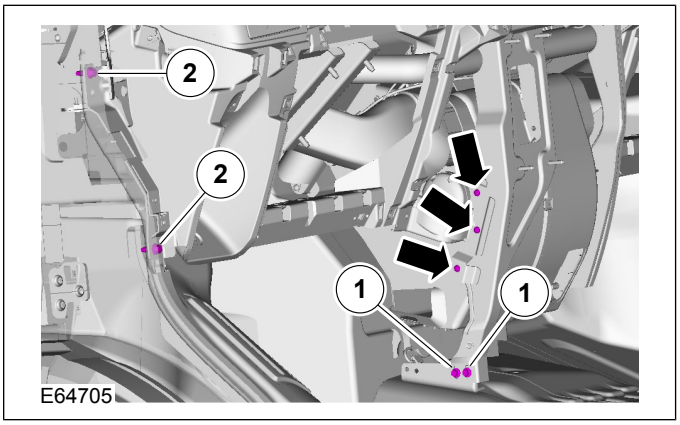
34. Torque: 20 Nm



35. 1. Torque: 25 Nm

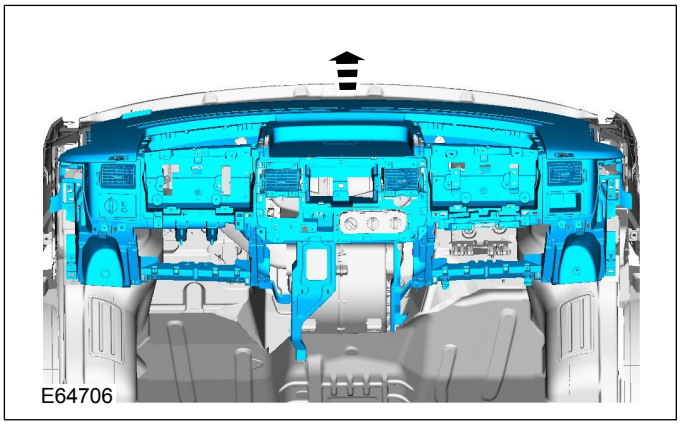


36. 1. Torque: 20 Nm
2. Torque: 25 Nm



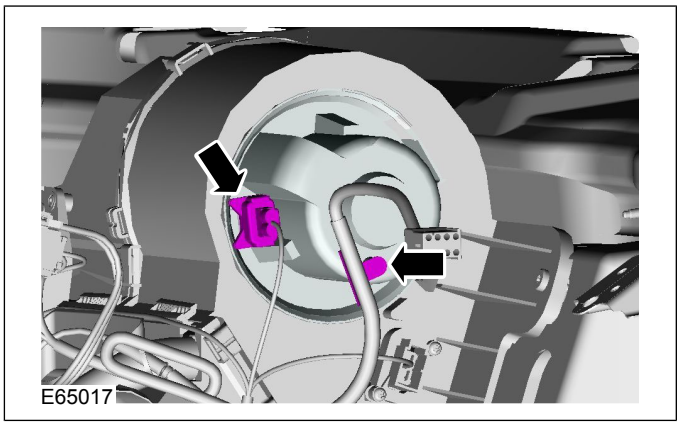
REMOVAL AND INSTALLATION

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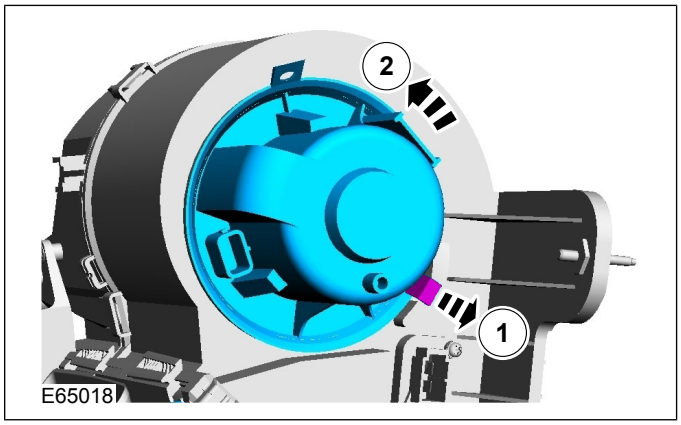


Vehicles without air conditioning

38.



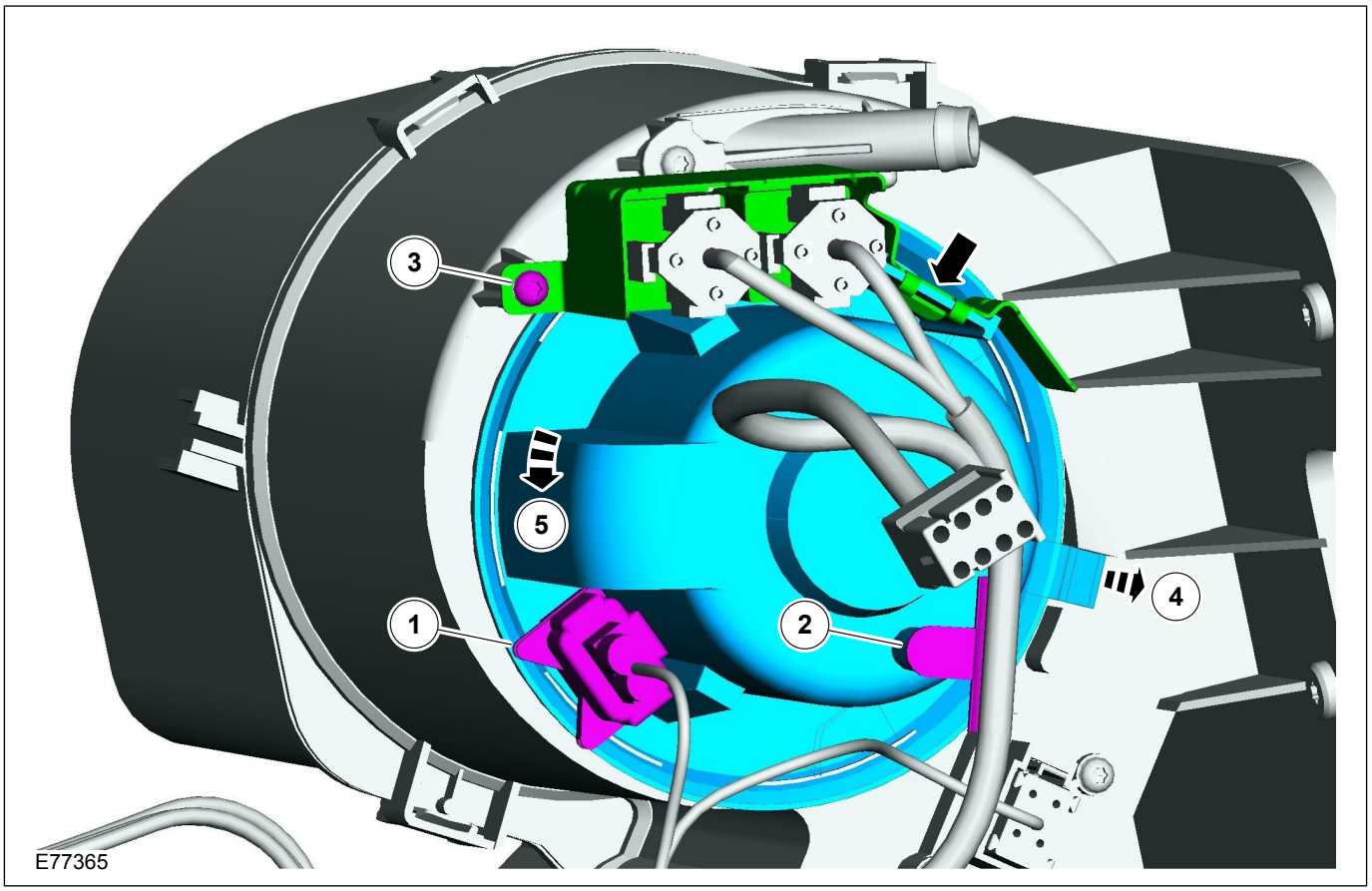
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Vehicles with air conditioning

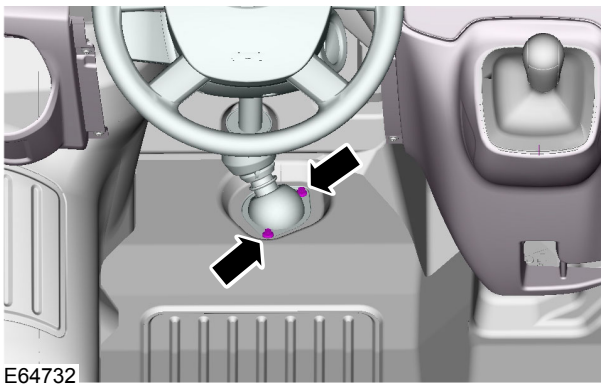
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REMOVAL AND INSTALLATION

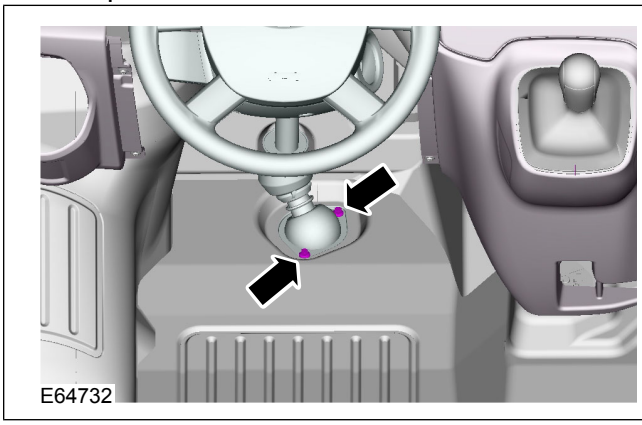


Installation

1. To install, reverse the removal procedure.
2. Loosen the bolts four turns.



3. Start the engine, turn the steering wheel from lock to lock.
4. Torque: 12 Nm



REMOVAL AND INSTALLATION

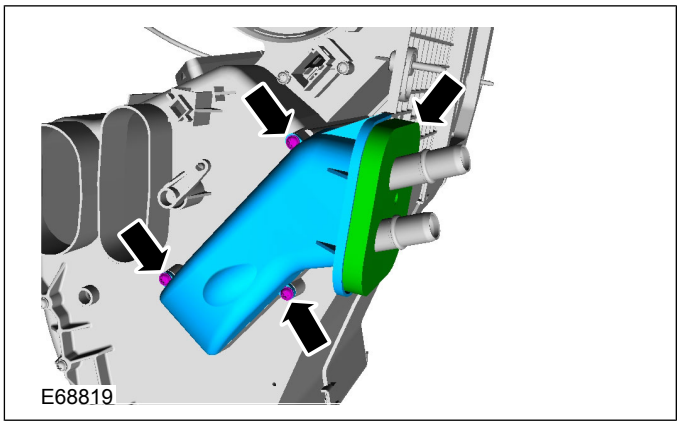
Heater Core — Vehicles Without: Air Conditioning

Removal

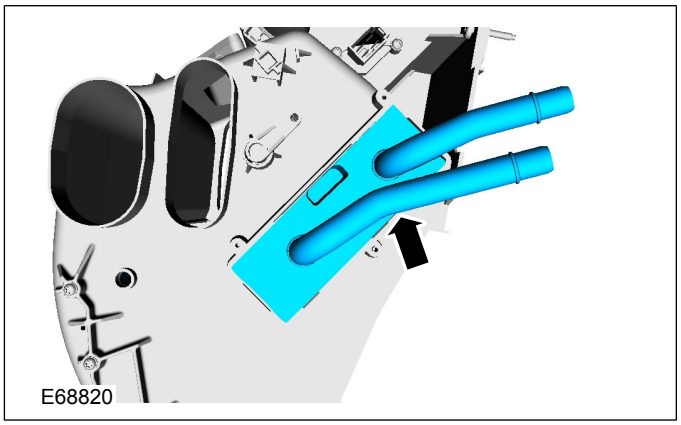
1. Remove the heater/evaporator housing.

   Refer to: Heater Core and Evaporator Core (412-02A, Removal and Installation).

2.



3.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

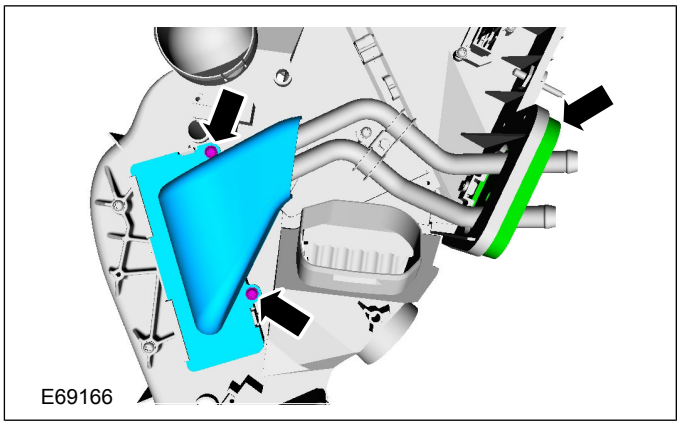
Heater Core — Vehicles With: Air Conditioning

Removal

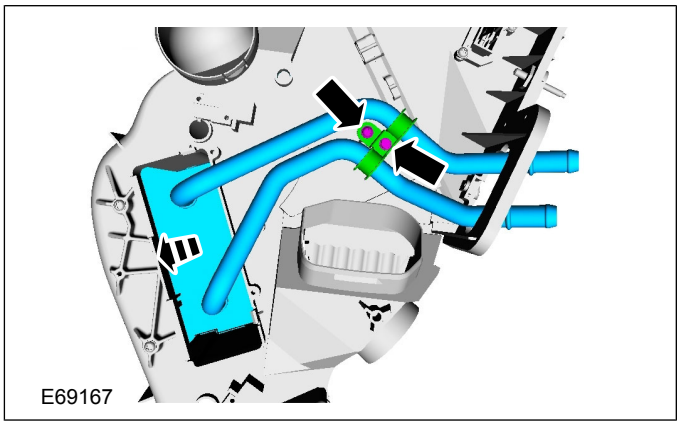
1. Remove the heater/evaporator housing.

   Refer to: Heater Core and Evaporator Core (412-02A, Removal and Installation).

2.



3.



Installation

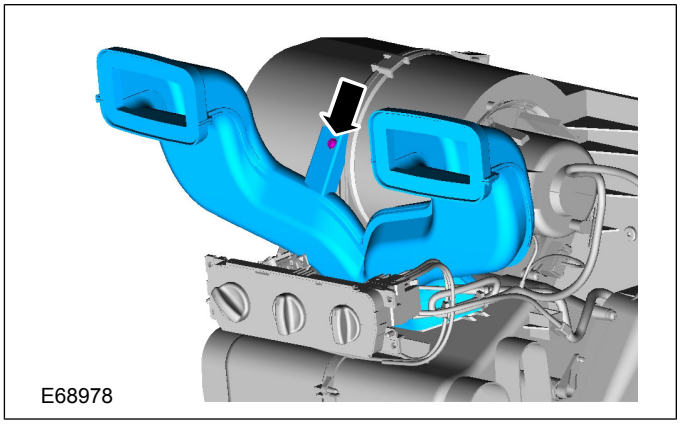
1. To install, reverse the removal procedure.

DISASSEMBLY AND ASSEMBLY

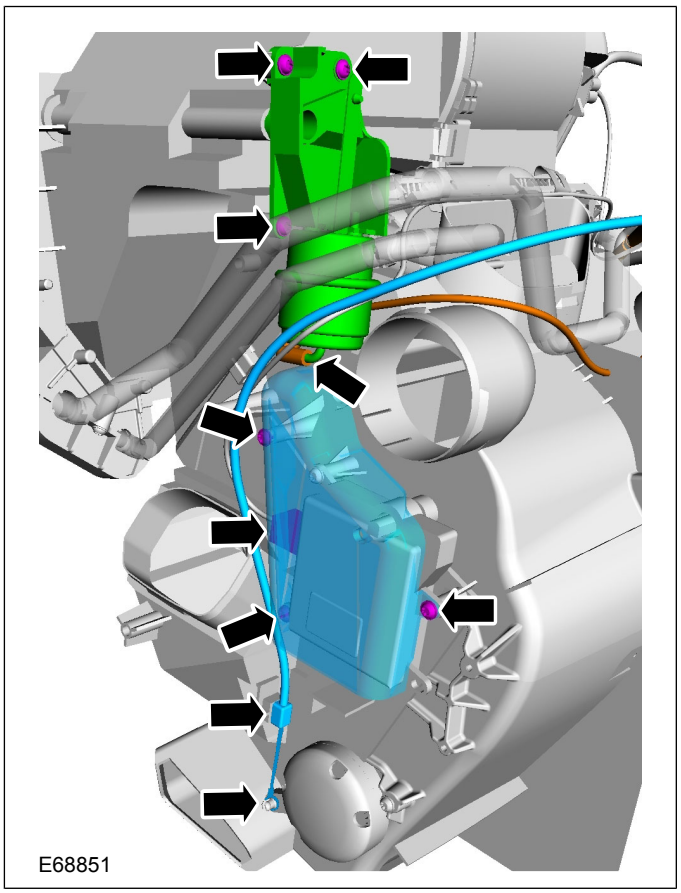
Heater Core Housing — Vehicles With: Air Conditioning

Disassembly

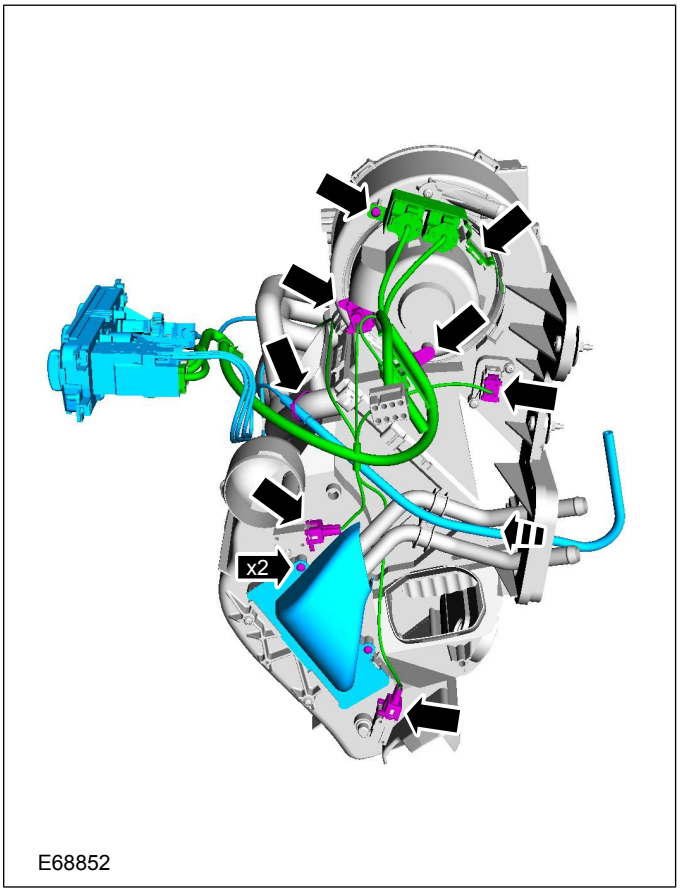
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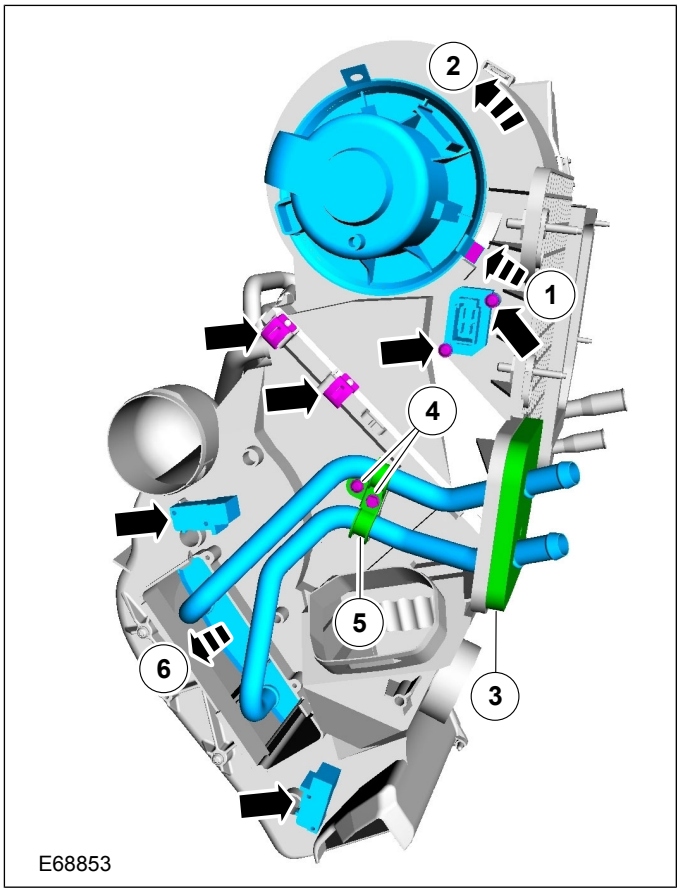


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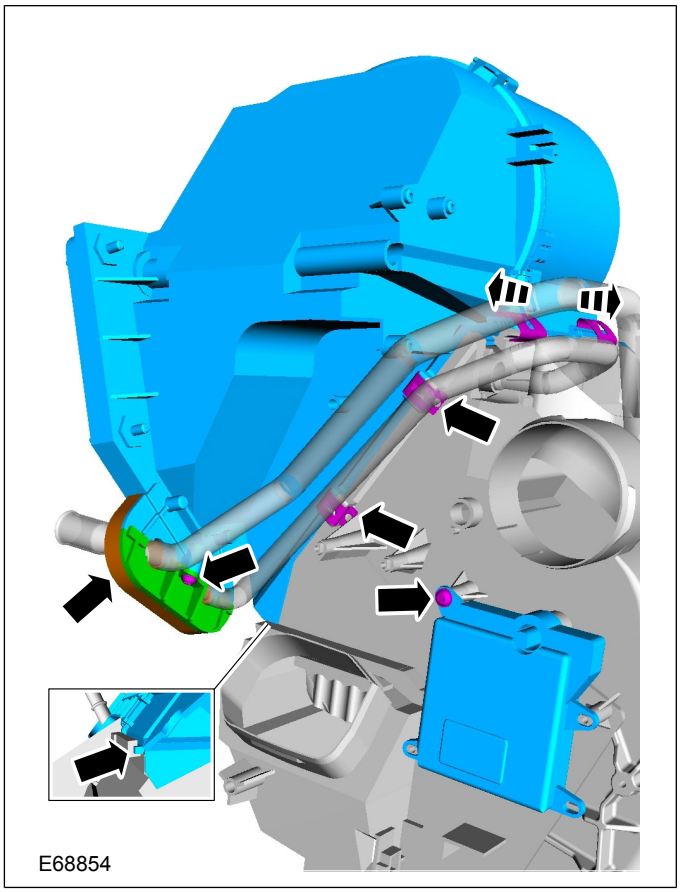


DISASSEMBLY AND ASSEMBLY

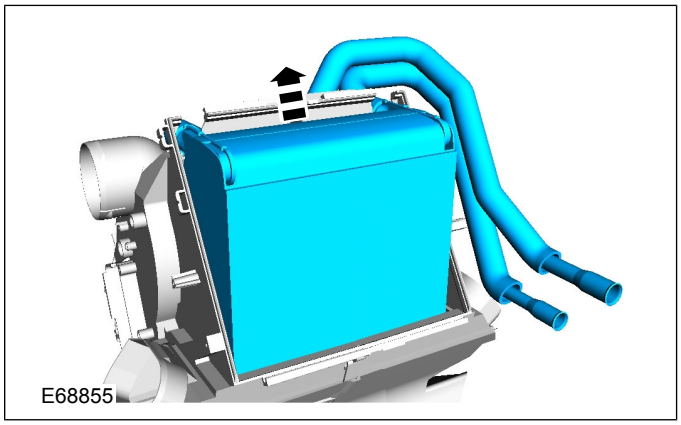
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5.



6.



Assembly

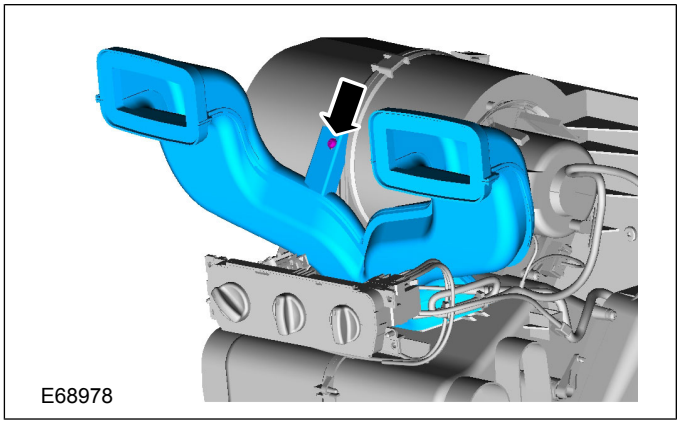
7. Follow the disassembly procedure in reverse order.

DISASSEMBLY AND ASSEMBLY

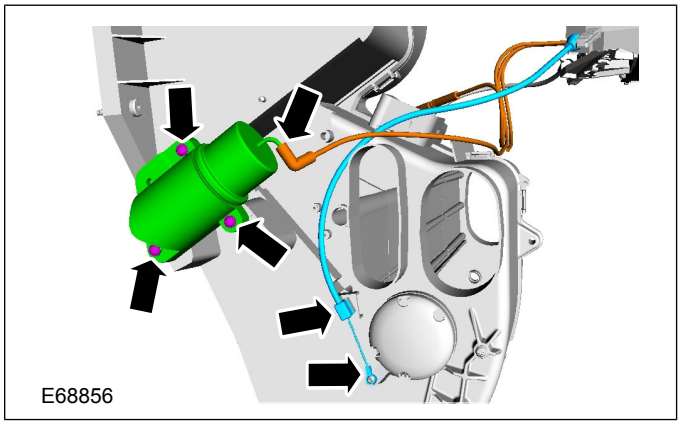
Heater Core Housing — Vehicles Without: Air Conditioning

Disassembly

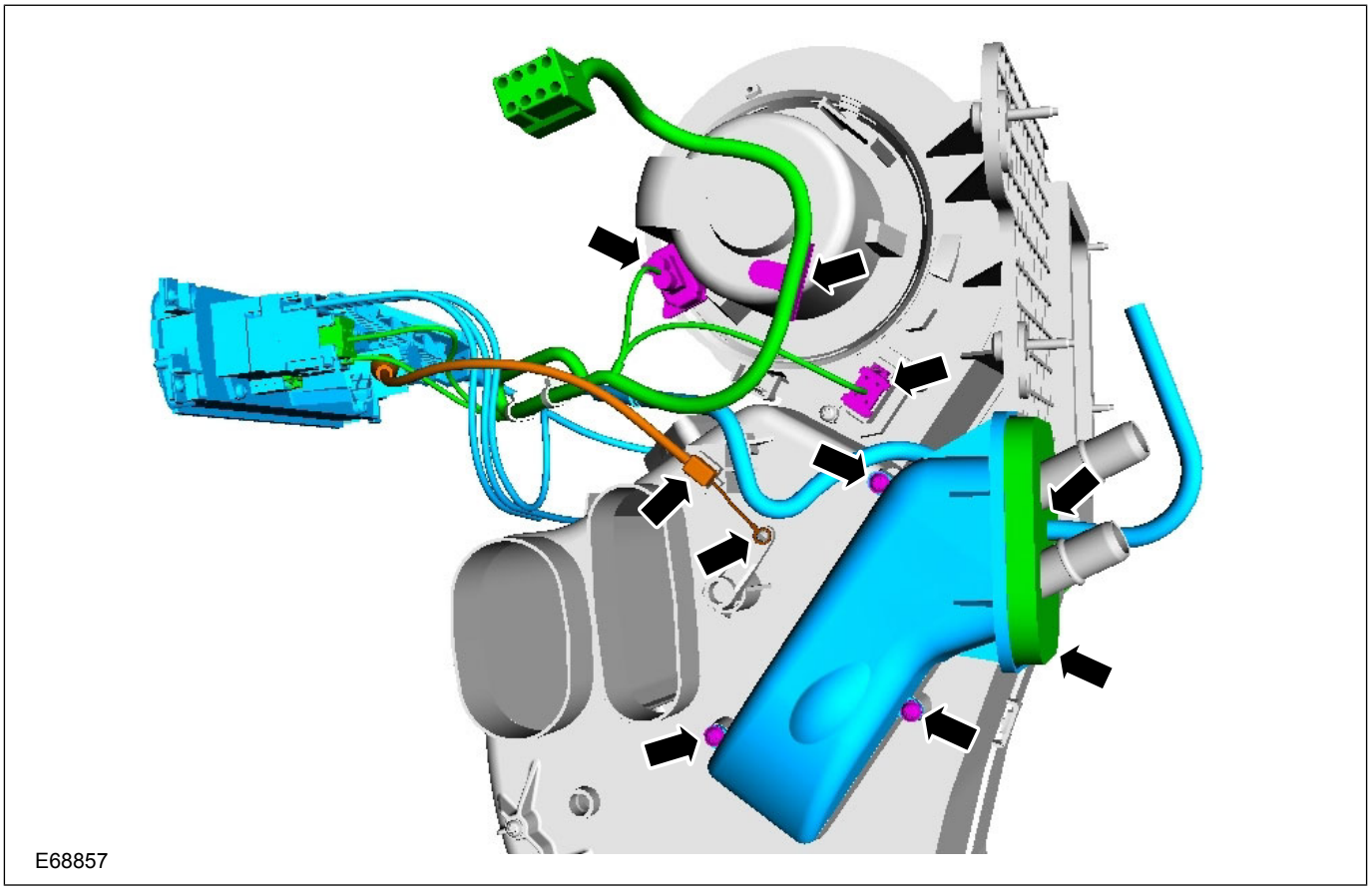
1.



2.

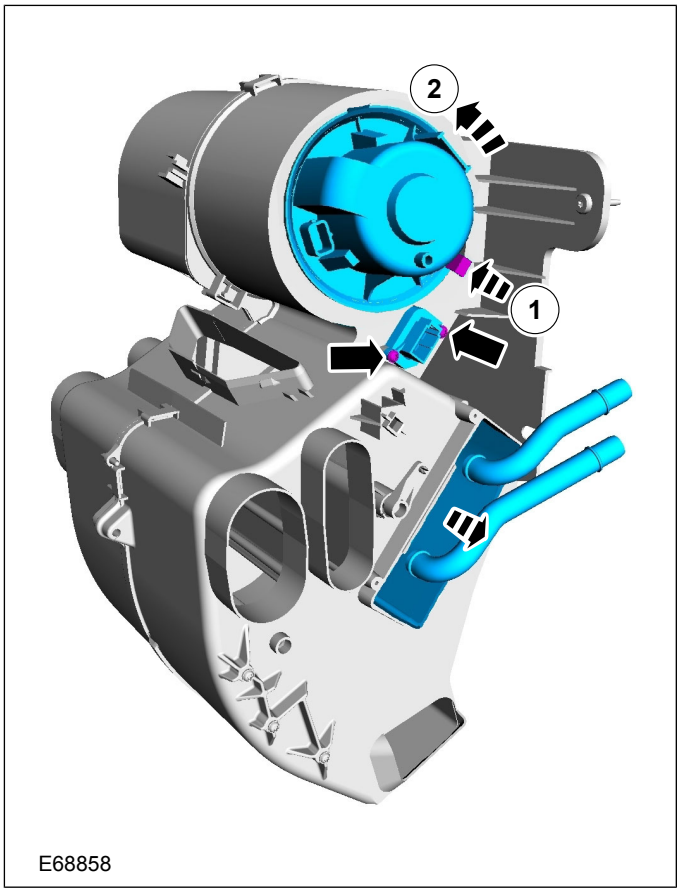


3.



DISASSEMBLY AND ASSEMBLY

4.



Assembly

5. Follow the disassembly procedure in reverse order.

SECTION 412-03A Air Conditioning

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 412-03A-2

DESCRIPTION AND OPERATION

Air Conditioning 412-03A-3
Refrigerant circuit 412-03A-3
Overview - air conditioning system 412-03A-4

DIAGNOSIS AND TESTING

Air Conditioning 412-03A-6

REMOVAL AND INSTALLATION

Clutch and Clutch Field Coil ..... (34 628 0) 412-03A-7
Air Conditioning (A/C) Compressor — 2.4L Duratorq-TDCi (Puma) Diesel 412-03A-8
Air Conditioning (A/C) Compressor — 2.3L Duratec-HE (MI4) 412-03A-9
Evaporator Core 412-03A-10
Evaporator Core Orifice 412-03A-12
Suction Accumulator 412-03A-14
Low-Pressure Cutoff Switch 412-03A-15
High-Pressure Cutoff Switch 412-03A-16
Condenser Core 412-03A-17
Compressor to Condenser Discharge Line — 2.4L Duratorq-TDCi (Puma) Diesel 412-03A-19
Condenser to Evaporator Line 412-03A-20
Evaporator Outlet Line 412-03A-23
Suction Accumulator to Compressor Line — 2.4L Duratorq-TDCi (Puma) Diesel 412-03A-26
Suction Accumulator to Condenser Line — 2.3L Duratec-HE (MI4) 412-03A-27

SPECIFICATIONS

A/C compressor

	Description
A/C compressor	VS16

Fixed orifice tube

	Colour
Fixed orifice tube	Red

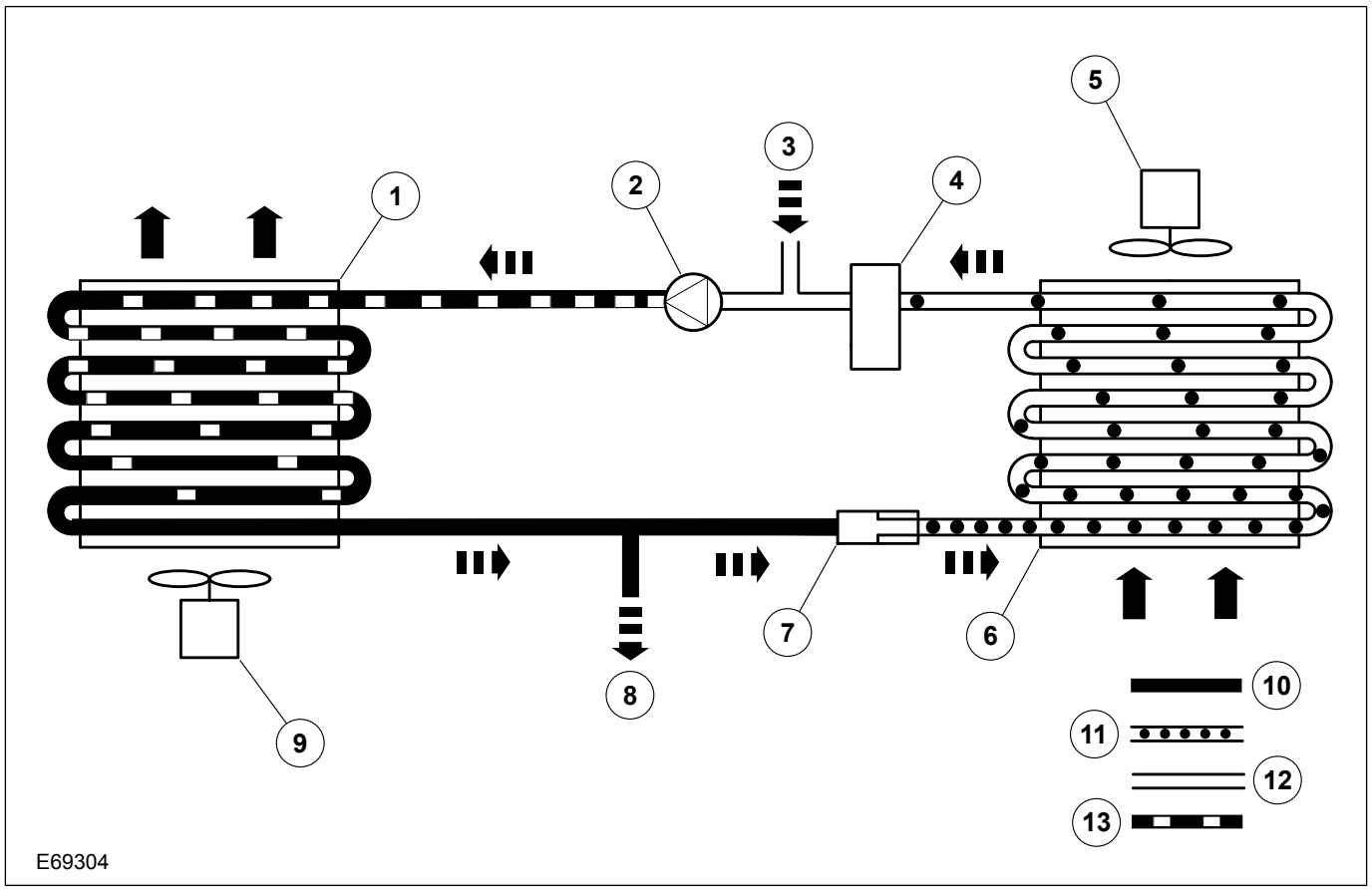
DESCRIPTION AND OPERATION

Air Conditioning

Two options are available:

- Front air conditioning system with manual temperature control
- Air conditioning system front and rear with manual temperature control

Refrigerant circuit



Item	Description
1	Condenser
2	A/C compressor
3	Outlet line - additional evaporator (if present)
4	Suction accumulator
5	Blower motor
6	Evaporator
7	Fixed orifice tube
8	Inlet line - additional evaporator (if present)
9	Cooling fans
10	High pressure (liquid and warm)

Item	Description
11	Low pressure (liquid and cool)
12	Low pressure (gaseous and cold)
13	High pressure (gaseous and hot)

The engine driven refrigerant compressor (2) sucks in gaseous refrigerant from the suction accumulator and compresses it. The temperature of the refrigerant rises to a value between 70 °C and 110 °C. It passes to the condenser (1) under high pressure.

At this point heat is drawn from the refrigerant by the air being forced past the cooling fins. Because of this heat loss, the refrigerant liquefies and leaves the condenser.

DESCRIPTION AND OPERATION

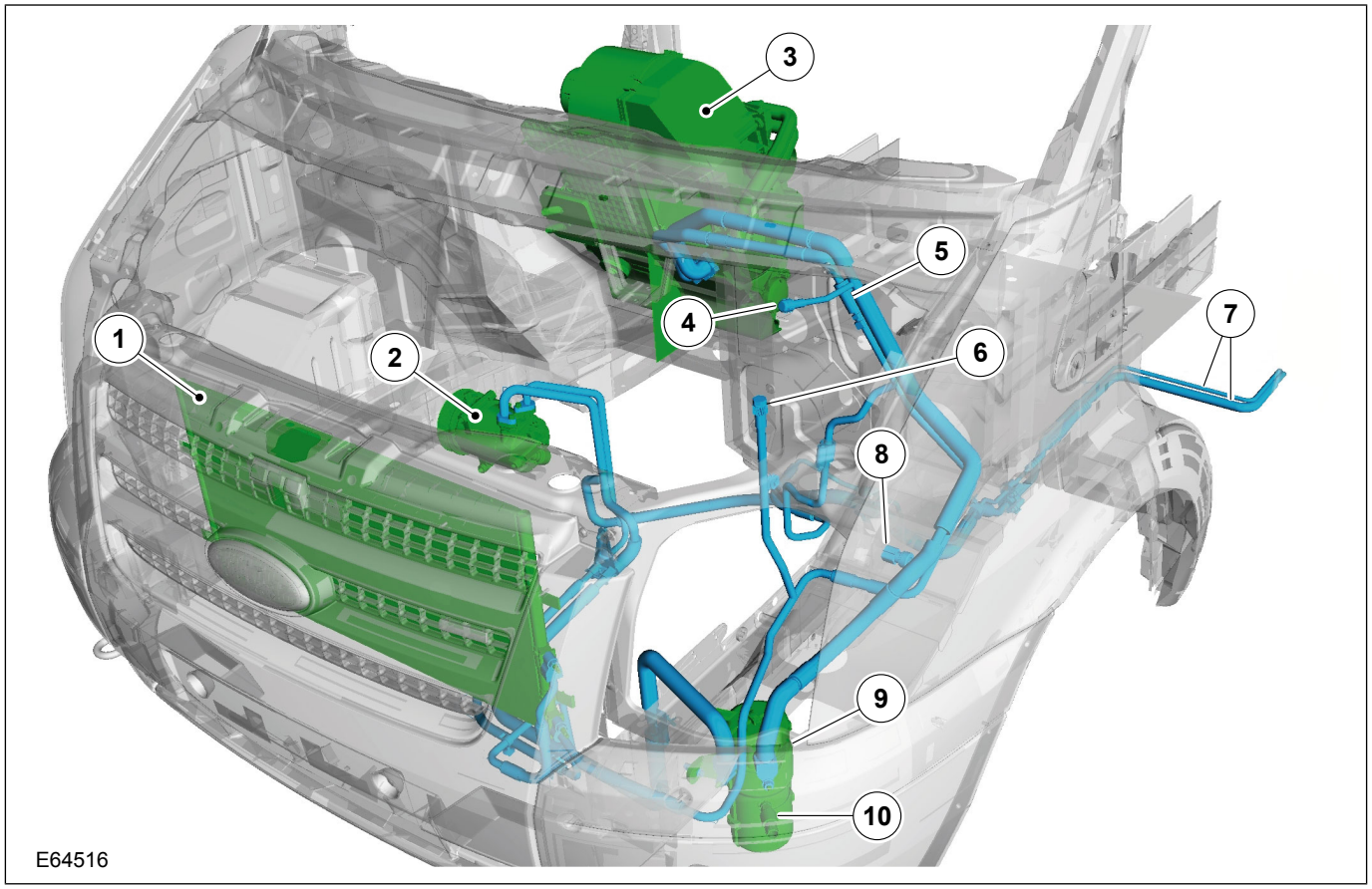
A fixed orifice tube (7), which separates the refrigerant at high pressure from that at low pressure, is located between the condenser and the evaporator (6). This fixed orifice tube slows down the flow of the refrigerant from the compressor, so that pressure builds up in the condenser.

After passing through the fixed orifice tube the liquid refrigerant expands in the circuit to the evaporator, where it becomes gaseous. Thereby, heat is removed from the air before it enters the passenger compartment. The air cools down, and excess moisture contained in it is condensed and is drained off. The refrigerant coming from the evaporator flows into the refrigerant accumulator and is again sucked in by the refrigerant compressor.

The system is protected by a high-pressure switch, in order to prevent damage by excessive pressure (e.g. because of overfilling with refrigerant). If the pressure exceeds the maximum permitted, the high-pressure switch turns off the refrigerant compressor.

The compressor on-off cycle is controlled by the low-pressure switch depending on the pressure in the refrigerant accumulator. The low-pressure switch turns the refrigerant compressor off permanently if the pressure falls below a permitted value (e.g. if there is a leak).

Overview - air conditioning system



Item	Description
1	Condenser
2	A/C compressor
3	Heater/ Evaporator Core Housing
4	Low pressure charging connection
5	Fixed orifice tube

Item	Description
6	High pressure charging connection
7	Refrigerant lines - additional air conditioning system (if present)
8	Low-pressure switch

DESCRIPTION AND OPERATION

Item	Description
9	Suction accumulator
10	High-pressure switch

DIAGNOSIS AND TESTING

Air Conditioning

REFER to: Climate Control System (412-00, Diagnosis and Testing).

REMOVAL AND INSTALLATION

Clutch and Clutch Field Coil (34 628 0)

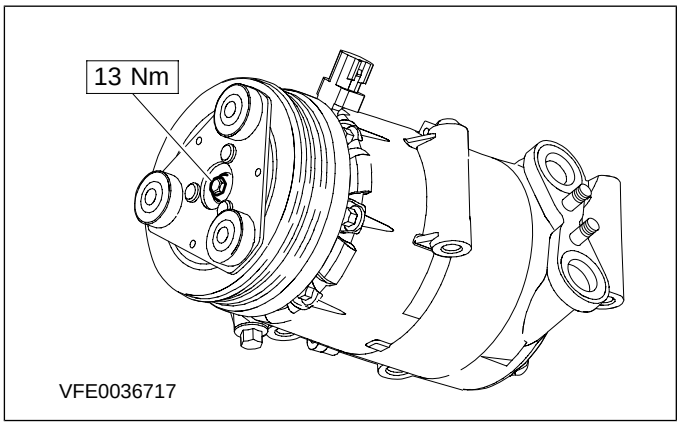
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. **Remove the A/C compressor.**

   For additional information, refer to:Air Conditioning (A/C) Compressor - 2.2L Duratorq-TDCi (Puma) Diesel (412-03 Air Conditioning, Removal and Installation).

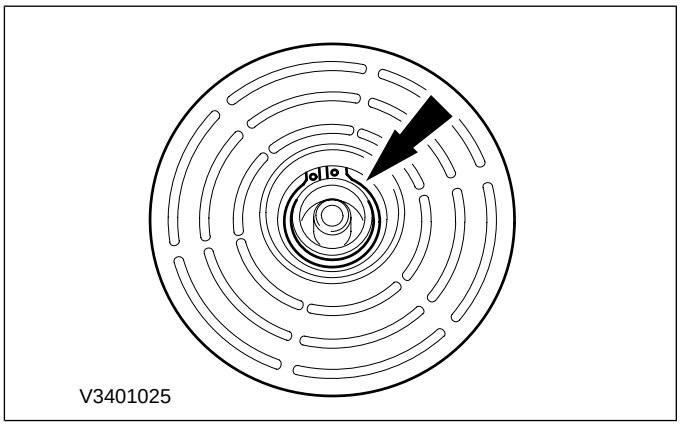
2. **Remove the A/C compressor drive plate.**



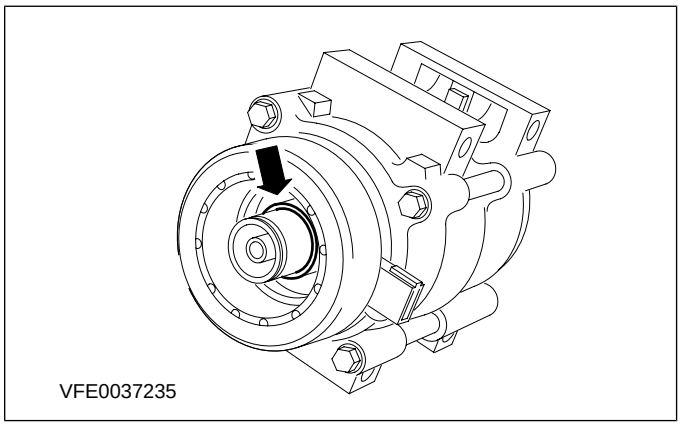
3. **NOTE:If necessary, remove a seized A/C compressor pulley using a suitable remover.**

   Remove the A/C compressor pulley.

   - Remove the spacer washers.
   - Discard the pulley snap ring.

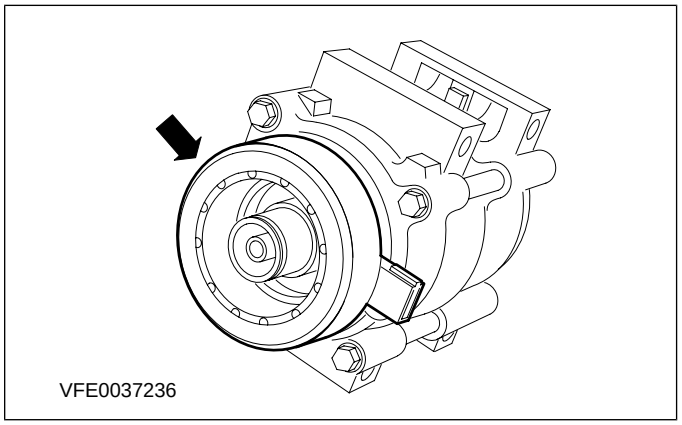


4. **Remove the solenoid coil snap ring.**



5. **NOTE:Mark the installation position of the A/C compressor clutch connector in relation to the compressor housing.**

   Remove the solenoid coil.



Installation

CAUTION:Do not tilt the solenoid coil when installing in the A/C compressor.

NOTE: Installation position of the A/C compressor clutch connector in relation to the compressor housing.

NOTE: Install a new A/C compressor pulley snap ring.

1. **To install, reverse the assembly procedure.**
2. **Check the A/C compressor clutch air gap.**

   For additional information, refer to:Air Conditioning (A/C) Clutch Air Gap Adjustment (412-00 Climate Control System - General Information, General Procedures).

REMOVAL AND INSTALLATION

Air Conditioning (A/C) Compressor — 2.4L Duratorq-TDCi (Puma) Diesel

1. Information not available at this time.

REMOVAL AND INSTALLATION

Air Conditioning (A/C) Compressor — 2.3L Duratec-HE (MI4)

1. **Information not available at this time.**

REMOVAL AND INSTALLATION

Evaporator Core

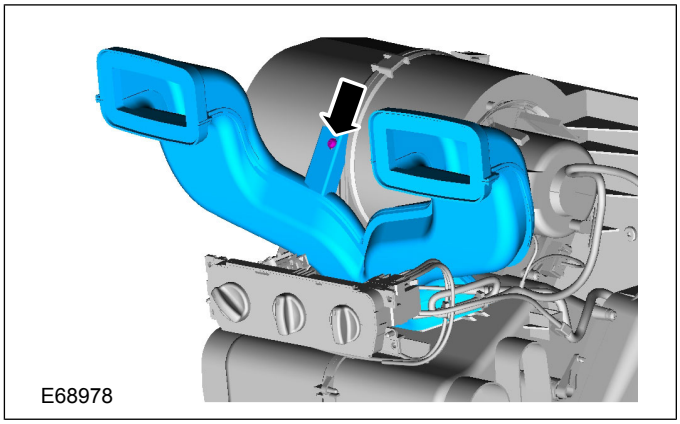
Removal

NOTE: Removal steps in this procedure may contain installation details.

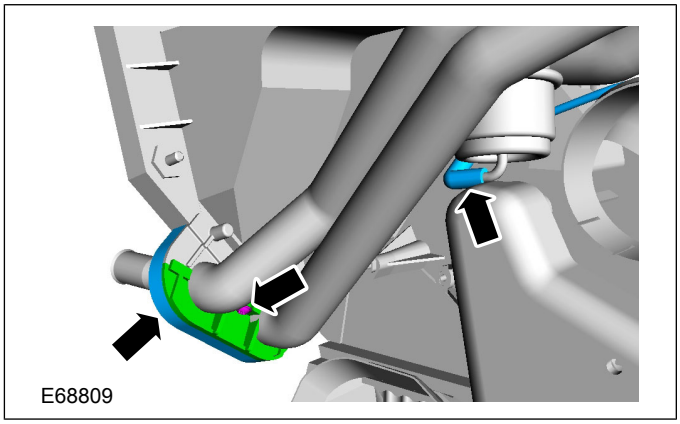
1. Remove the heater/evaporator housing.

   Refer to: Heater Core and Evaporator Core Housing (412-02 Heating and Ventilation, Removal and Installation).

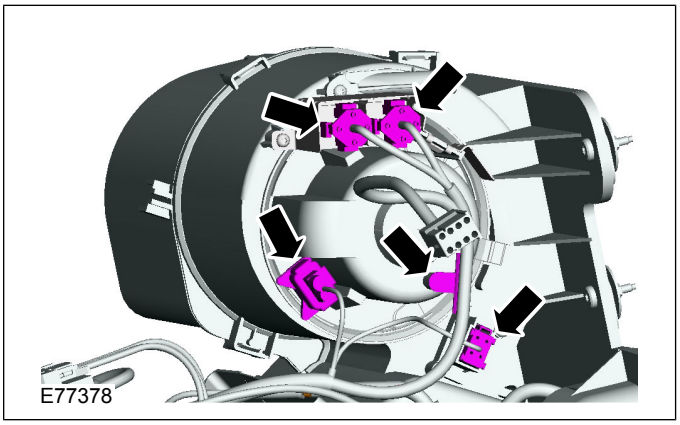
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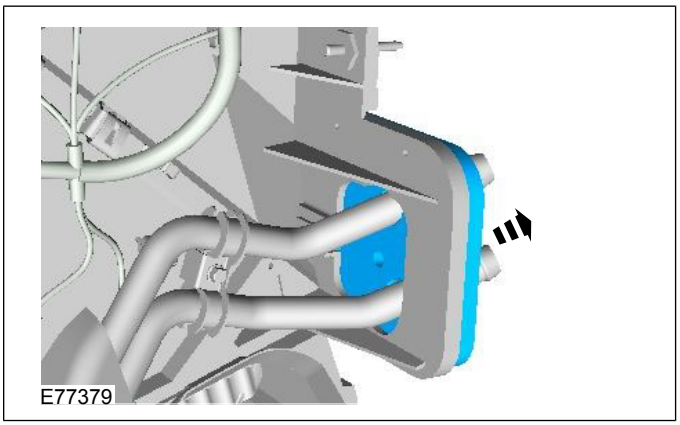
3.



4.

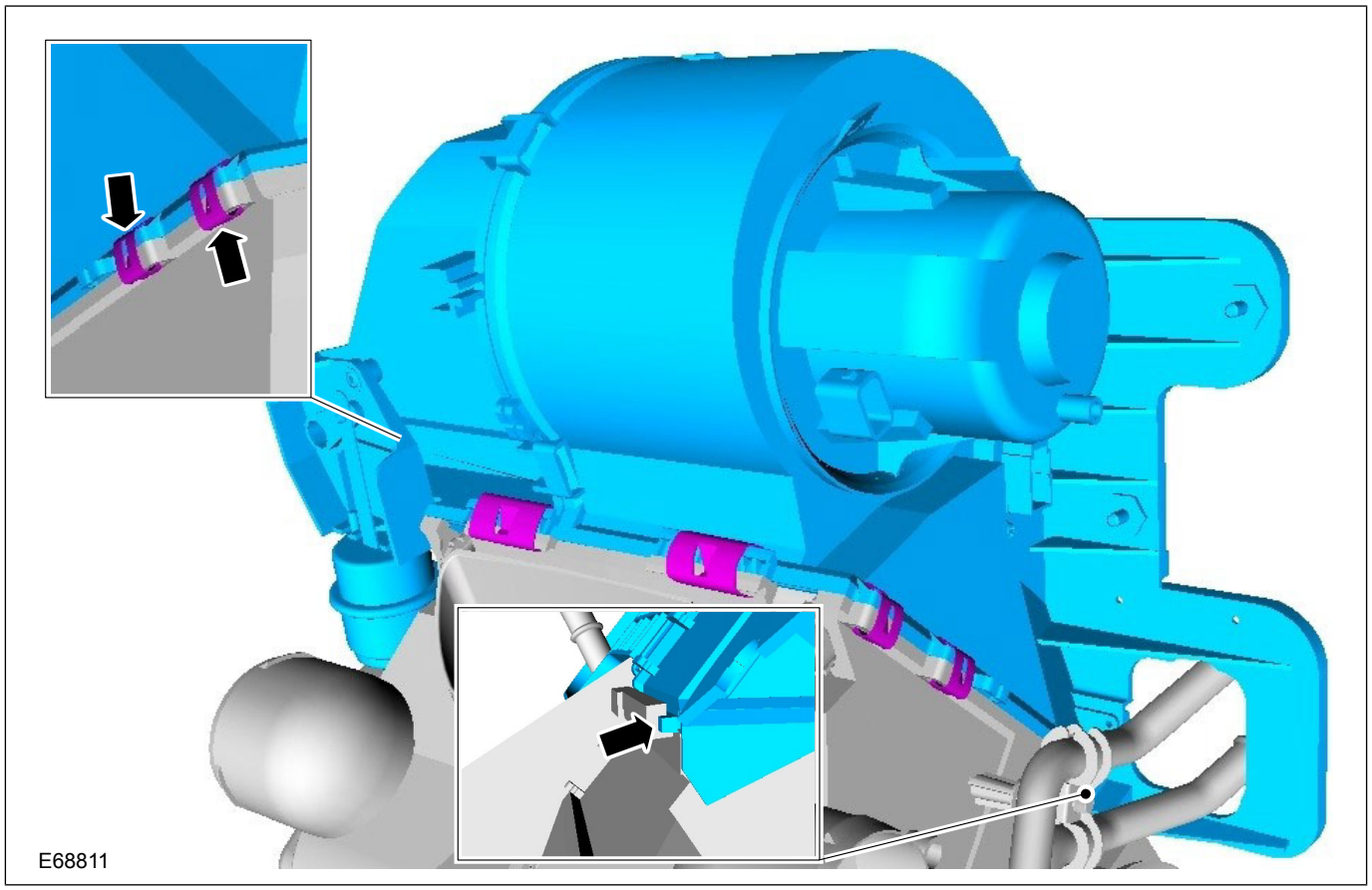


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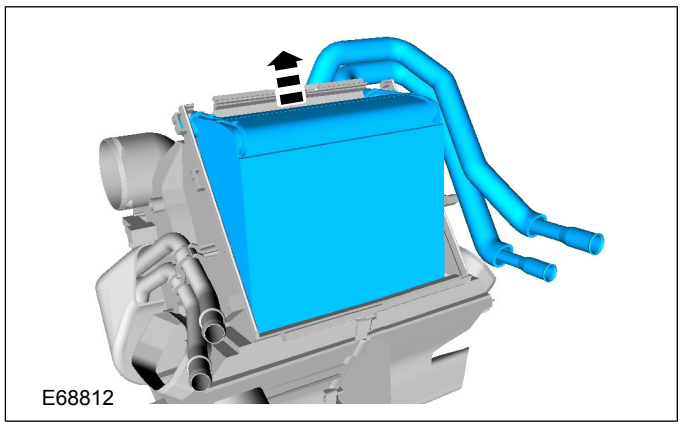


6.

REMOVAL AND INSTALLATION



7.



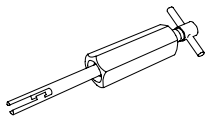
Installation

1. To install, reverse the removal procedure.

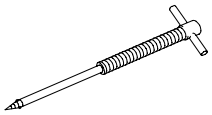
REMOVAL AND INSTALLATION

Evaporator Core Orifice

Special Tool(s)

 34004	Remover/Installer, Evaporator Core Orifice 412-034

Special Tool(s)

 34005	Remover, Damaged Evaporator Core Orifice 412-035

Materials	
Name	**Specification**
Refrigerant Oil	WSH-M1C231-B

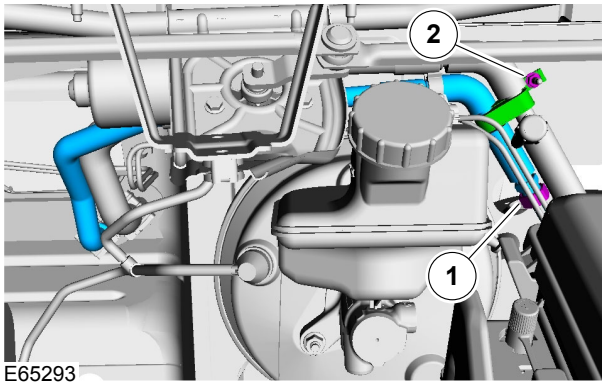
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Drain the air conditioning system.

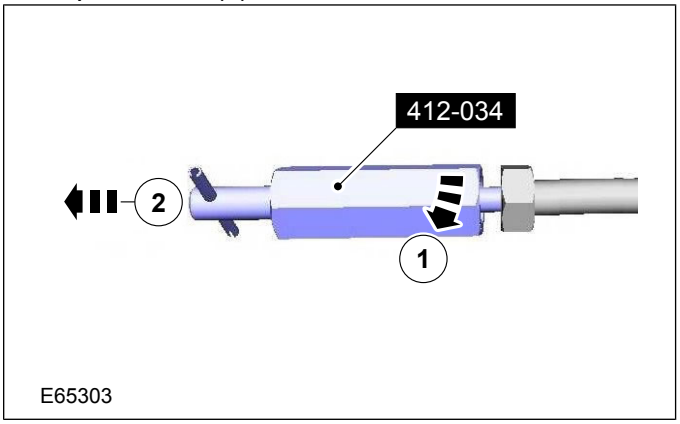
   Refer to:Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).

2. ⚠ **CAUTION:Make sure that all openings are sealed.**
   1. Torque: 25 Nm
   2. Torque: 8 Nm



E65293

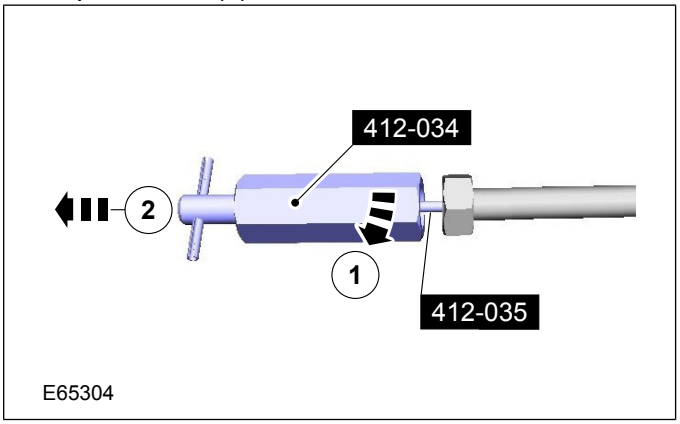
3. Special Tool(s): 412-034



E65303

4. **NOTE:**This step is necessary if the evaporator core orifice is broken.

   Special Tool(s): 412-034, 412-035



E65304

Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

2. Coat the O-rings for the refrigerant lines with clean refrigerant oil.

   Material: Refrigerant Oil

REMOVAL AND INSTALLATION

Suction Accumulator

Materials	
Name	**Specification**
Refrigerant Oil	WSH-M1C231-B

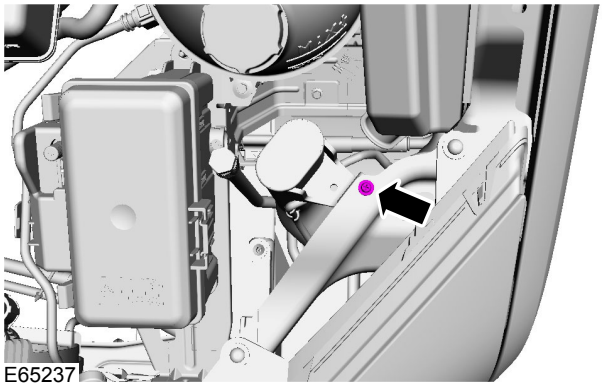
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Drain the air conditioning system.

   Refer to:Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).

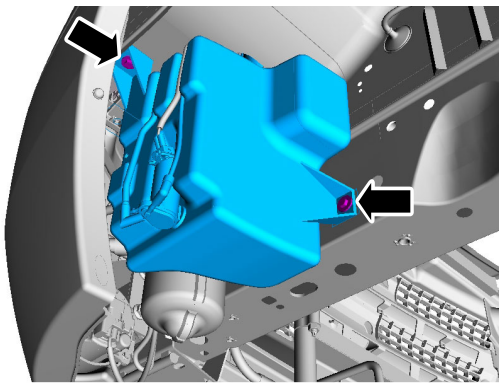
2.


E65237

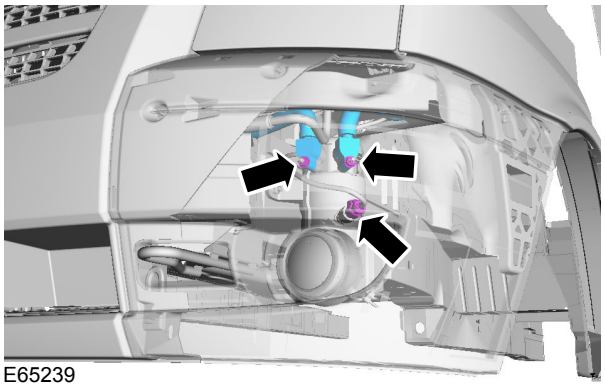
3. Raise the vehicle for access.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

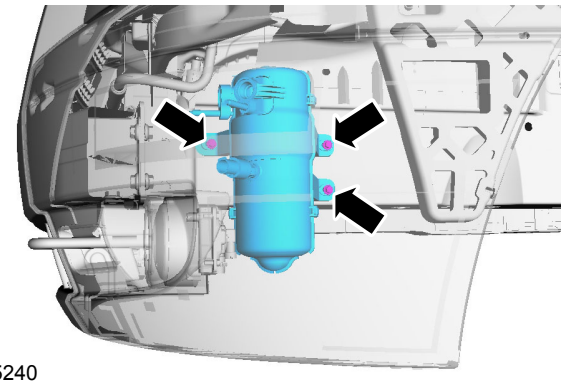
4. Detach the windshield wiper fluid reservoir from the side member and lay it to one side.


E65238

5. ⚠ **CAUTION:Make certain that all openings are sealed.**
   - Torque: 8 Nm


E65239

6. Torque: 25 Nm


E65240

Installation

1. To install, reverse the removal procedure.
2. Coat the O-rings for the refrigerant lines with clean refrigerant oil.

   Material: Refrigerant Oil

REMOVAL AND INSTALLATION

Low-Pressure Cutoff Switch

Materials	
Name	**Specification**
Refrigerant Oil	WSH-M1C231-B

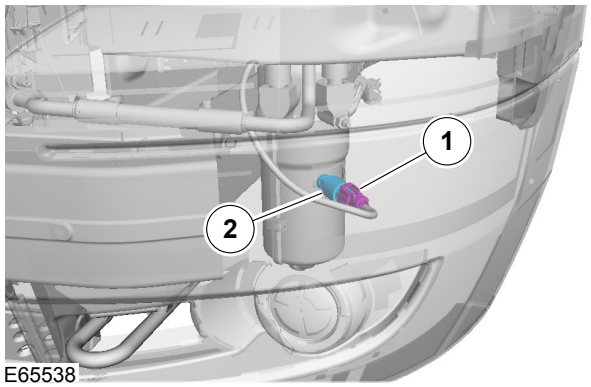
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Refer to:Air Conditioning (A/C) System Health and Safety Precautions (100-00 General Information, Description and Operation).
2. Remove the left-hand side headlamp.

   Refer to:Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).
3. **CAUTION:Make sure that the low-pressure cutoff switch valve closes completely after removal of the low-pressure cutoff switch.**

   Torque: 8 Nm



Installation

1. To install, reverse the assembly procedure.
2. Coat the low pressure switch O-rings with clean refrigerant oil before installation.

   Material: Refrigerant Oil

REMOVAL AND INSTALLATION

High-Pressure Cutoff Switch

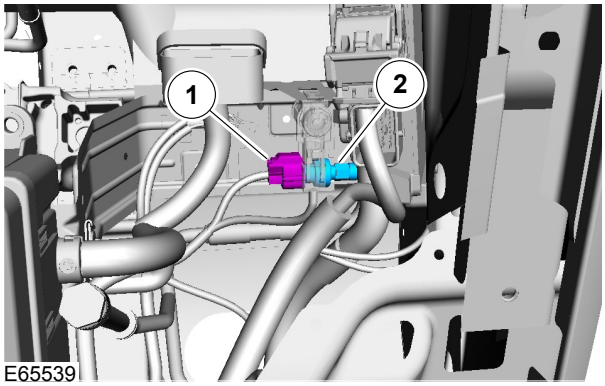
Materials	
Name	**Specification**
Refrigerant Oil	WSH-M1C231-B

Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Refer to:Air Conditioning (A/C) System Health and Safety Precautions (100-00 General Information, Description and Operation).
2. **CAUTION:Make sure that the high-pressure cutoff switch valve closes completely after removal of the high-pressure cutoff switch.**

   Torque: 8 Nm



Installation

1. To install, reverse the assembly procedure.
2. Lubricate the high-pressure cutoff switch O-rings with clean refrigerant oil before installation.

   Material: Refrigerant Oil

REMOVAL AND INSTALLATION

Condenser Core

Materials	
Name	Specification
Refrigerant Oil	WSH-M1C231-B

General Equipment

Cable ties

Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Drain the air conditioning system.

   Refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00).

2. Remove the front bumper cover.

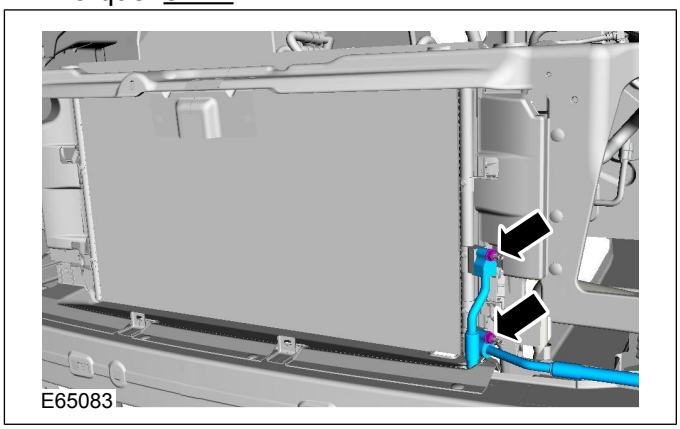
   Refer to:Front Bumper Cover (501-19 Bumpers, Removal and Installation).

3. Secure the radiator using cable ties.

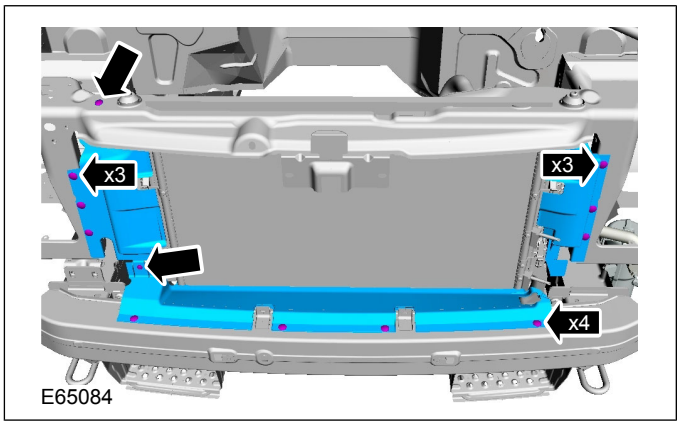
   General Equipment: Cable ties

4. **CAUTION:Make certain that all openings are sealed.**

   Torque: 8 Nm



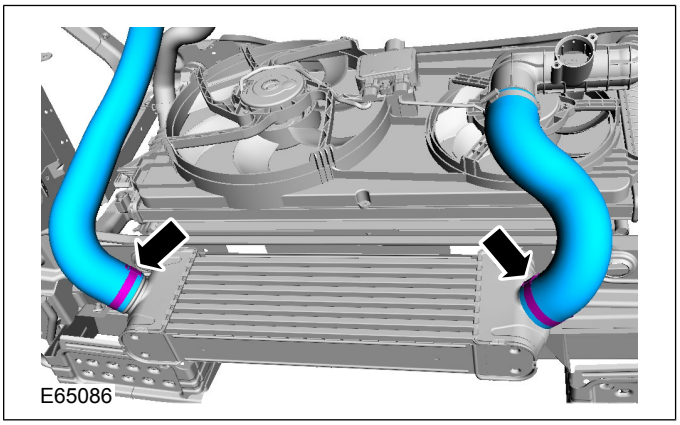
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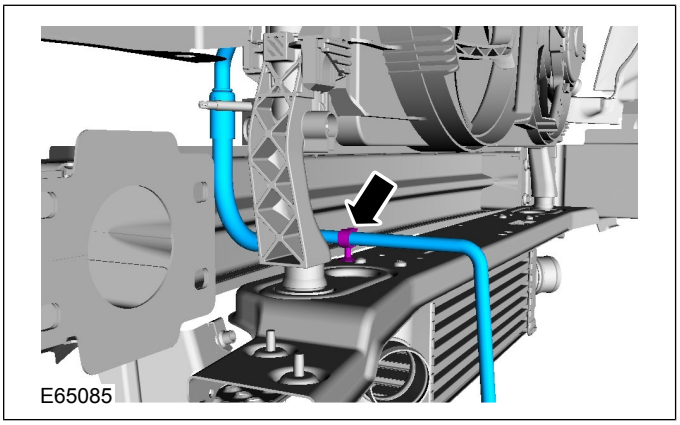
6. Raise the vehicle for access.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

7.

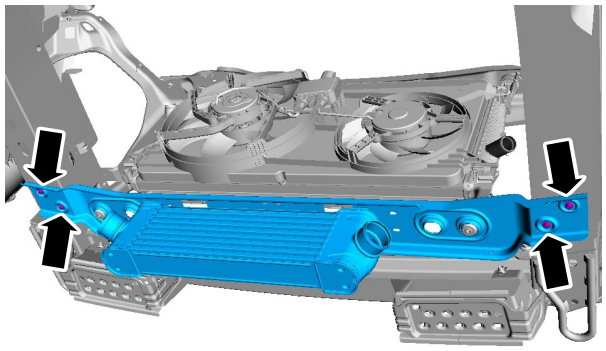


8.

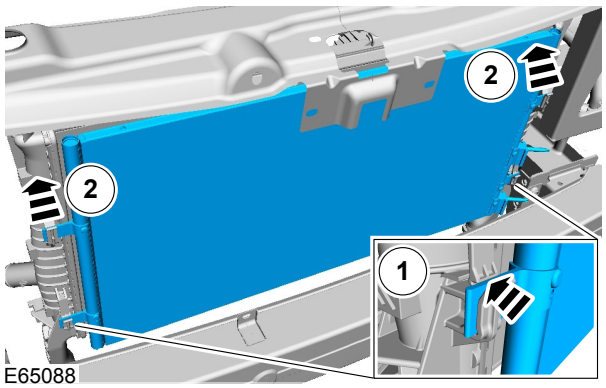


REMOVAL AND INSTALLATION

9. Torque: 25 Nm


E65087

10.



E65088

Installation

1. To install, reverse the removal procedure.
2. Coat the O-rings for the refrigerant lines with clean refrigerant oil.

   Material: Refrigerant Oil

REMOVAL AND INSTALLATION

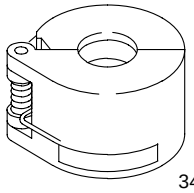
Compressor to Condenser Discharge Line — 2.4L Duratorq-TDCi (Puma) Diesel

1. Information not available at this time.

REMOVAL AND INSTALLATION

Condenser to Evaporator Line

Special Tool(s)

 34001	Disconnect Tool, Spring Lock Coupling (1/2" blue) 412-027

Special Tool(s)

Materials

Name	Specification
Refrigerant Oil	WSH-M1C231-B

Removal

NOTE: Removal steps in this procedure may contain installation details.

All vehicles

1. Drain the air conditioning system.

   Refer to:Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).

2. Remove the left-hand headlamp.

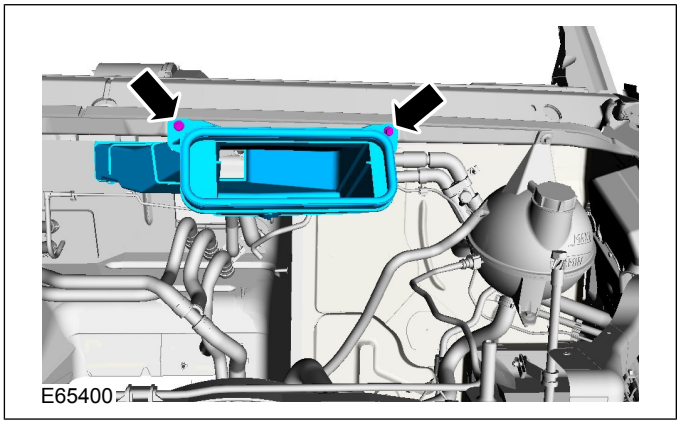
   Refer to:Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).

3. Remove the pump and reservoir of the windshield washer system.

   Refer to:Windshield Washer Pump and Reservoir - Van/Kombi/Bus (501-16 Wipers and Washers, Removal and Installation).
   Refer to:Windshield Washer Pump and Reservoir - Chassis Cab/Chassis Double Cab (501-16 Wipers and Washers, Removal and Installation).

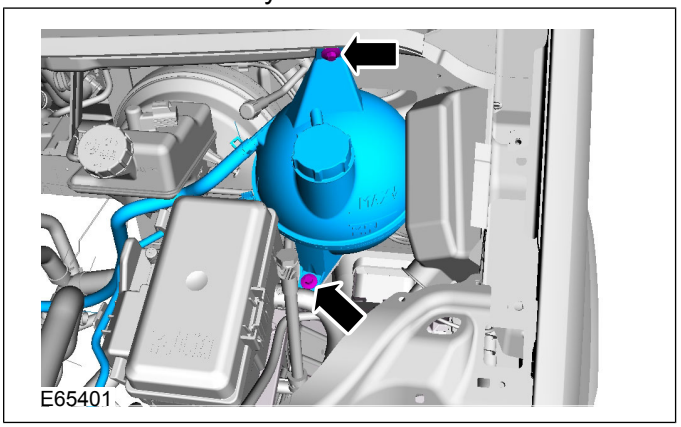
Right-hand drive vehicles

4.

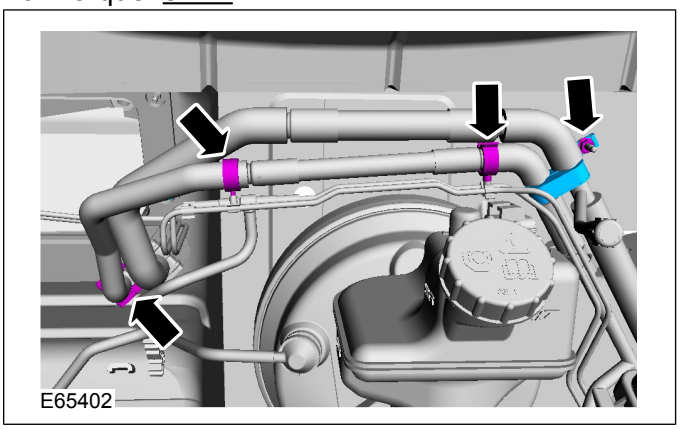


All vehicles

5. Detach the coolant expansion tank from the bulkhead and lay it to one side.

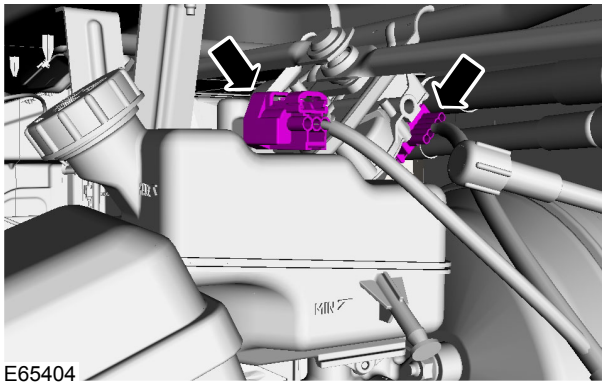


6. Torque: 8 Nm

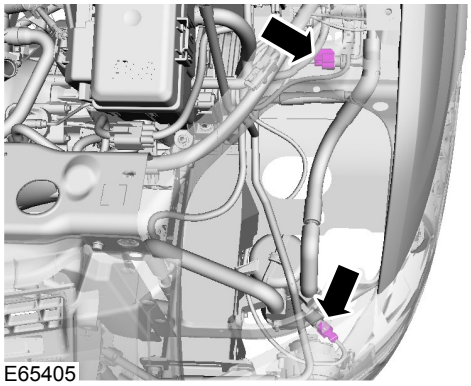


REMOVAL AND INSTALLATION

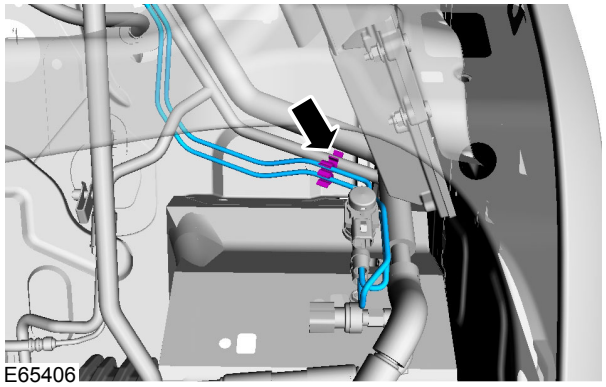
7.



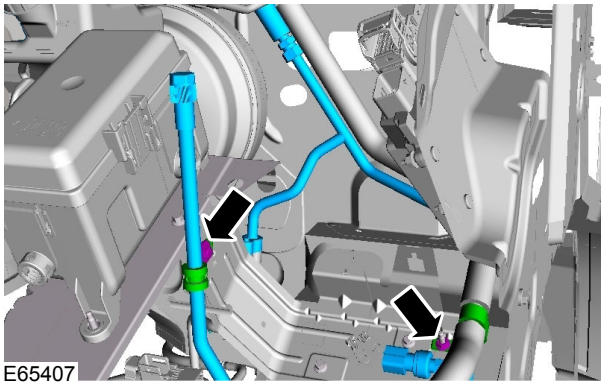
8.



9.

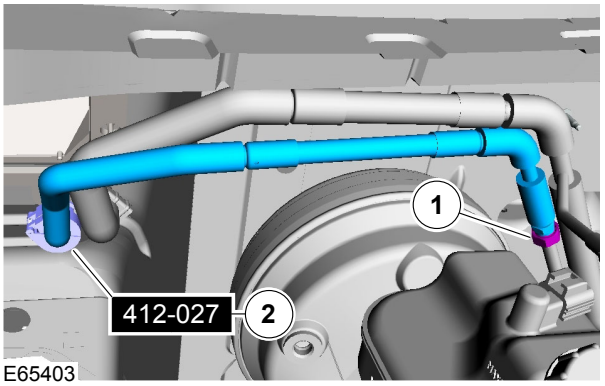


10. Torque: 8 Nm



11. ⚠ **CAUTION:Make certain that all openings are sealed.**

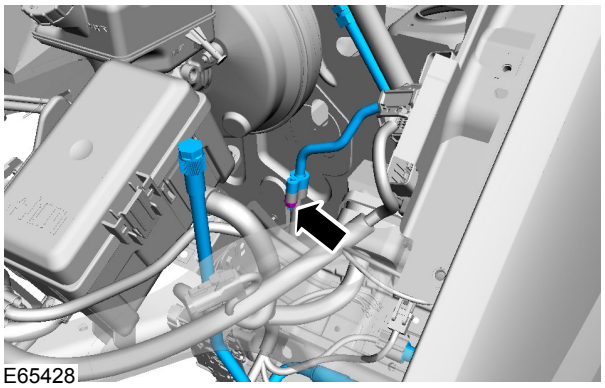
1. Torque: 25 Nm
2. Special Tool(s): 412-027



Vehicles with additional air conditioning system

12. ⚠ **CAUTION:Make certain that all openings are sealed.**

Torque: 8 Nm

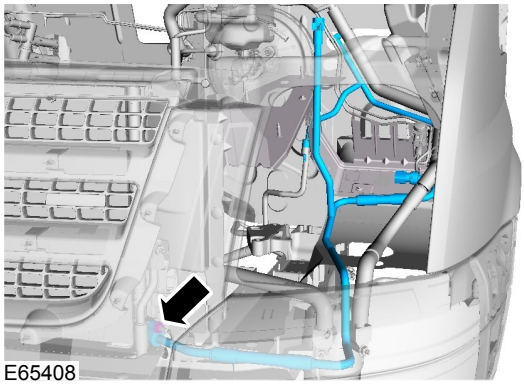


REMOVAL AND INSTALLATION

All vehicles

13. ⚠ **CAUTION:Make certain that all openings are sealed.**

    Torque: 8 Nm



Installation

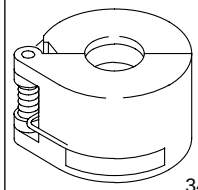
1. To install, reverse the removal procedure.
2. Coat the O-rings for the refrigerant lines with clean refrigerant oil.

   Material: Refrigerant Oil

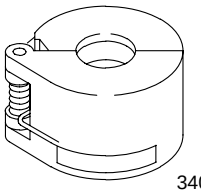
REMOVAL AND INSTALLATION

Evaporator Outlet Line

Special Tool(s)

 34001	Disconnect Tool, Spring Lock Coupling (1/2" blue) 412-027

Special Tool(s)

 34003	Disconnect Tool, Spring Lock Coupling (5/8" black) 412-038

Materials	
Name	**Specification**
Refrigerant Oil	WSH-M1C231-B

Removal

NOTE: Removal steps in this procedure may contain installation details.

All vehicles

1. Drain the air conditioning system.

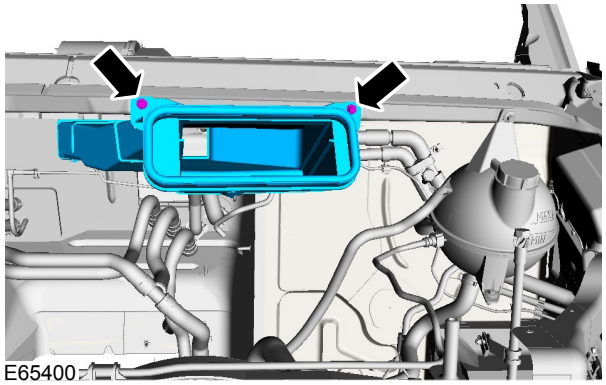
   Refer to:Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).

2. Remove the left-hand headlamp.

   Refer to:Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).

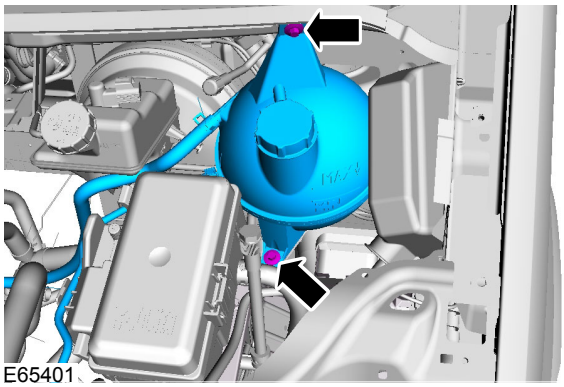
Right-hand drive vehicles

3.

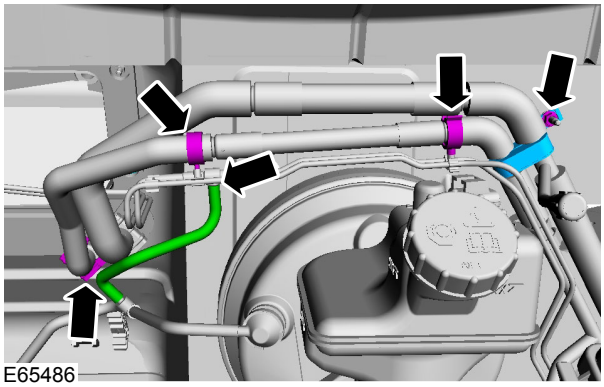


All vehicles

4. Detach the coolant expansion tank from the bulkhead and lay it to one side.

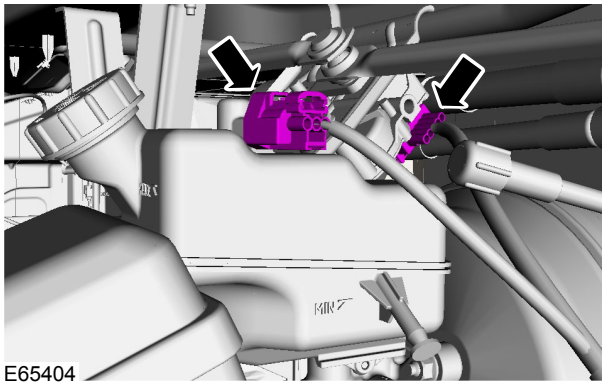


5. Torque: 8 Nm

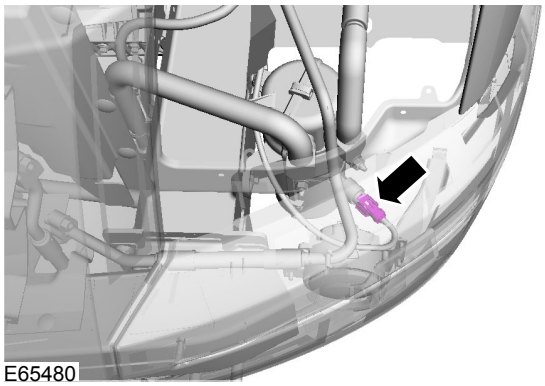


REMOVAL AND INSTALLATION

6.

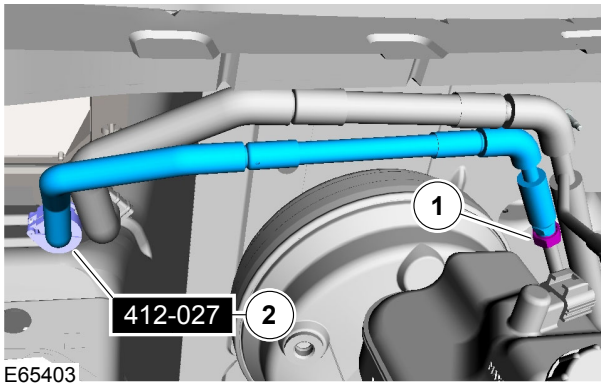


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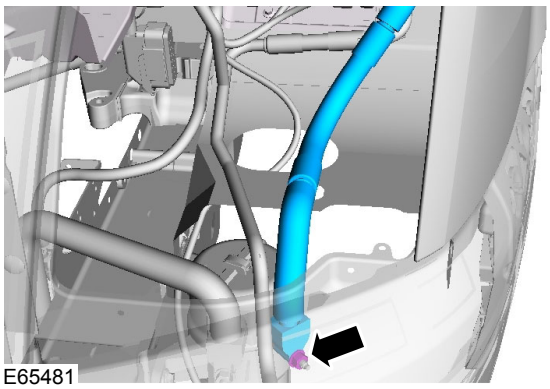
8. **CAUTION:Make certain that all openings are sealed.**

1. Torque: 25 Nm
2. Special Tool(s): 412-027

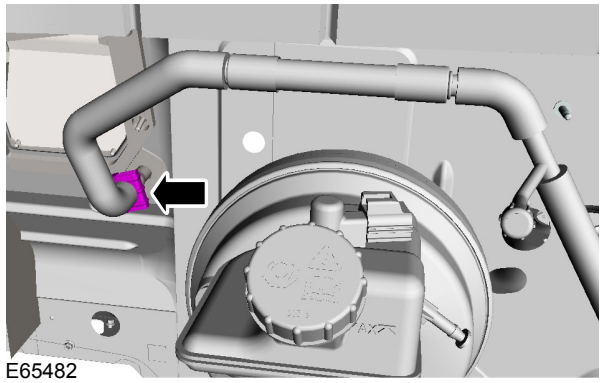


9. **CAUTION:Make certain that all openings are sealed.**

Torque: 8 Nm

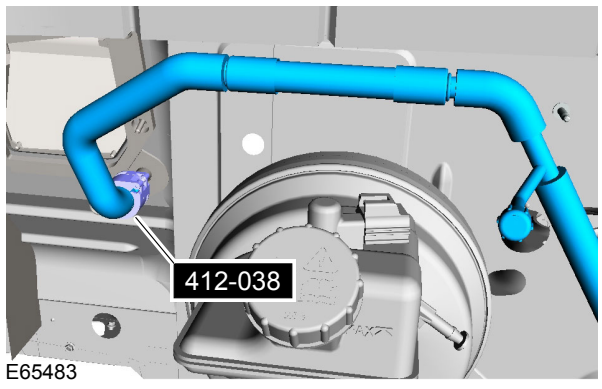


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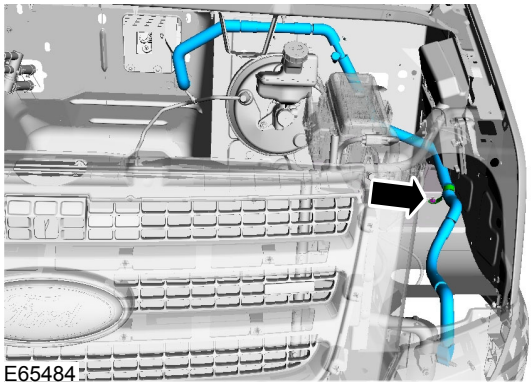
11. **CAUTION:Make certain that all openings are sealed.**

Special Tool(s): 412-038



REMOVAL AND INSTALLATION

12 Torque: 8 Nm



Installation

1. To install, reverse the removal procedure.
2. Coat the O-rings for the refrigerant lines with clean refrigerant oil.

   Material: Refrigerant Oil

REMOVAL AND INSTALLATION

Suction Accumulator to Compressor Line — 2.4L Duratorq-TDCi (Puma) Diesel

1. Information not available at this time.

REMOVAL AND INSTALLATION

Suction Accumulator to Condenser Line — 2.3L Duratec-HE (MI4)

1. **Information not available at this time.**

SECTION 412-03B Auxiliary Climate Control

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Auxiliary Climate Control 412-03B-2
Refrigerant circuit 412-03B-2
Overview - air conditioning system 412-03B-3

DIAGNOSIS AND TESTING

Auxiliary Climate Control 412-03B-4

REMOVAL AND INSTALLATION

Auxiliary Climate Control Housing 412-03B-5
Auxiliary Blower Motor 412-03B-6
Evaporator Core 412-03B-7
Thermostatic Expansion Valve 412-03B-8
Auxiliary Evaporator Inlet Line 412-03B-9
Auxiliary Evaporator Outlet Line 412-03B-10
Auxiliary Evaporator Front Outlet and Inlet Line 412-03B-11
Auxiliary Evaporator Rear Outlet and Inlet Line 412-03B-12

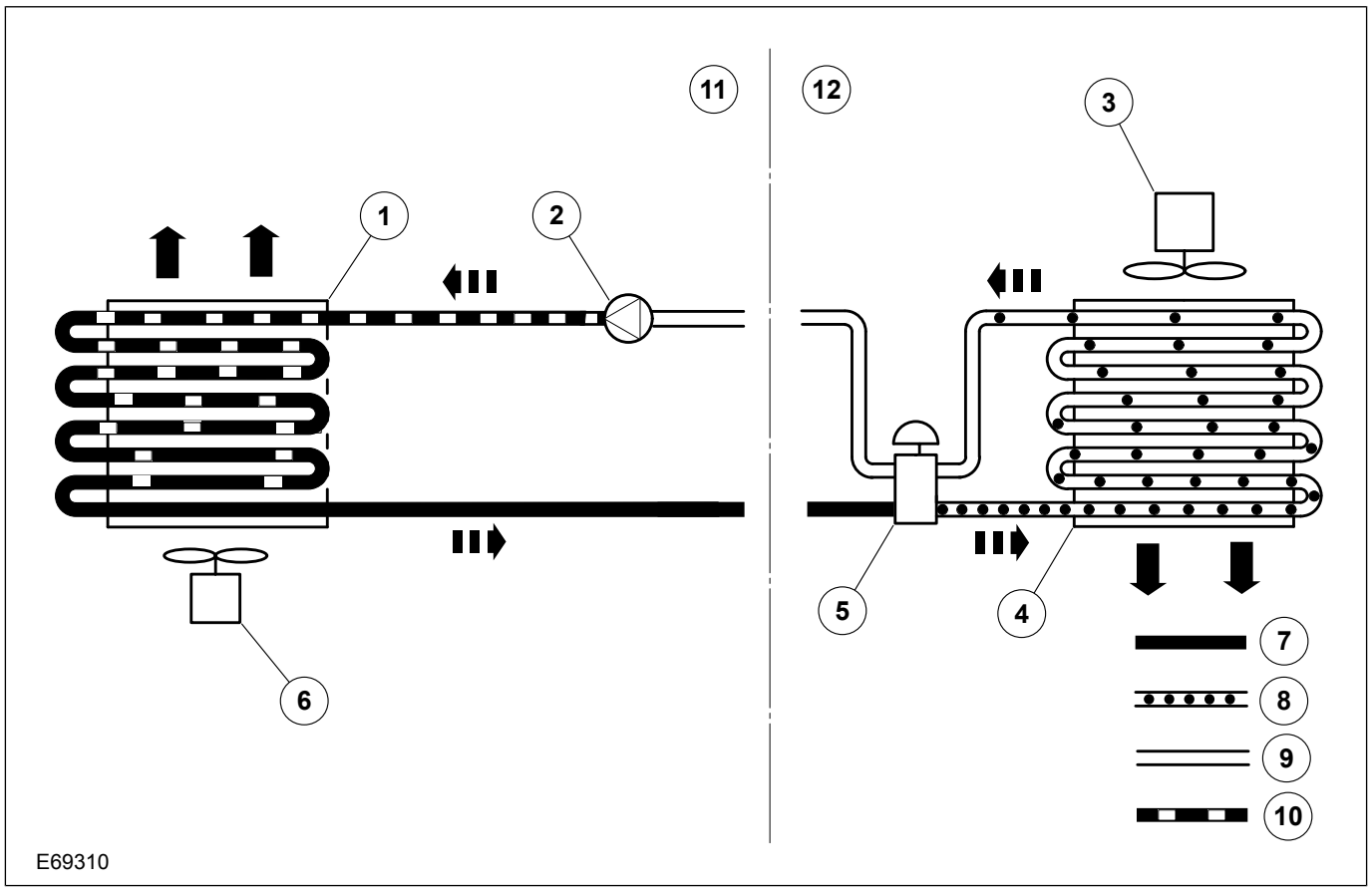
DISASSEMBLY AND ASSEMBLY

Auxiliary Climate Control Housing 412-03B-13

DESCRIPTION AND OPERATION

Auxiliary Climate Control

Refrigerant circuit



Item	Description
1	Condenser
2	A/C compressor
3	Blower motor
4	Additional evaporator
5	Expansion valve
6	Cooling fan
7	High pressure (liquid and warm)
8	Low pressure (liquid and cool)
9	Low pressure (gaseous and cold)
10	High pressure (gaseous and hot)

Item	Description
11	Front air conditioning system
12	Additional air conditioning system

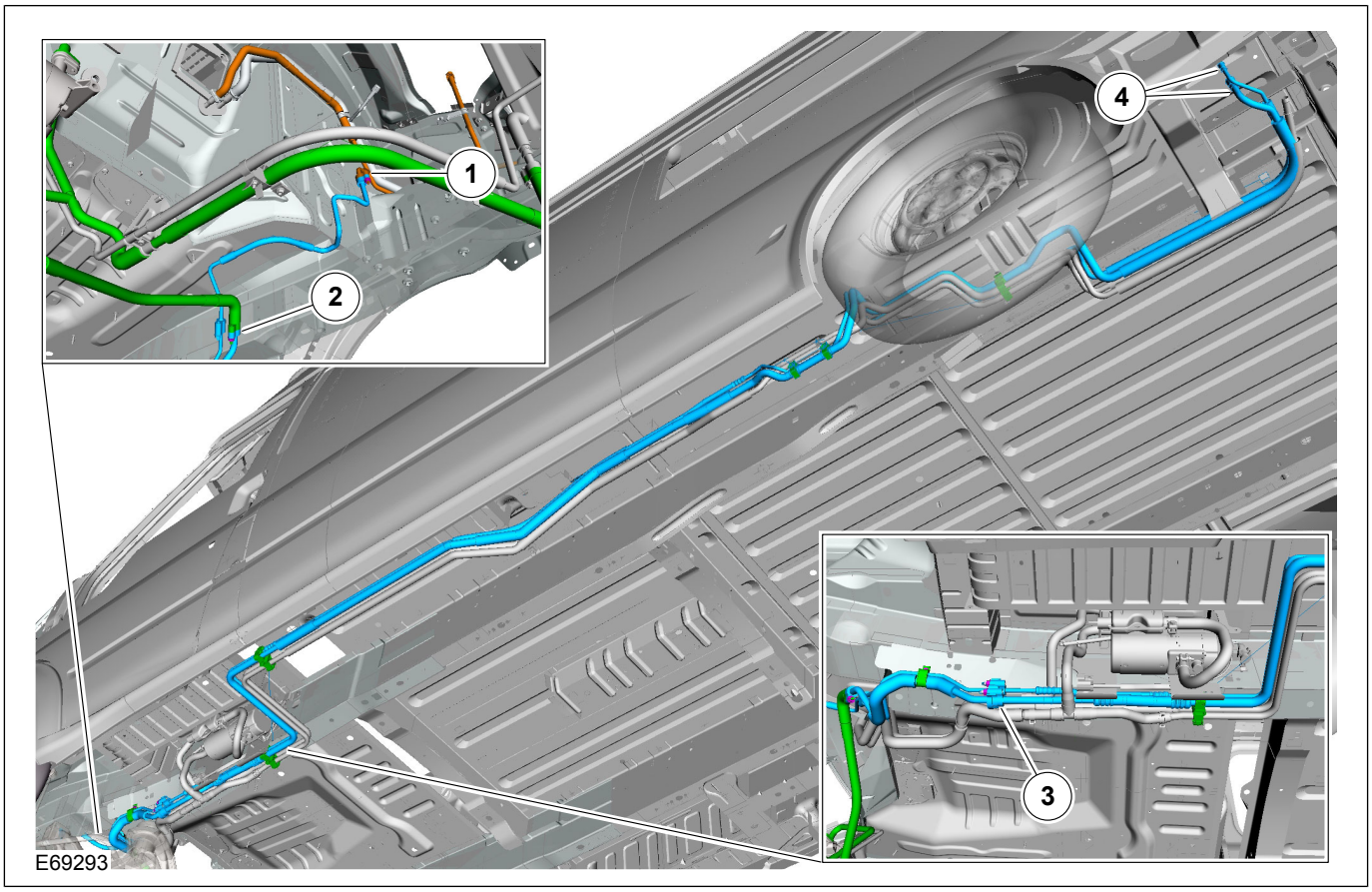
The refrigerant required for the rear circuit is taken in liquid form from the front circuit before the fixed orifice tube and passed to the expansion valve (5) of the rear circuit.

The expansion valve controls the quantity of refrigerant entering the additional evaporator (4) depending on the temperature and pressure in the additional evaporator.

The refrigerant leaves the additional evaporator in the gaseous state and is passed back into the front circuit through the expansion valve.

DESCRIPTION AND OPERATION

Overview - air conditioning system



Item	Description
1	High-pressure pipe
2	Low-pressure pipe
3	Separation point
4	Evaporator connections

DIAGNOSIS AND TESTING

Auxiliary Climate Control

REFER to: Climate Control System (412-00, Diagnosis and Testing).

REMOVAL AND INSTALLATION

Auxiliary Climate Control Housing

Removal

1. Additional air conditioning system housing.
   Refer to: (412-02B, Removal and Installation).

Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Auxiliary Blower Motor

Removal

1. Remove the blower motor.

   Refer to: Auxiliary Blower Motor (412-02B, Removal and Installation).

Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

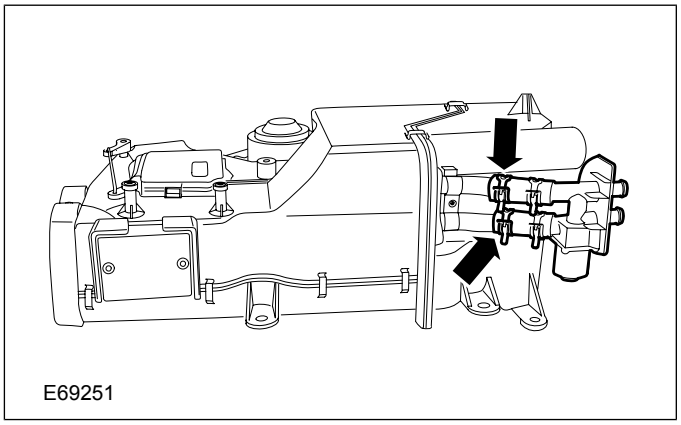
Evaporator Core

Removal

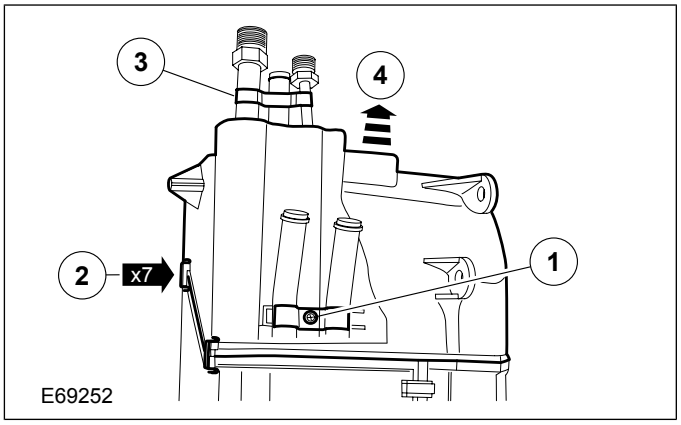
1. Remove the additional climate control housing.

   Refer to:Auxiliary Climate Control Housing (412-03 Auxiliary Climate Control, Removal and Installation).

2.



3.



4. Remove the evaporator.

Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Thermostatic Expansion Valve

Materials	
Name	**Specification**
Refrigerant Oil	WSH-M1C231-B

General Equipment

Cable ties

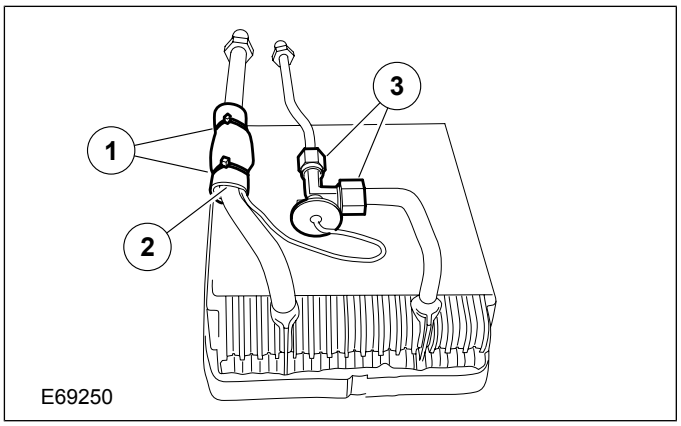
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Remove the evaporator.

   Refer to:Evaporator Core (412-03 Auxiliary Climate Control, Removal and Installation).

2. **CAUTION:Make sure that all openings are sealed.**
   1. General Equipment: Cable ties
   2. Detach the control line from the refrigerant line.
   3. Torque: 8 Nm



Installation

1. To install, reverse the removal procedure.
2. Coat the O-rings for the refrigerant lines with clean refrigerant oil.

   Material: Refrigerant Oil

REMOVAL AND INSTALLATION

Auxiliary Evaporator Inlet Line

1. Information not available at this time.

REMOVAL AND INSTALLATION

Auxiliary Evaporator Outlet Line

1. Information not available at this time.

REMOVAL AND INSTALLATION

Auxiliary Evaporator Front Outlet and Inlet Line

1. **Information not available at this time.**

REMOVAL AND INSTALLATION

Auxiliary Evaporator Rear Outlet and Inlet Line

1. **Information not available at this time.**

DISASSEMBLY AND ASSEMBLY

Auxiliary Climate Control Housing

Disassembly

1. Disassemble the additional air conditioning system housing.

   Refer to: (412-02B, Disassembly and Assembly).

Assembly

2. To install, reverse the removal procedure.

SECTION 412-04 Control Components

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Control Components 412-04-2
Climate control Assembly 412-04-2
Overview of the heater/evaporator housing 412-04-3

DIAGNOSIS AND TESTING

Control Components 412-04-5

REMOVAL AND INSTALLATION

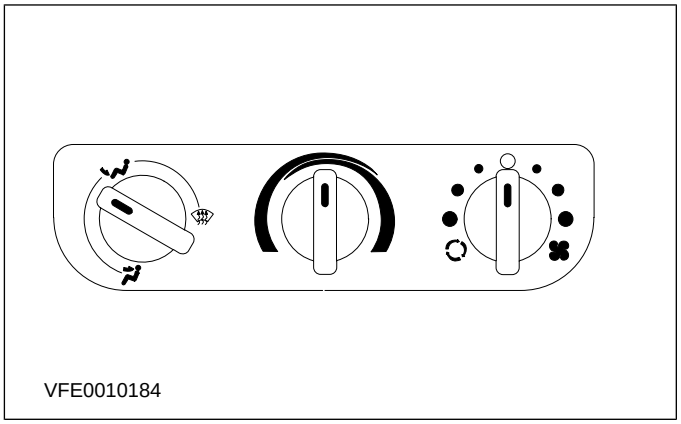
Climate Control Assembly — Vehicles With: Air Conditioning 412-04-6
Climate Control Assembly — Vehicles Without: Air Conditioning 412-04-8
Blower Motor Resistor 412-04-10
Air Inlet Blend Door Actuator — Vehicles With: Air Conditioning 412-04-12
Air Inlet Blend Door Actuator — Vehicles Without: Air Conditioning 412-04-20
Temperature Blend Door Actuator 412-04-21

DESCRIPTION AND OPERATION

Control Components

Climate control Assembly

Vehicles without air conditioning



VFE0010184

The climate control assembly is located on the instrument panel center console.

The blower speed, interior temperature and air distribution are controlled here via three rotary knobs.

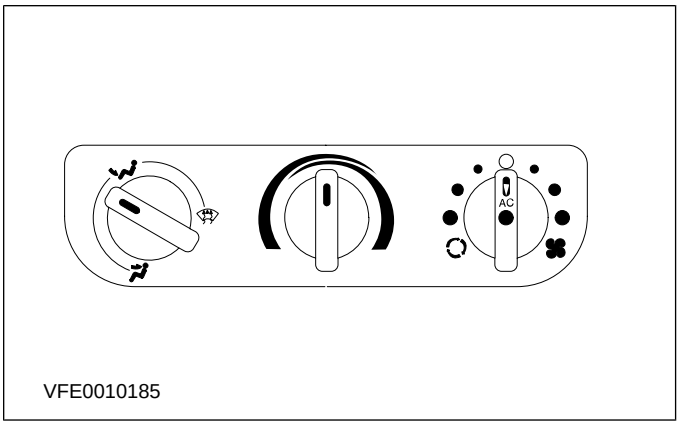
Movement of the air distribution flaps is performed by the air distribution flap actuating unit, which is connected via a cable to the control assembly.

Movement of the temperature flap is performed by the temperature flap control unit, which is also connected via a cable to the control assembly.

The blower switch is connected to a three-stage blower resistor, as a result of which four blower motor settings can be selected.

In addition, the operating switch for air recirculation mode is also integrated in the blower switch. When the air recirculation switch is operated, the vacuum-controlled actuator for the air recirculation flap is actuated and opens or closes the air recirculation flap.

Vehicles with air conditioning



VFE0010185

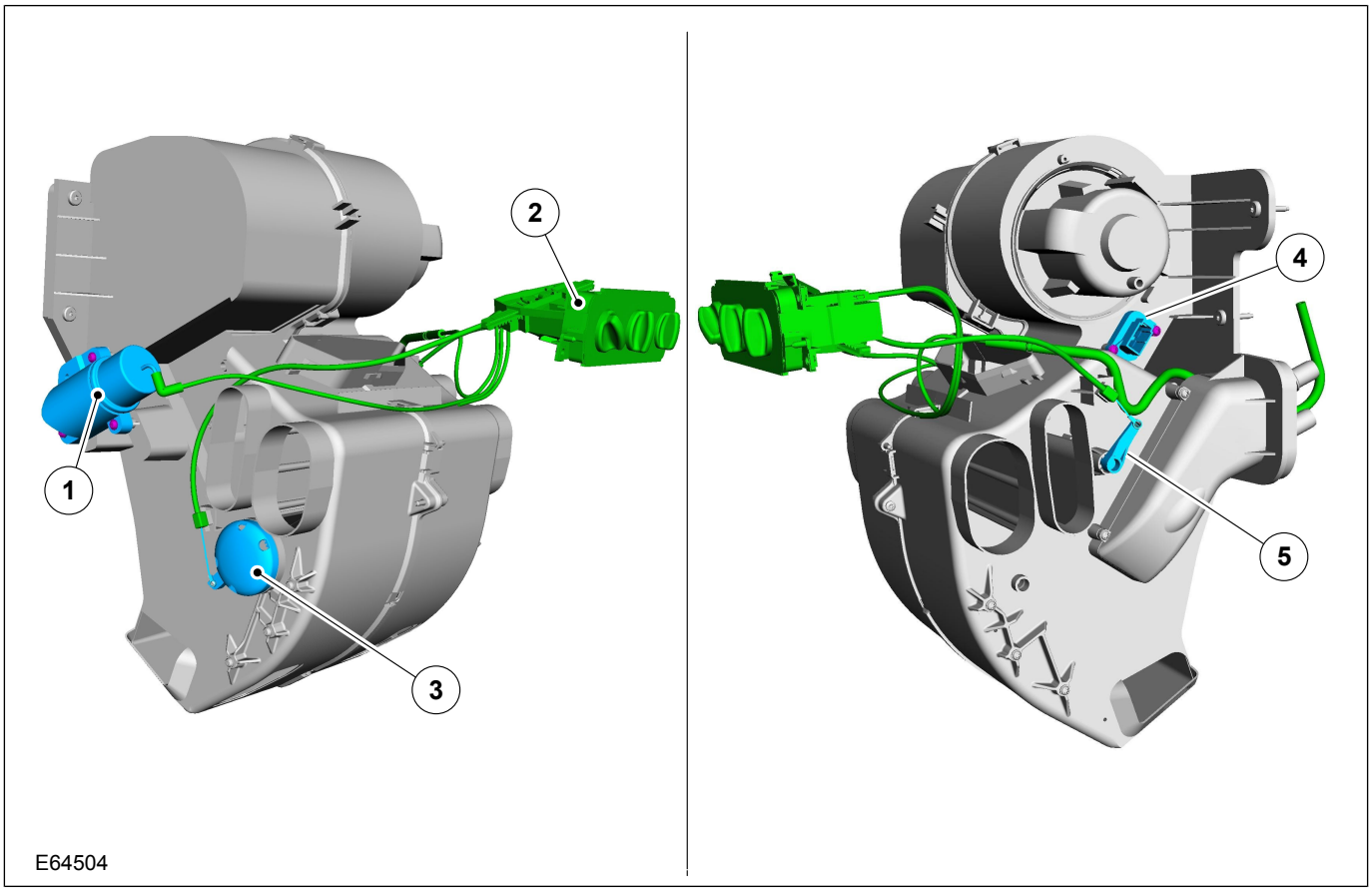
The climate control assembly on vehicles with air conditioning is different in that it has an on/off switch for the air conditioning which is integrated in the blower switch.

In addition, the temperature flap is actuated via the temperature switch, which is electrically connected to the temperature control flap actuator.

DESCRIPTION AND OPERATION

Overview of the heater/evaporator housing

Vehicles equipped with manual temperature control

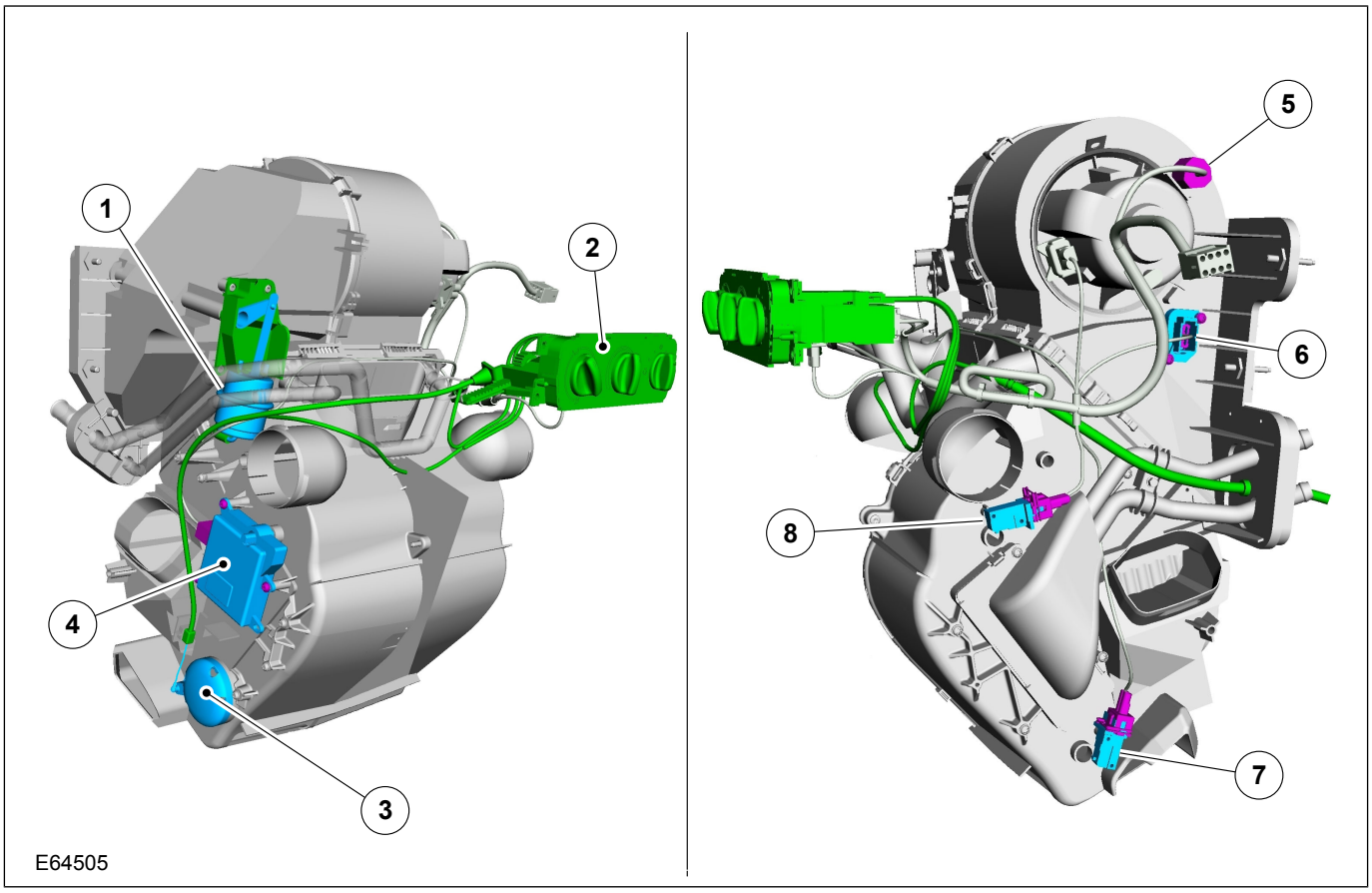


Item	Description
1	Actuator – recirculated air flap
2	Climate control Assembly

Item	Description
3	Air distribution flap actuation
4	Blower motor resistor
5	Operating lever - temperature control flap

DESCRIPTION AND OPERATION

Overview - heater/evaporator housing - vehicles equipped with automatic temperature control



Item	Description
1	Actuator – recirculated air flap
2	Climate control Assembly
3	Air distribution flap actuation
4	Temperature control flap actuator
5	Relay – blower motor
6	Blower motor resistor
7	Compressor defroster switch
8	Maximum cooling switch

The compressor defroster switch switches the air conditioning to the defrost setting when the air distribution flap is at full deflection. It also switches the blower motor to level 1 via the blower motor relay if the blower motor switch is set to "0".

When the temperature flap is at full deflection in the "cold" position, the maximum cooling switch switches off the coolant flow through the heater radiator via the coolant shutoff valve.

DIAGNOSIS AND TESTING

Control Components

REFER to: Climate Control System (412-00, Diagnosis and Testing).

REMOVAL AND INSTALLATION

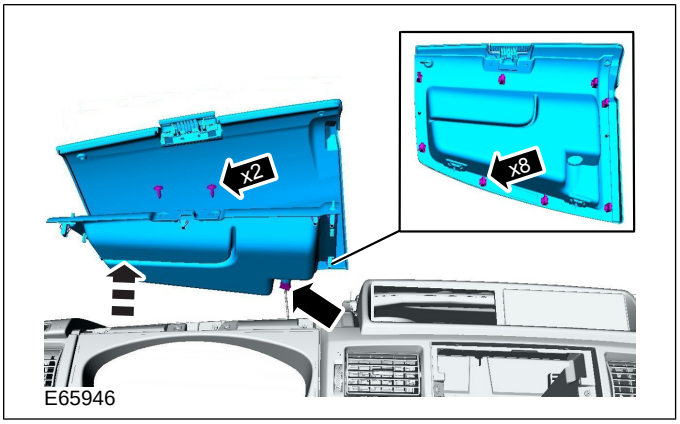
Climate Control Assembly — Vehicles With: Air Conditioning

Removal

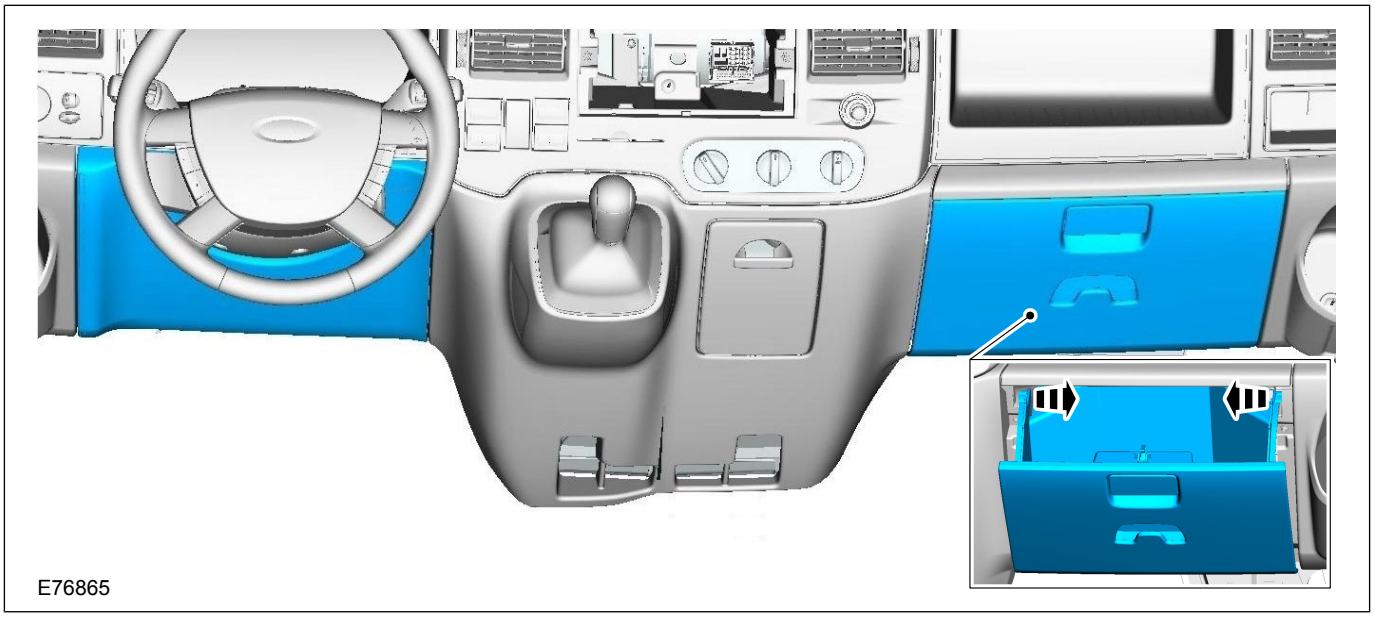
1. Remove the audio unit.

Refer to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation).

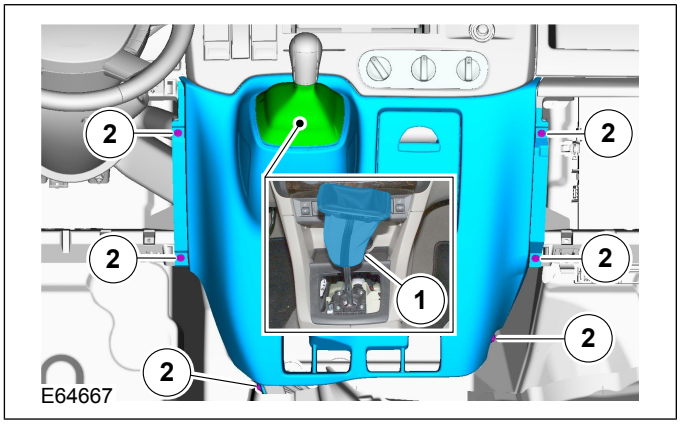
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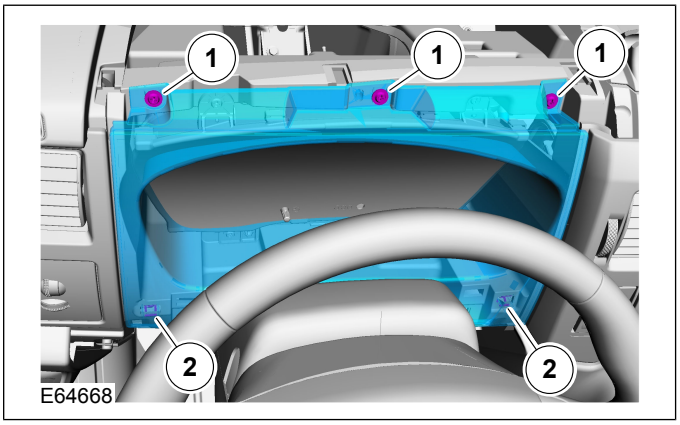
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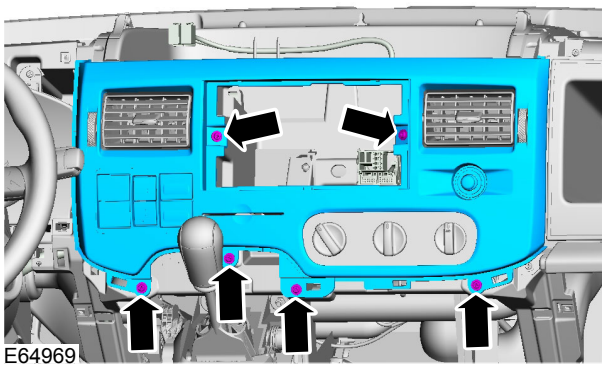


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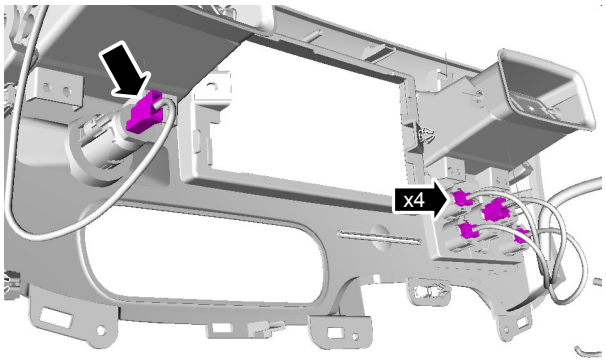


REMOVAL AND INSTALLATION

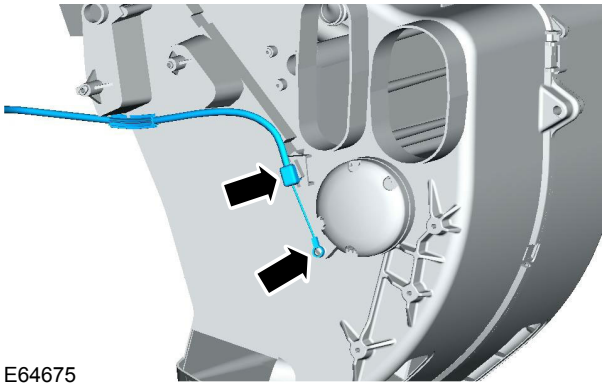
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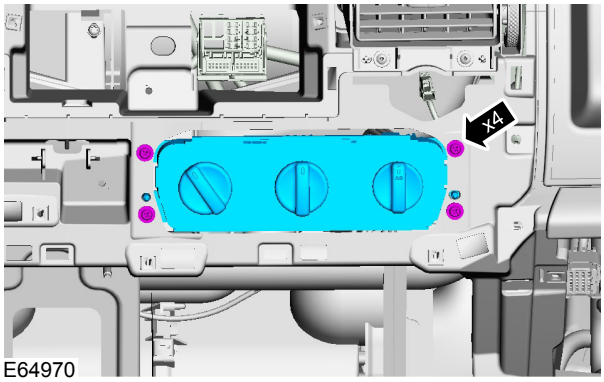
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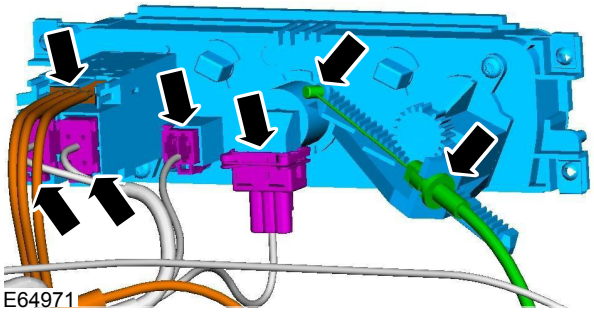
8.



9.



10.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

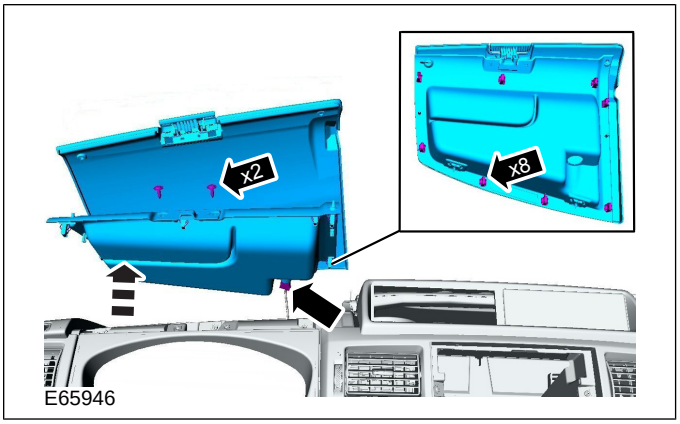
Climate Control Assembly — Vehicles Without: Air Conditioning

Removal

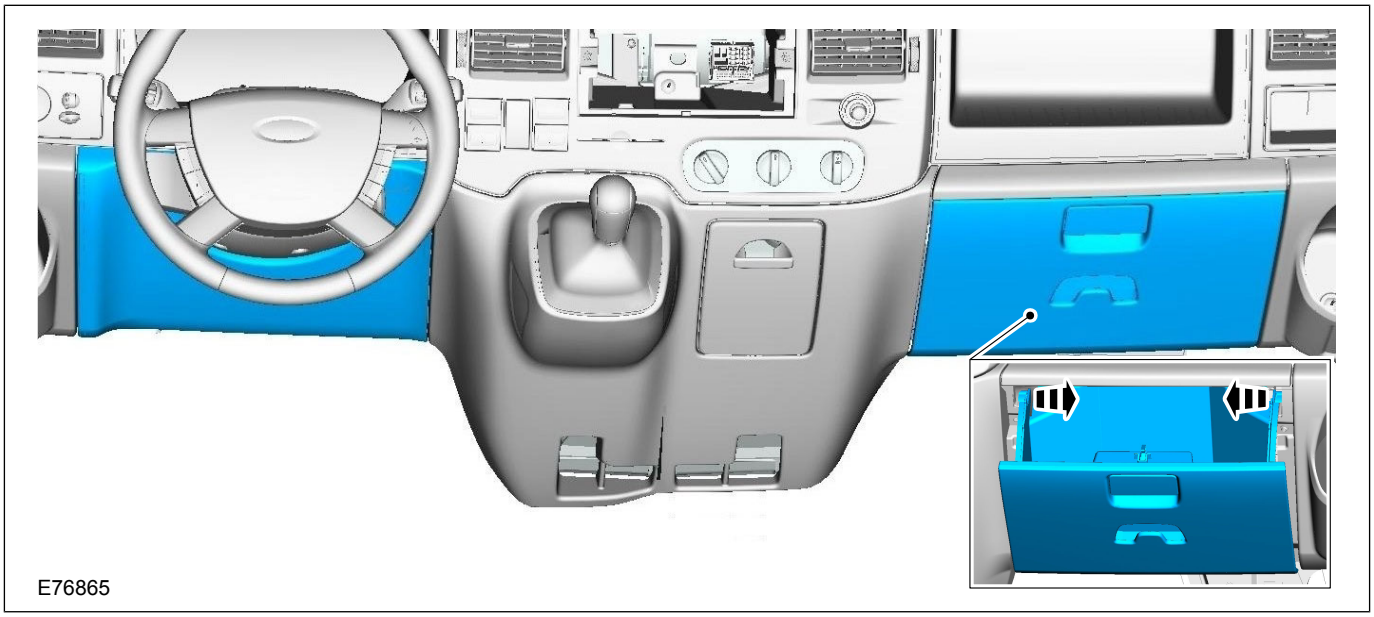
1. Remove the audio unit.

   Refer to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation).

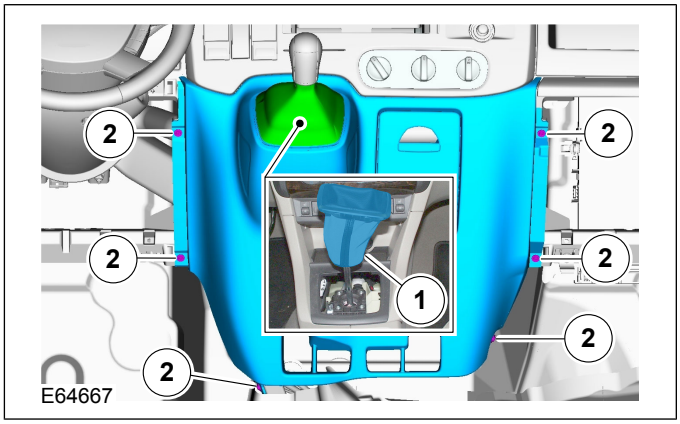
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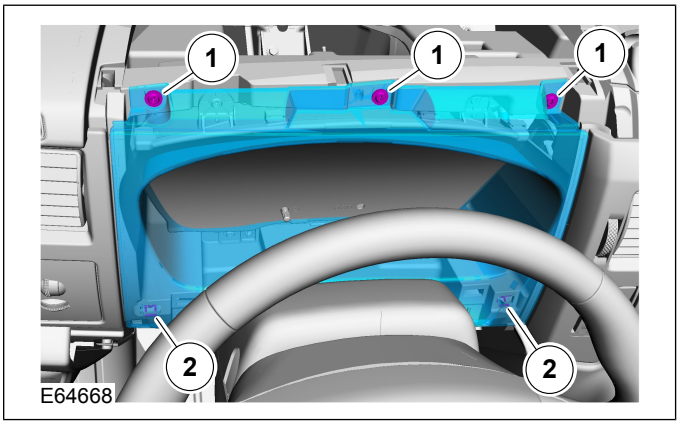
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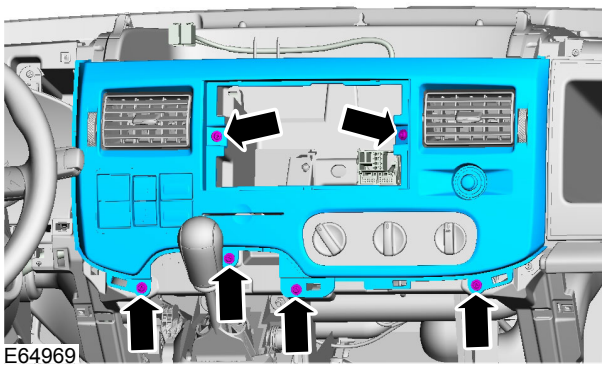


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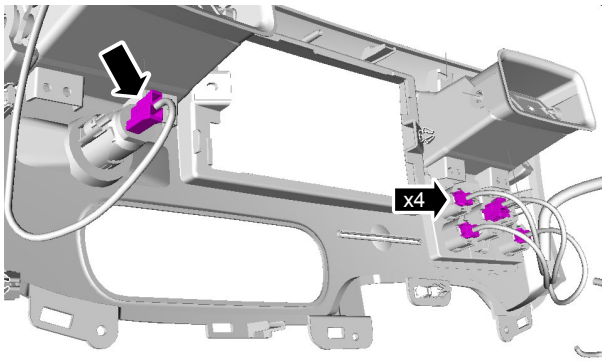


REMOVAL AND INSTALLATION

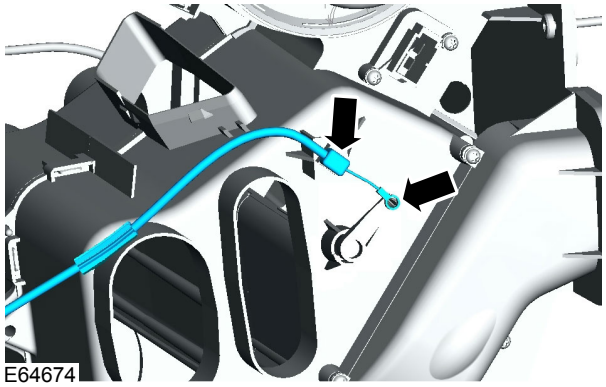
6.



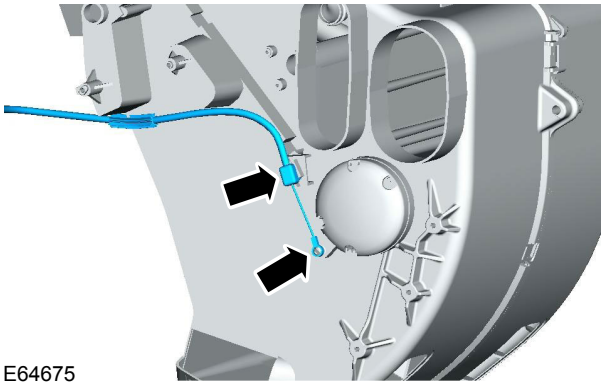
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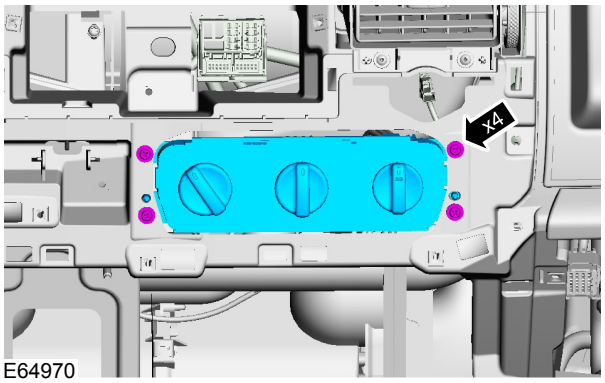
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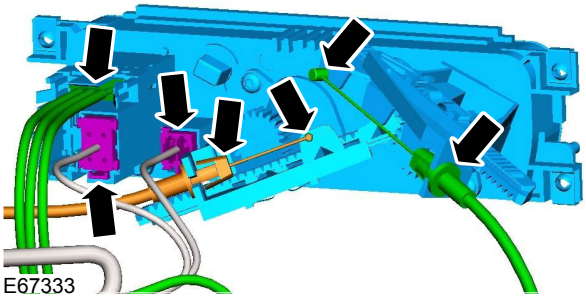
9.



10.



11.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

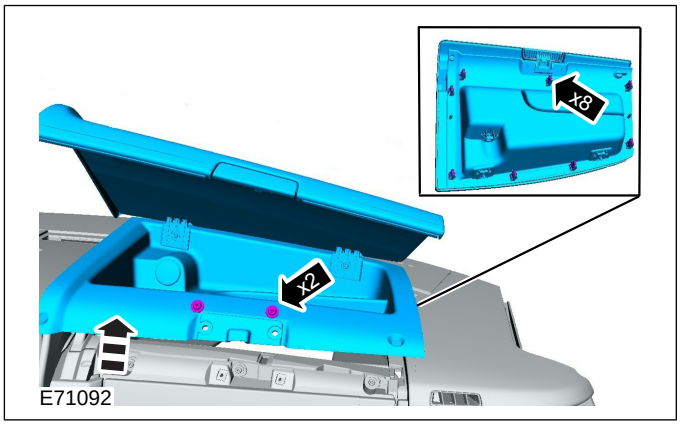
Blower Motor Resistor

Removal

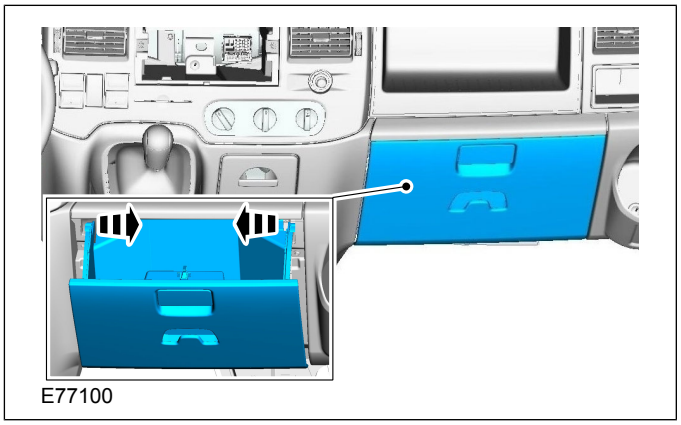
NOTE: Removal steps in this procedure may contain installation details.

Left-hand drive vehicles

1.

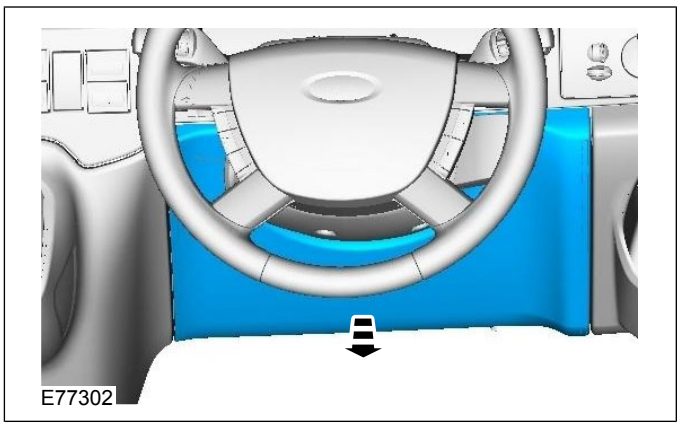


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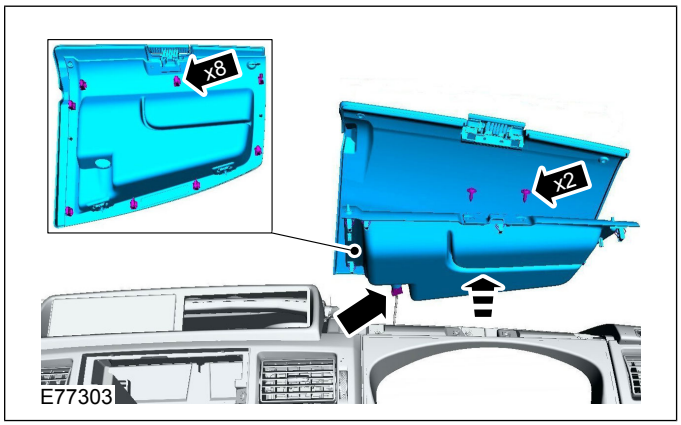


Right-hand drive vehicles

3.

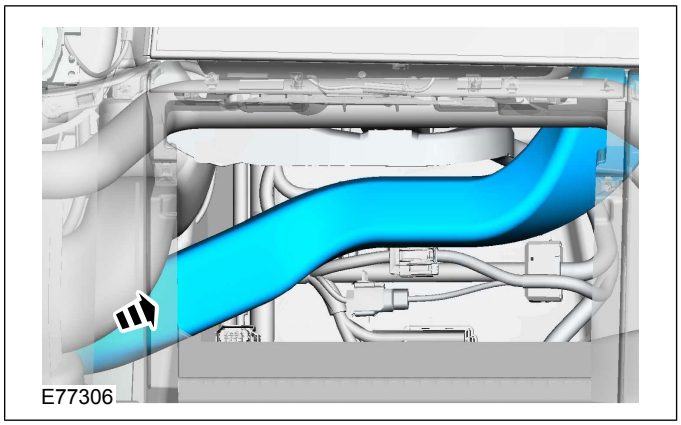


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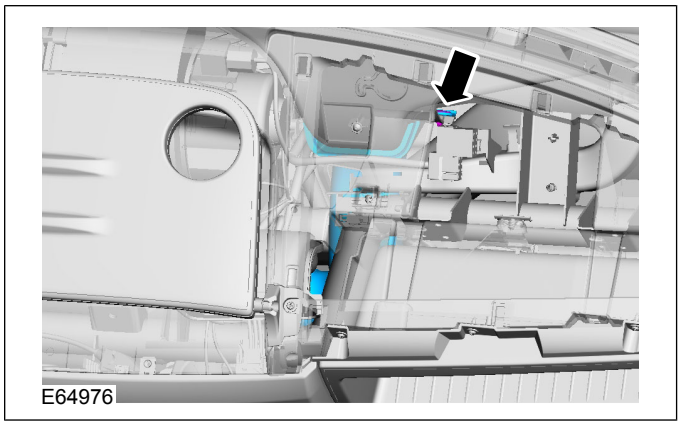


All Vehicles

5.

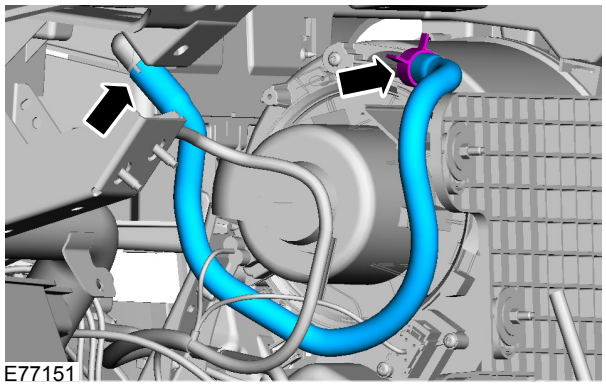


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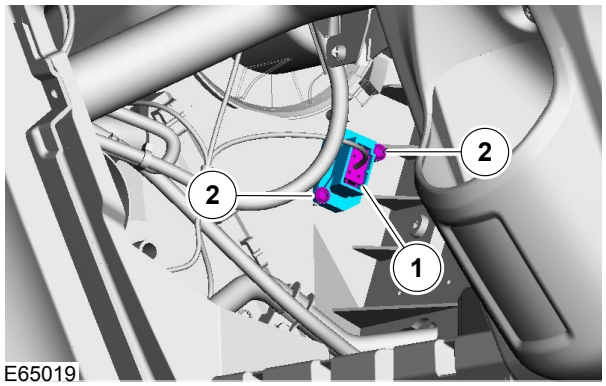


REMOVAL AND INSTALLATION

7.



8.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Air Inlet Blend Door Actuator — Vehicles With: Air Conditioning

Removal

All Vehicles

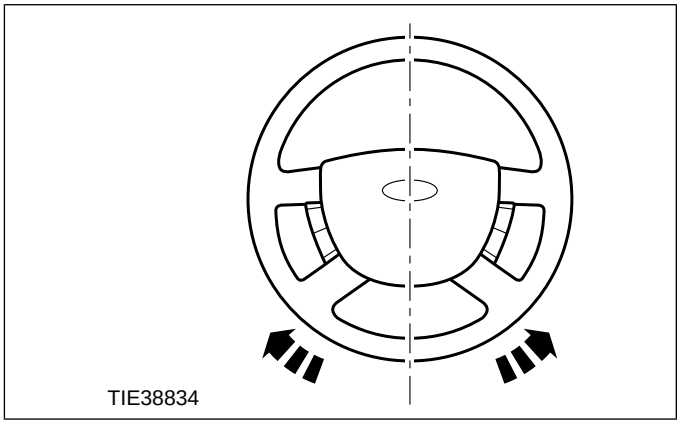
NOTE: Removal steps in this procedure may contain installation details.

1. Refer to:Supplemental Restraint System (SRS) Health and Safety Precautions (100-00 General Information, Description and Operation).
2. Disconnect the battery ground cable.

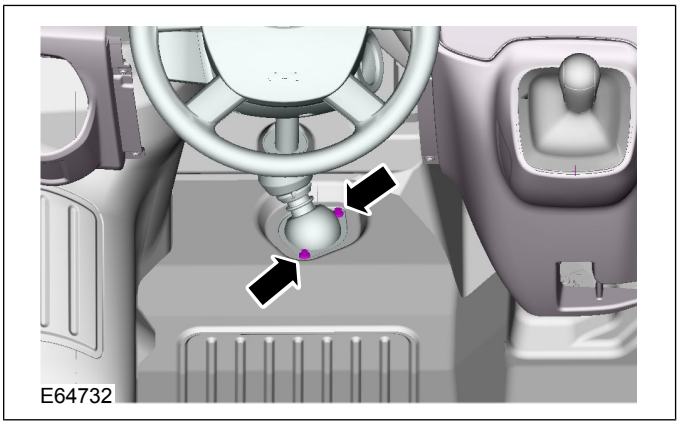
   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).
3. Remove the audio unit.

   Refer to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation).
4. Remove the left and right-hand A-pillar trim.

   Refer to:A-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
5. **NOTE:**Make sure that the road wheels are in the straight ahead position.

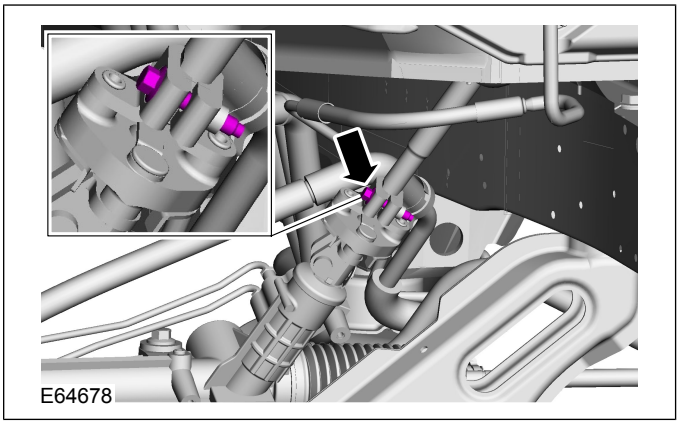


6. • Pull the footwell carpet to one side.
   • Torque: 12 Nm



7. Raise the vehicle.

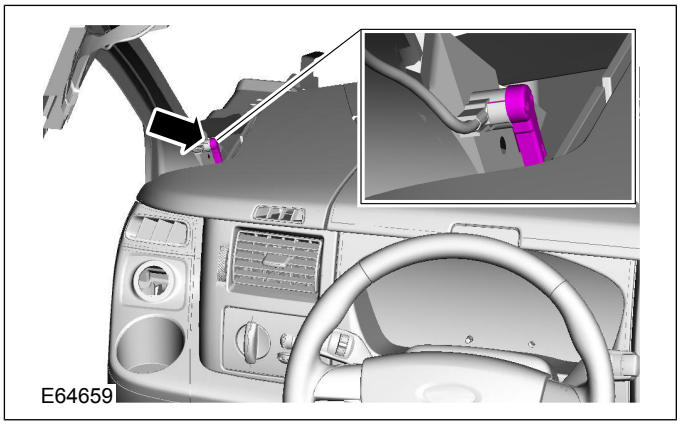
   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).
8. ⚠ **CAUTION:Make sure that new bolts are installed.**
   • Detach the steering column shaft joint from the steering column shaft.
   • Torque: 28 Nm



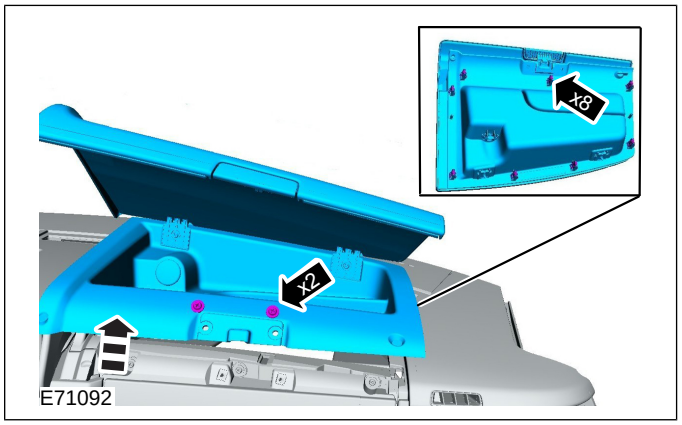
9. Lower the vehicle.

REMOVAL AND INSTALLATION

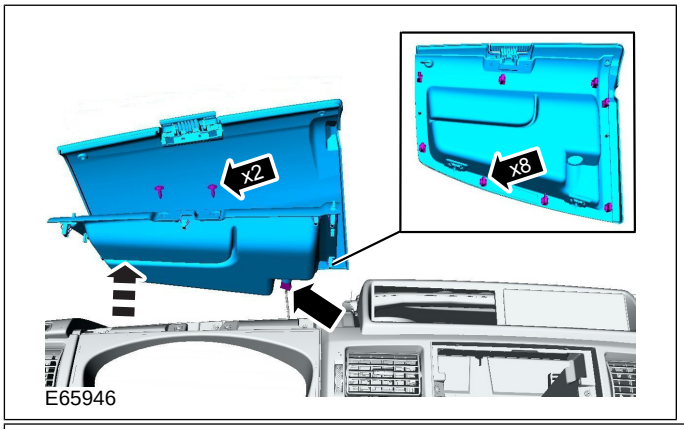
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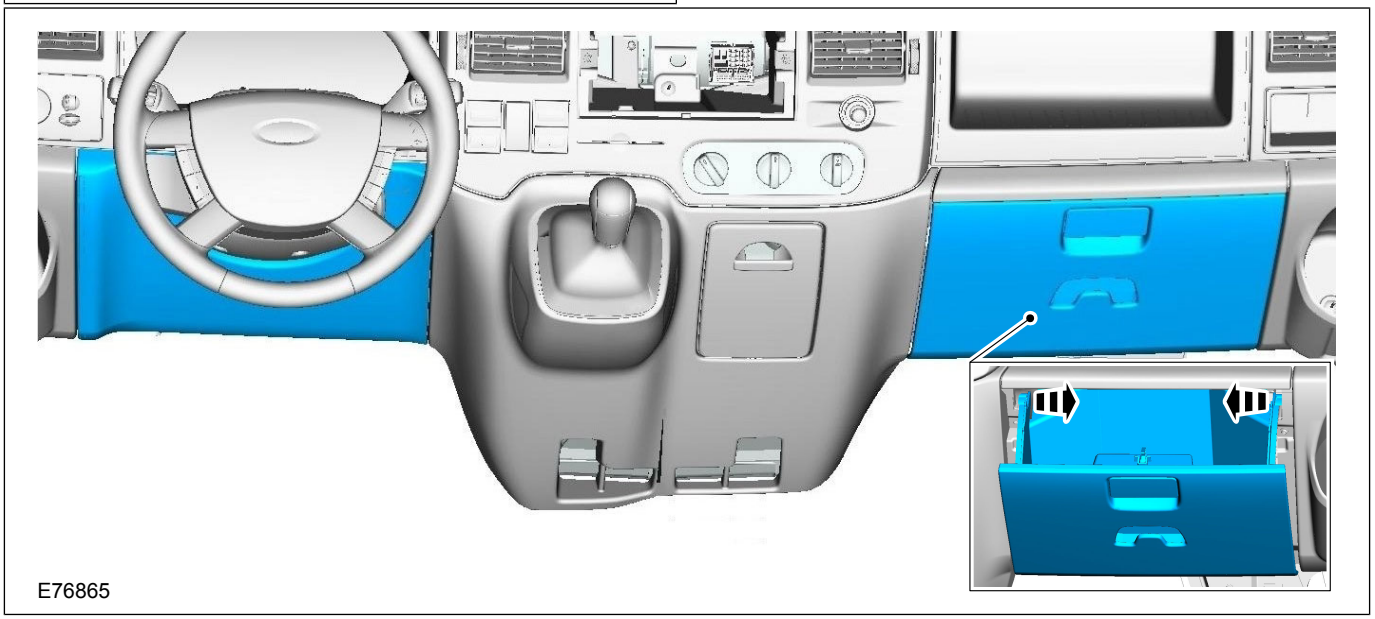
12.



11.

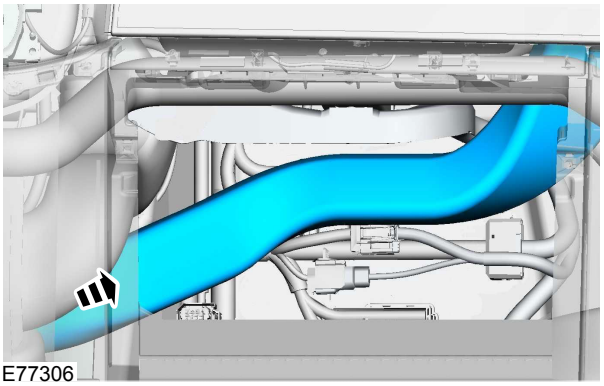


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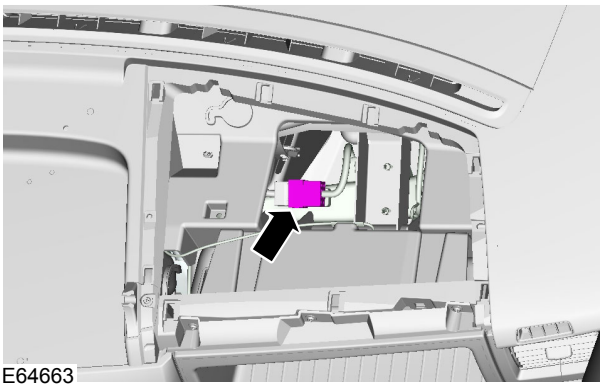


REMOVAL AND INSTALLATION

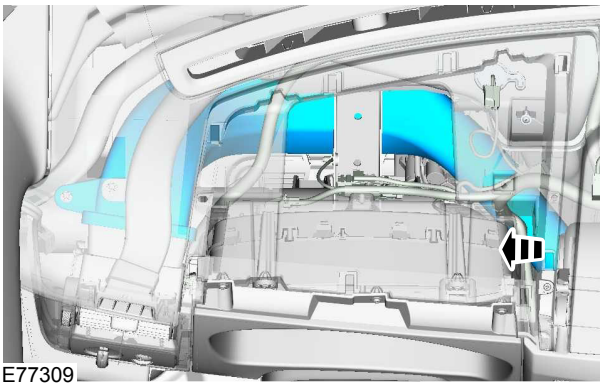
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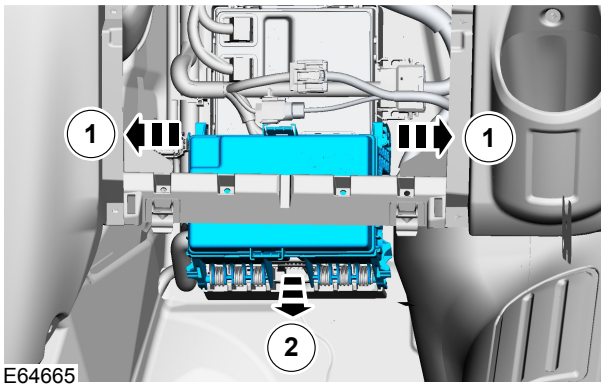
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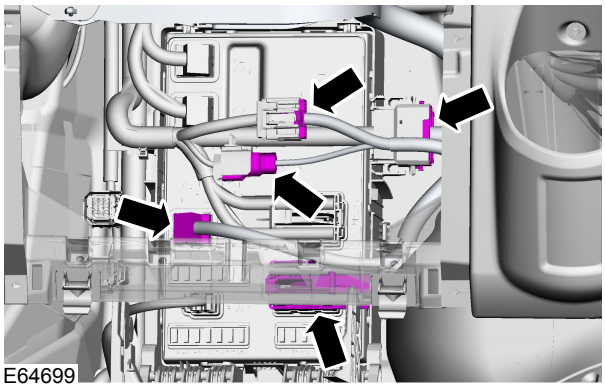
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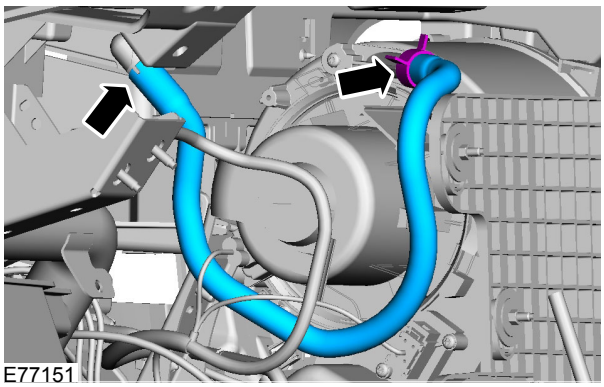
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18.

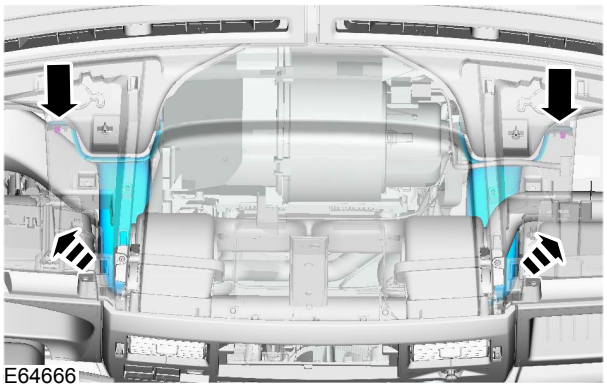


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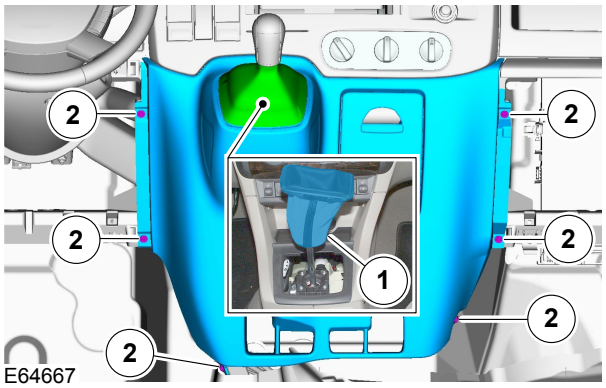


REMOVAL AND INSTALLATION

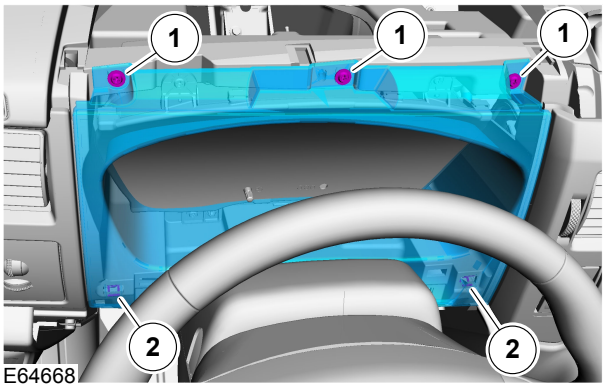
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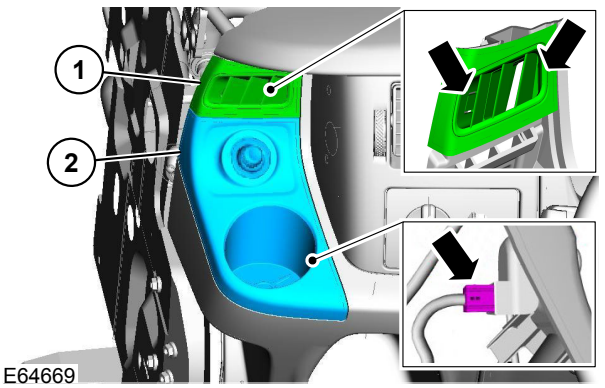
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22.

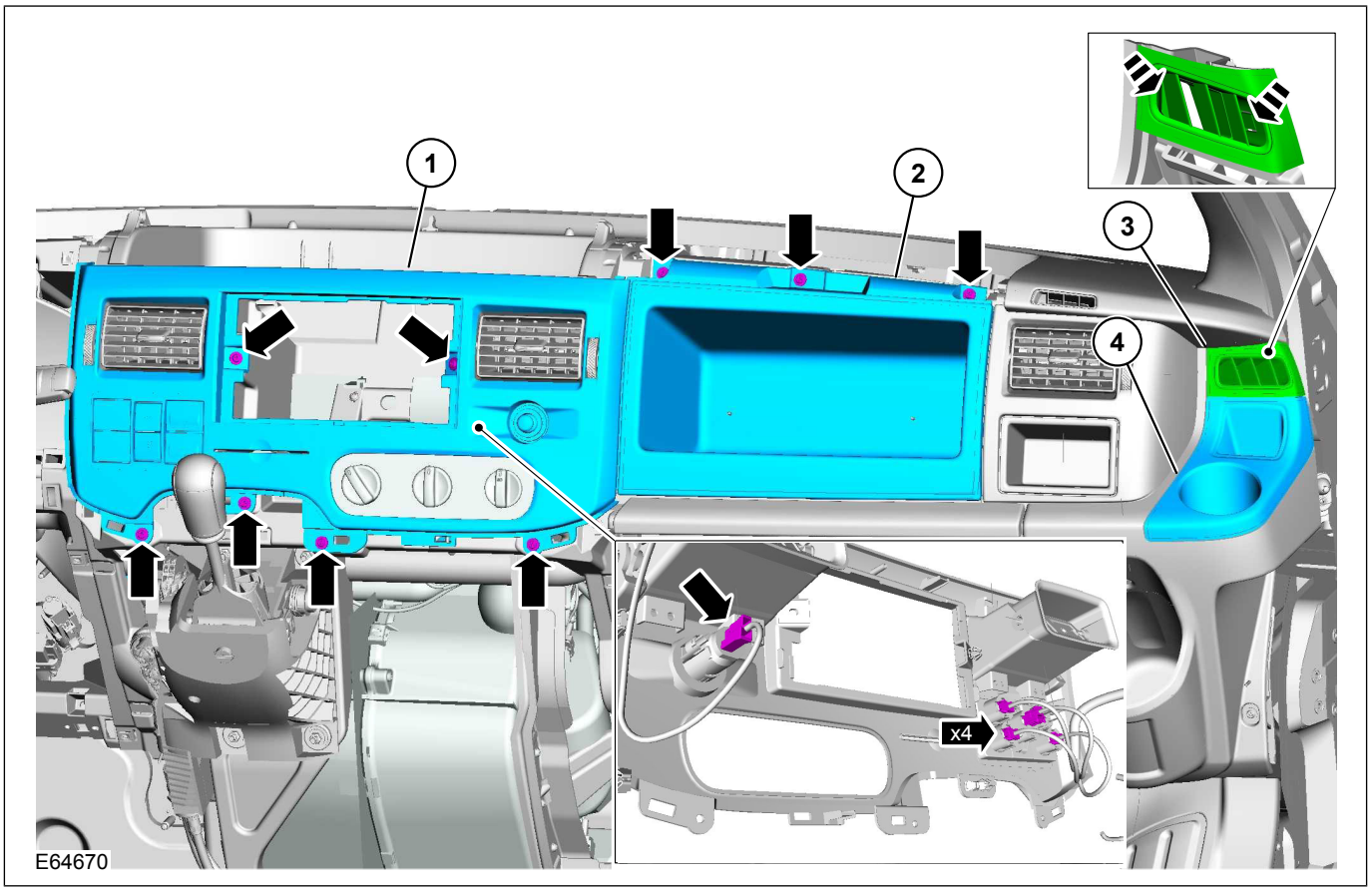


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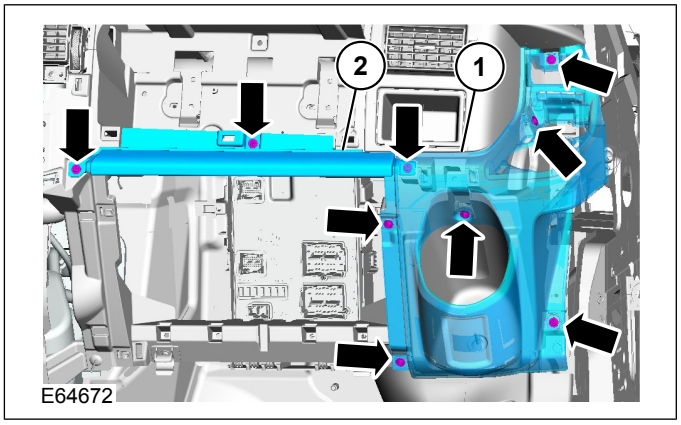


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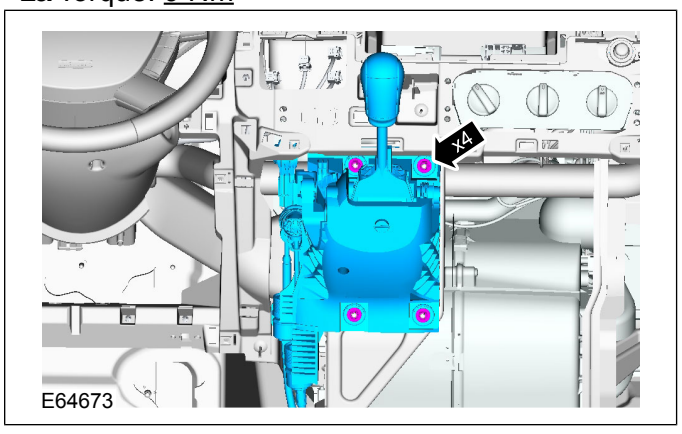
REMOVAL AND INSTALLATION



25.



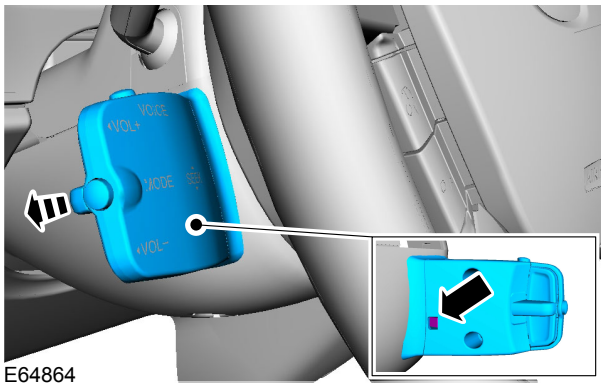
26. Torque: 9 Nm



REMOVAL AND INSTALLATION

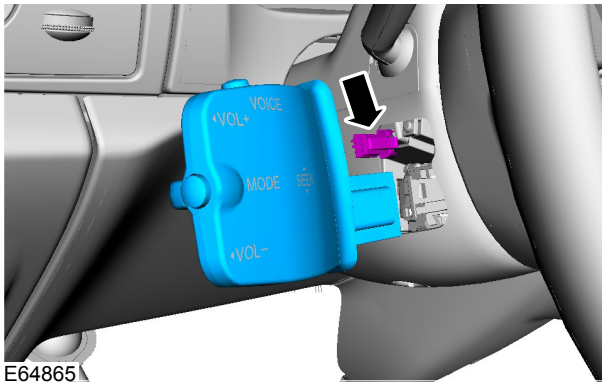
Vehicles with remote control for the audio unit

27.



E64864

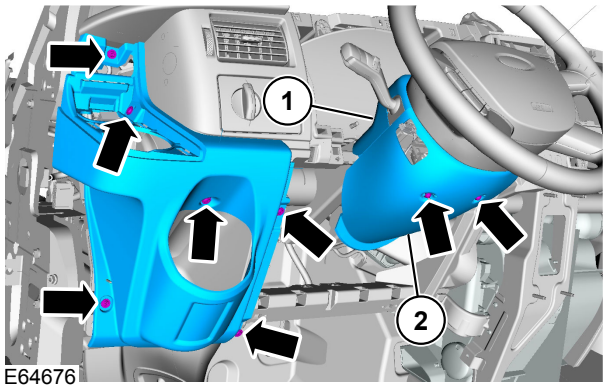
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E64865

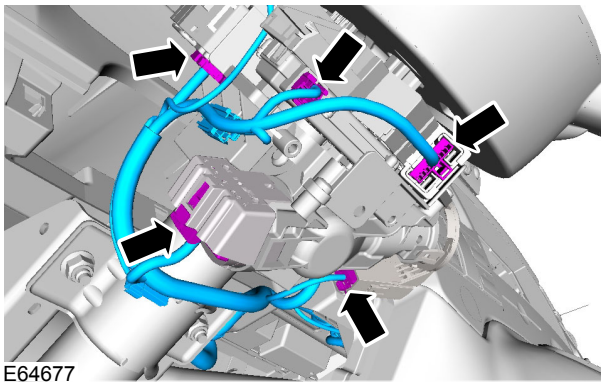
All Vehicles

29.

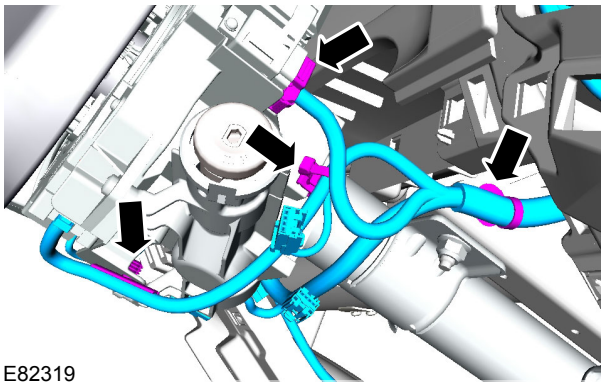


E64676

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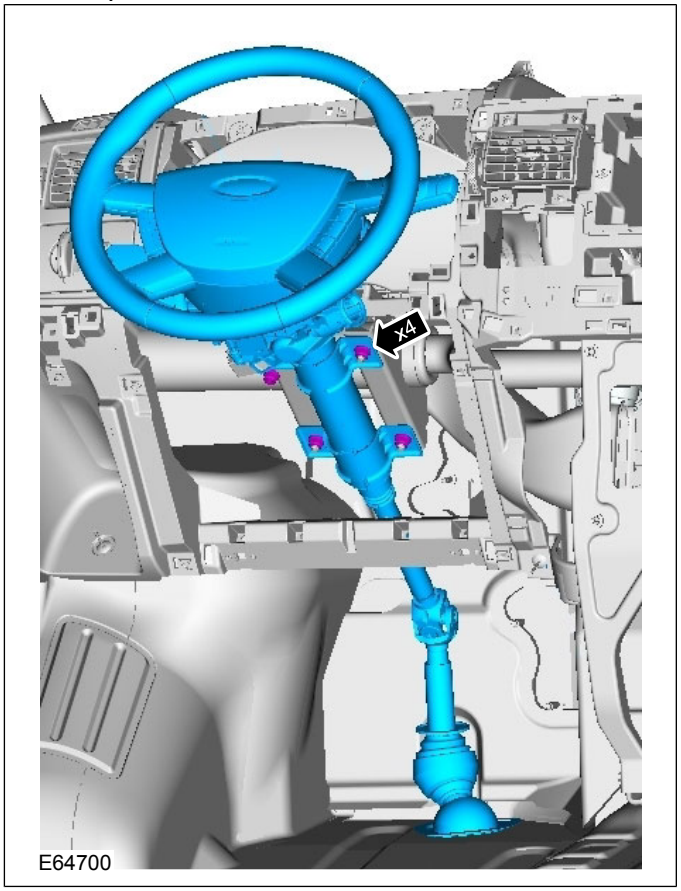

E64677

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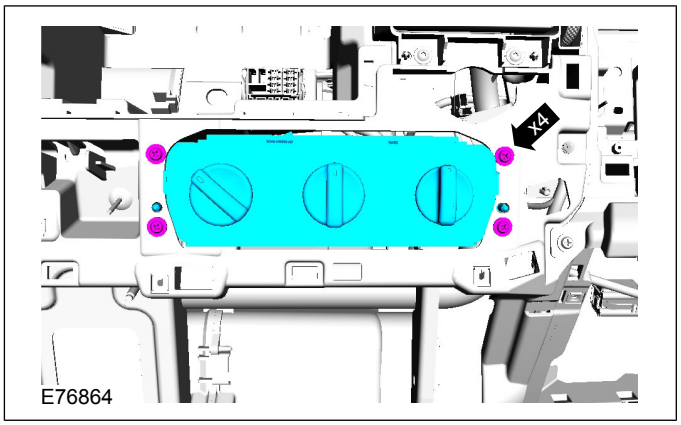

E82319

REMOVAL AND INSTALLATION

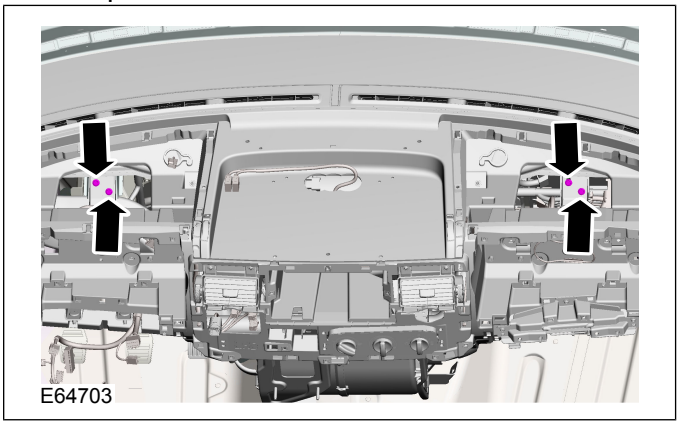
32. ⚠ **WARNING:Make sure that new self-locking nuts are installed.**
Torque: 20 Nm



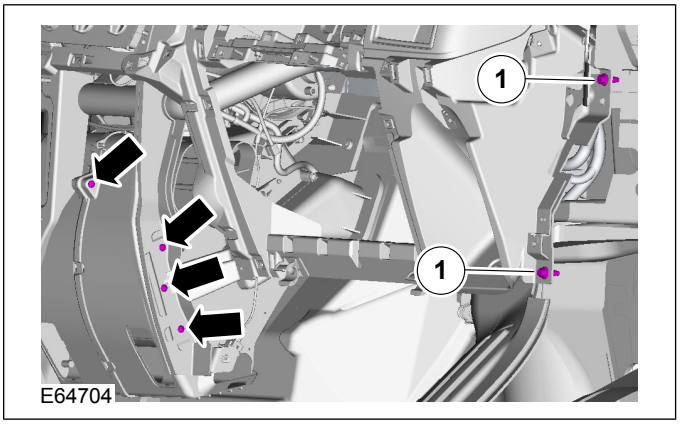
33.



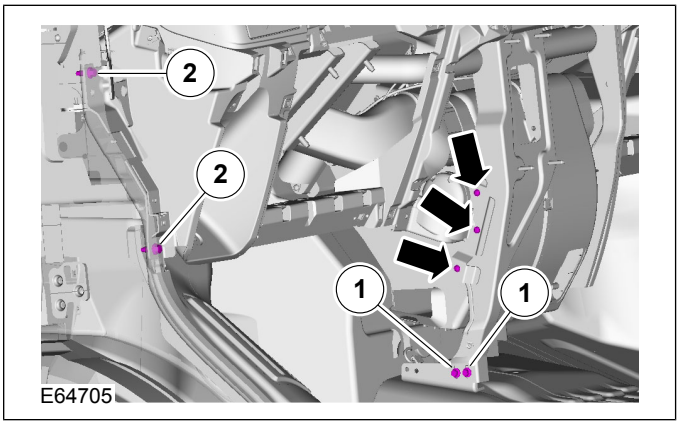
34. Torque: 20 Nm



35. 1. Torque: 25 Nm

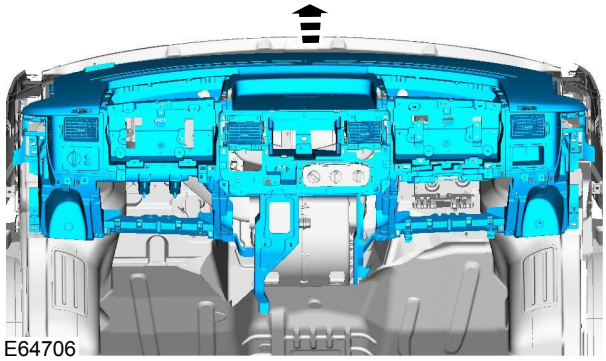


36. 1. Torque: 20 Nm
2. Torque: 25 Nm

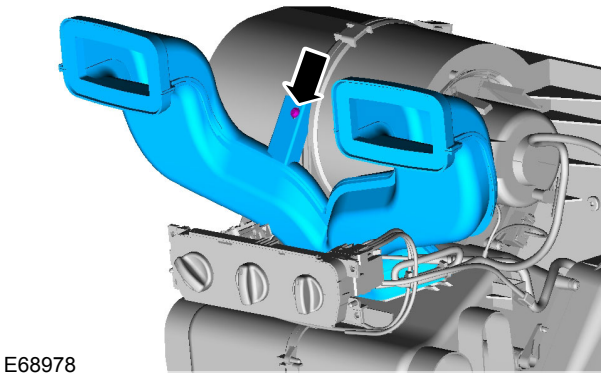


REMOVAL AND INSTALLATION

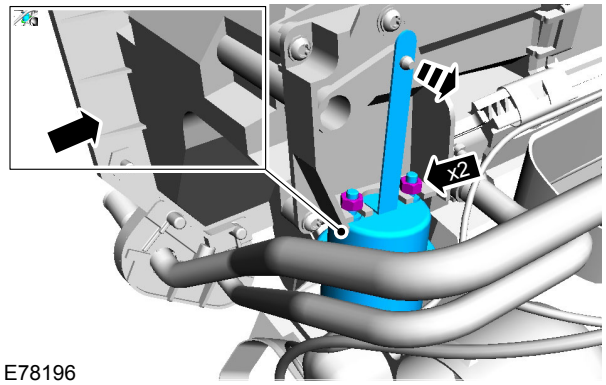
37.



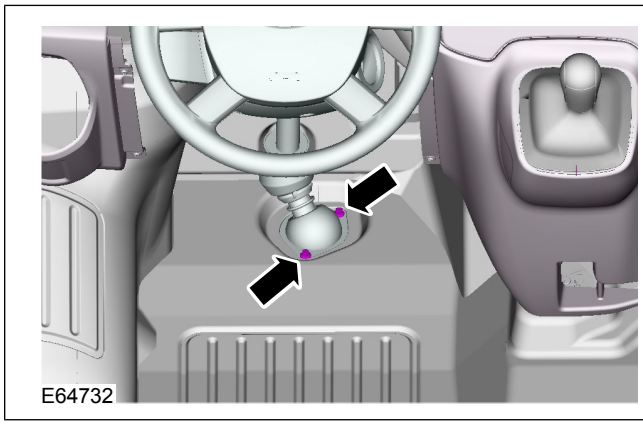
38.



39.

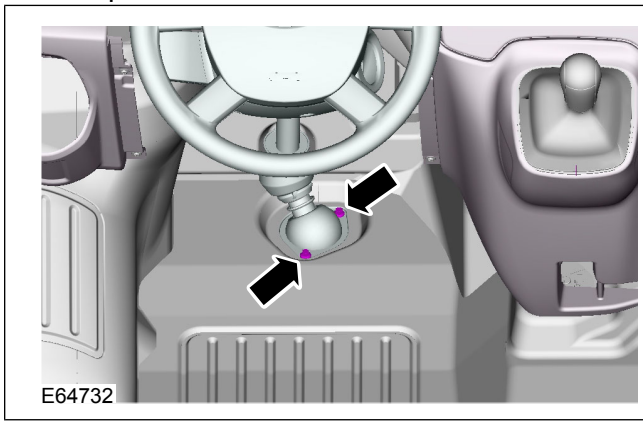


2. Loosen the bolts four turns.



3. Start the engine, turn the steering wheel from lock to lock.

4. Torque: 12 Nm



Installation

1. To install reverse the removal procedure.

REMOVAL AND INSTALLATION

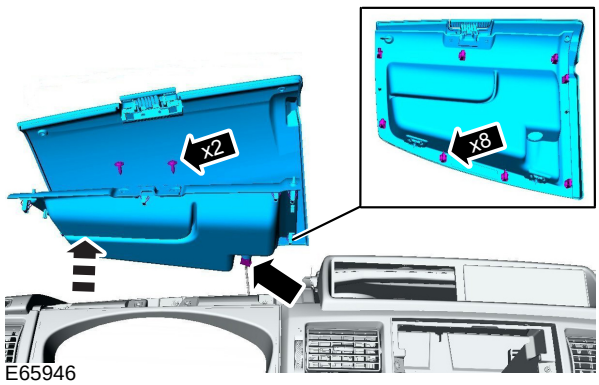
Air Inlet Blend Door Actuator — Vehicles Without: Air Conditioning

Removal

NOTE: Removal steps in this procedure may contain installation details.

Left-hand drive vehicles

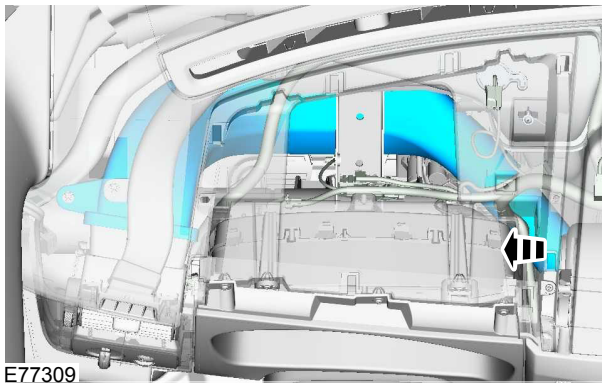
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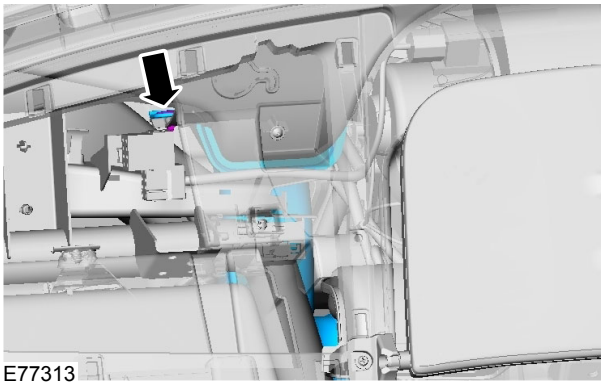
2.



3.

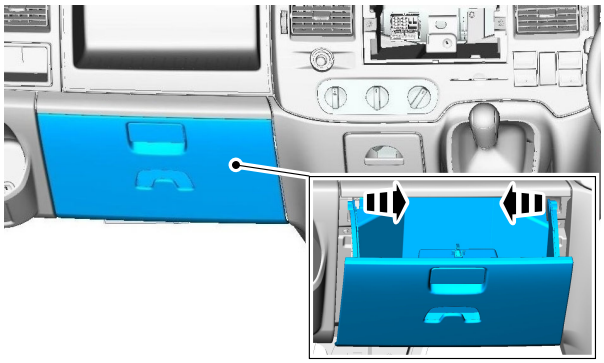


4.



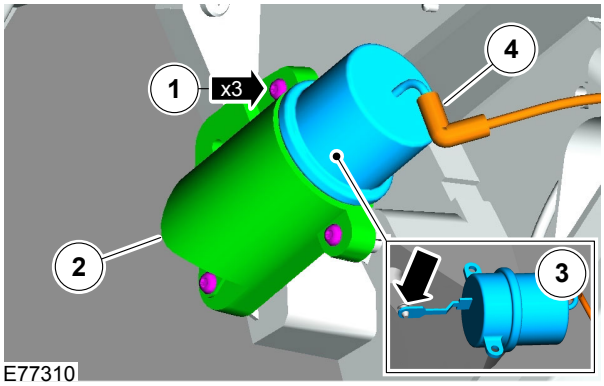
Right-hand drive vehicles

5.



All Vehicles

6.



Installation

1. To install reverse the removal procedure.

REMOVAL AND INSTALLATION

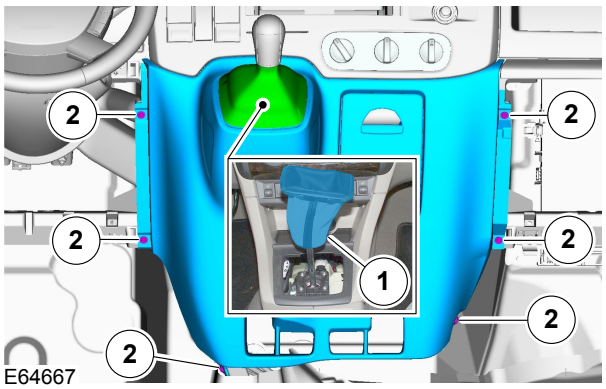
Temperature Blend Door Actuator

Removal

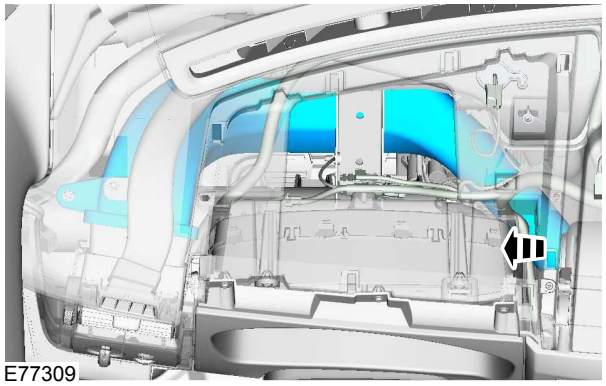
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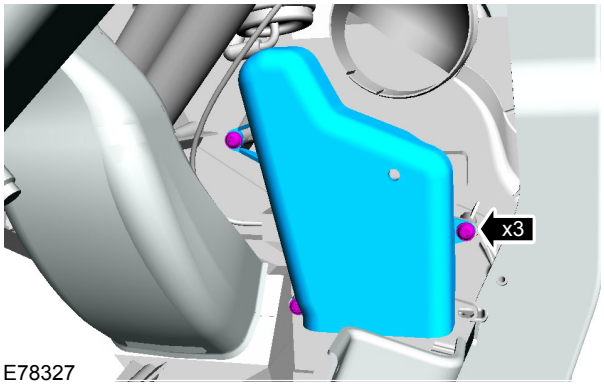
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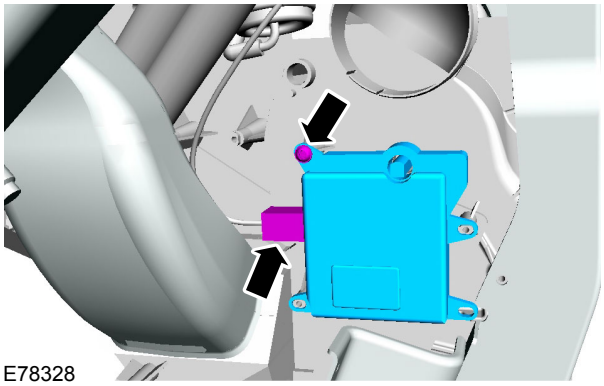
3.



4.



5.



REMOVAL AND INSTALLATION

Installation

1. To install reverse the removal procedure.

SECTION 413-00 Instrument Cluster and Panel Illumination

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Instrument Cluster and Panel Illumination 413-00-2
Inspection and Verification 413-00-2
Symptom Chart 413-00-2
Pinpoint Tests 413-00-3

DIAGNOSIS AND TESTING

Instrument Cluster and Panel Illumination

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical damage.

Visual Inspection Chart

Electrical
Fuse(s)
Wiring harness
Electrical connector(s)
Light emitting diode(s) LED(s)
Bulb(s)

Electrical
Switch(es)
Instrument cluster
Audio unit
Climate control assembly
Audio unit
Tachograph

3. If an obvious cause for an observed or reported concern is found , correct the (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• The control illumination is inoperative	• Fuse. • Headlamp switch. • Circuit.	• GO to Pinpoint Test A.
• The instrument cluster illumination is inoperative	• Fuse(s). • Circuit(s). • Instrument cluster.	• GO to Pinpoint Test B.
• The climate control/integrated control panel illumination is inoperative	• Fuse(s). • Circuit(s). • Climate control assembly.	• GO to Pinpoint Test C.
• The audio unit illumination is inoperative	• Fuse(s). • Circuit. • Audio unit.	• GO to Pinpoint Test D.
• The hazard lamp switch illumination is inoperative	• Fuse(s). • Circuit. • Hazard lamp switch.	• GO to Pinpoint Test E.
• The tachograph illumination is inoperative	• Fuse(s). • Circuit. • Tachograph.	• GO to Pinpoint Test F.
• The heated windshield switch illumination is inoperative	• Fuse(s). • Circuit. • Heated windshield switch.	• GO to Pinpoint Test G.
• The heated rear window switch illumination is inoperative	• Fuse(s). • Circuit. • Heated rear window switch.	• GO to Pinpoint Test H.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• The stability assist deactivation switch illumination is inoperative	• Fuse(s). • Circuit(s). • Stability assist deactivation switch	• GO to Pinpoint Test I.

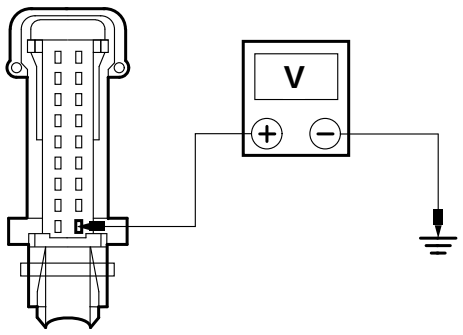
Pinpoint Tests

NOTE: Use a digital multimeter for all electrical measurements.

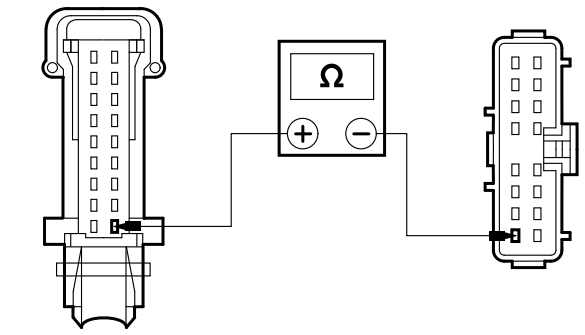
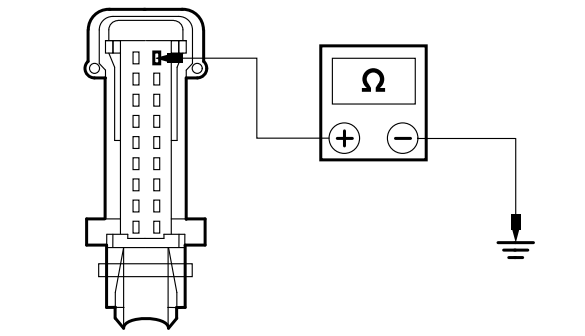
PINPOINT TEST A : THE CONTROL ILLUMINATION IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK EXTERIOR LAMPS	
	1 Turn the headlamp switch to the ON position. • Are the exterior lamps on? → **Yes** INSTALL a new headlamp switch. TEST the system for normal operation. → **No** REFER to:Headlamps (417-01 Exterior Lighting, Diagnosis and Testing).

PINPOINT TEST B : THE INSTRUMENT CLUSTER ILLUMINATION IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK THE INSTRUMENT CLUSTER ILLUMINATION FOR POWER	
	1 Disconnect Instrument Cluster CMC01.
	2 Turn the headlamp switch to the ON position.
 E69753	3 Measure the voltage between the instrument cluster CMC01 pin 10, circuit CLN17 (BU/RD), harness side and ground while operating the dimmer switch from the minimum to the maximum positions. • Does the voltage vary between 1 volt and 10 volts approximately? → **Yes** GO to B3. → **No** GO to B2.

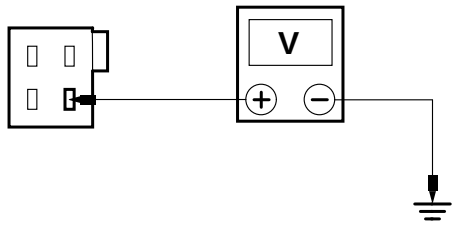
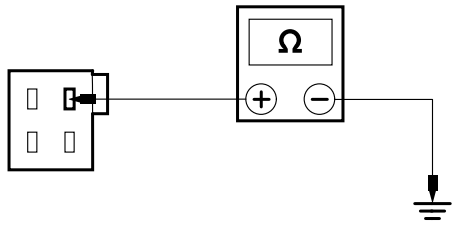
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B2: CHECK CIRCUIT CLN17 (BU/RD) FOR OPEN CIRCUIT	
 E73216	1 Measure the resistance between the instrument cluster CMC01 pin 10, circuit CLN17 (BU/RD), harness side and the headlamp switch CLF23 pin 9, circuit CLN17 (BU/RD), harness side • Is the resistance less than 1 ohm? → **Yes** Install a new headlamp switch. REFER to:Headlamp Switch (417-01 Exterior Lighting, Removal and Installation). → **No** REPAIR the circuit. TEST the system for normal operation.
B3: CHECK THE INSTRUMENT CLUSTER ILLUMINATION FOR GROUND	
 E69754	1 Measure the resistance between the instrument cluster CMC01 pin 18, circuit GD116 (BK/VT), harness side and ground. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new instrument cluster. REFER to:Instrument Cluster (413-01 Instrument Cluster, Removal and Installation). TEST the system for normal operation. → **No** REPAIR the circuit. TEST the system for normal operation.

PINPOINT TEST C : THE CLIMATE CONTROL/INTEGRATED CONTROL PANEL ILLUMINATION IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CHECK THE CLIMATE CONTROL ASSEMBLY ILLUMINATION FOR POWER	
	1 Disconnect Climate Control CH101A.
	2 Turn the headlamp switch to the ON position.

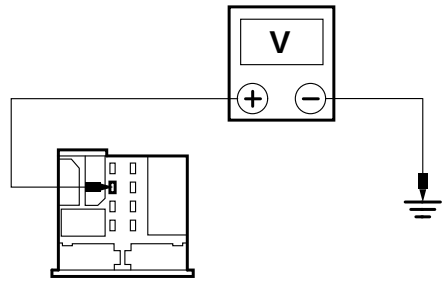
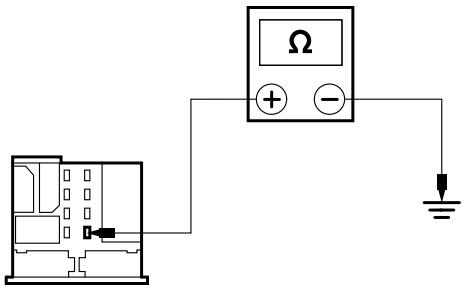
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69760	3 Measure the voltage between the climate control switch CH101A pin 2, circuit CLN17 (BU/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to C2. → **No** REPAIR circuit CLN17 (BU/RD). TEST the system for normal operation.
C2: CHECK THE CLIMATE CONTROL ASSEMBLY ILLUMINATION FOR GROUND	
 E69761	1 Measure the resistance between the climate control assembly CH101A pin 1, circuit GD115 (BK/GY), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new climate control assembly. REFER to: Climate Control Assembly - Vehicles With: Air Conditioning (412-04 Control Components, Removal and Installation) / Climate Control Assembly - Vehicles Without: Air Conditioning (412-04 Control Components, Removal and Installation). TEST the system for normal operation. → **No** REPAIR the circuit. TEST the system for normal operation.

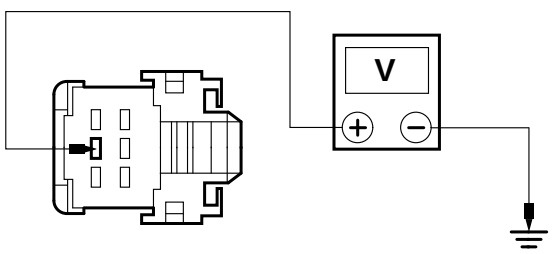
PINPOINT TEST D : THE AUDIO UNIT ILLUMINATION IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: CHECK THE AUDIO UNIT ILLUMINATION FOR POWER	
	1 Disconnect Audio Unit CME03B.
	2 Turn the headlamp switch to the ON position.

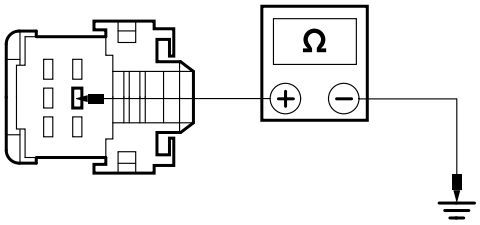
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E65913	3 Measure the voltage between the audio unit CME03B pin 14, circuit CLN17 (BU/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to D2. → **No** REPAIR circuit CLN17 (BU/RD). TEST the system for normal operation.
D2: CHECK THE AUDIO UNIT ILLUMINATION FOR GROUND	
 E65914	1 Measure the resistance between the audio unit CME03B pin 12, circuit GD114 (BK/OG), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new audio unit. REFER to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit GD114 (BK/OG). TEST the system for normal operation.

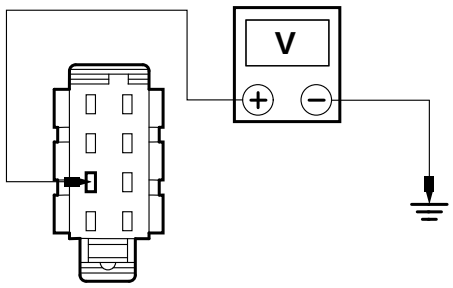
PINPOINT TEST E : THE HAZARD LAMP SWITCH ILLUMINATION IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: CHECK THE HAZARD LAMP SWITCH ILLUMINATION FOR POWER	
	1 Disconnect Hazard Lamp Switch CLS32.
	2 Turn the headlamp switch to the ON position.
 E69756	3 Measure the voltage between the hazard lamp switch CLS32 pin 5, circuit CLN17 (BU/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to E2. → **No** REPAIR circuit CLN17 (BU/RD). TEST the system for normal operation.

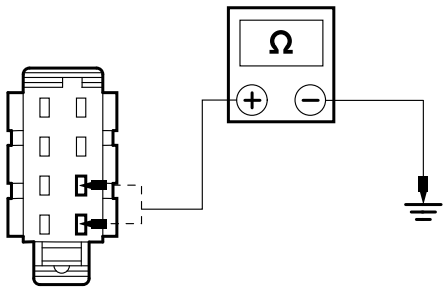
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E2: CHECK THE HAZARD LAMP SWITCH ILLUMINATION FOR GROUND	
 E69757	1 Measure the resistance between the hazard lamp switch CLS32 pin 2, circuit GD115 (BK/RD), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new hazard lamp switch. TEST the system for normal operation. → **No** REPAIR circuit GD115 (BK/RD). TEST the system for normal operation.

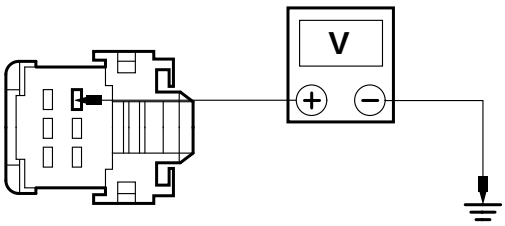
PINPOINT TEST F : THE TACHOGRAPH ILLUMINATION IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F1: CHECK THE TACHOGRAPH ILLUMINATION FOR POWER	
	1 Disconnect Tachograph CMC35A.
	2 Turn the headlamp switch to the ON position.
 E69758	3 Measure the voltage between the tachograph CMC35A pin 2, circuit CLN17 (BU/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to F2. → **No** REPAIR circuit CLN17 (BU/RD). TEST the system for normal operation.

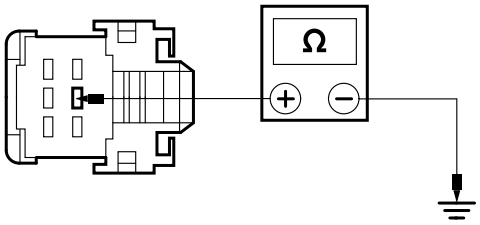
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F2: CHECK THE TACHOGRAPH ILLUMINATION FOR GROUND	
 E69640	1 Measure the resistance between the tachograph CMC35A pin 5, circuit GD116G (BK/VT), harness side and ground, and between the tachograph CMC35A pin 6, circuit GD116B (BK/VT), harness side and ground. • Are the resistances less than 0.1 ohm? → **Yes** INSTALL a new tachograph REFER to:Tachograph (413-17 Tachograph, Removal and Installation) / Digital Tachograph (413-17 Tachograph, Removal and Installation). . TEST the system for normal operation. → **No** REPAIR circuit GD116G (BK/VT) or circuit GD116B (BK/VT). Test the system for normal operation.

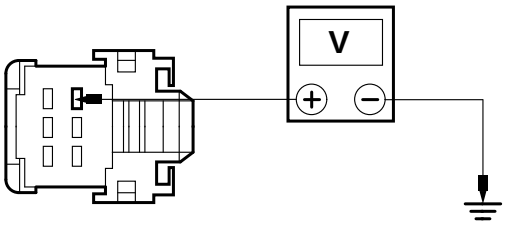
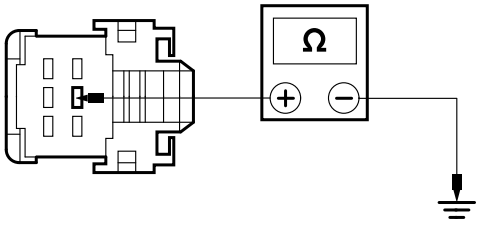
PINPOINT TEST G : THE HEATED WINDSHIELD SWITCH ILLUMINATION IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G1: CHECK THE HEATED WINDSHIELD SWITCH ILLUMINATION FOR POWER	
	1 Disconnect Heated Windshield Switch CRD08.
	2 Turn the headlamp switch to the ON position.
 E69759	3 Measure the voltage between the heated windshield switch CRD08 pin 3, circuit CLN17 (BU/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to G2. → **No** REPAIR circuit CLN17 (BU/RD). TEST the system for normal operation.

DIAGNOSIS AND TESTING

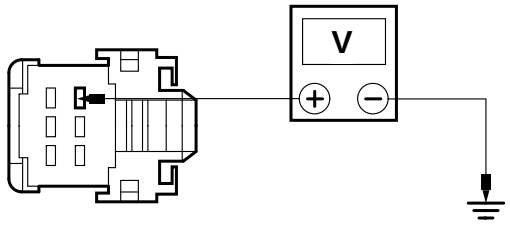
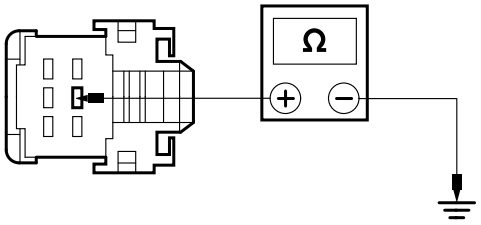
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G2: CHECK THE HEATED WINDSHIELD SWITCH ILLUMINATION FOR GROUND	
 E69757	1 Measure the resistance between the heated windshield switch CRD08 pin 2, circuit GD115 (BK/RD), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new heated windshield switch. TEST the system for normal operation. → **No** REPAIR circuit GD115 (BK/RD). TEST the system for normal operation.

PINPOINT TEST H : THE HEATED REAR WINDOW SWITCH ILLUMINATION IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
H1: CHECK THE HEATED REAR WINDOW SWITCH ILLUMINATION FOR POWER	
	1 Disconnect Heated Rear Window Switch CRD09.
	2 Turn the headlamp switch to the ON position.
 E69759	3 Measure the voltage between the heated rear window switch CRD09 pin 3, circuit CLN17 (BU/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to H2. → **No** REPAIR circuit CLN17 (BU/RD). TEST the system for normal operation.
H2: CHECK THE HEATED REAR WINDOW SWITCH ILLUMINATION FOR GROUND	
 E69757	1 Measure the resistance between the heated rear window switch CRD09 pin 2, circuit GD115 (BK/GY), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new heated rear window switch. TEST the system for normal operation. → **No** REPAIR circuit GD115 (BK/GY). TEST the system for normal operation.

DIAGNOSIS AND TESTING

PINPOINT TEST I : THE STABILITY ASSIST DEACTIVATION SWITCH ILLUMINATION IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I1: CHECK THE STABILITY ASSIST DEACTIVATION SWITCH ILLUMINATION FOR POWER	
	1 Disconnect Stability Assist Deactivation Switch CCA15.
	2 Turn the headlamp switch to the ON position.
 E69759	3 Measure the voltage between the stability assist deactivation switch CCA15 pin 3, circuit CLN17 (BU/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to I2. → **No** REPAIR circuit CLN17 (BU/RD). TEST the system for normal operation.
I2: CHECK THE STABILITY ASSIST DEACTIVATION SWITCH ILLUMINATION FOR GROUND	
 E69757	1 Measure the resistance between the stability assist deactivation switch CCA15 pin 2, circuit GD115 (BK/GY), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new stability assist deactivation switch. TEST the system for normal operation. → **No** REPAIR circuit GD115 (BK/GY). TEST the system for normal operation.

SECTION 413-01 Instrument Cluster

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Instrument Cluster 413-01-2
Inspection and Verification 413-01-2
Symptom Chart 413-01-2
Pinpoint Tests 413-01-2
Configuration of the Instrument Cluster 413-01-4

REMOVAL AND INSTALLATION

Instrument Cluster 413-01-5

DIAGNOSIS AND TESTING

Instrument Cluster

Refer to Wiring Diagrams Section413-01,for schematic and connector information.

General Equipment

Worldwide Diagnostic System (WDS)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Engine oil quality – Engine oil level – Cylinder head temperature (CHT) sensor – Engine coolant level – Collapsed or damaged fuel tank – Generator – Air bag(s) – Brake fluid reservoir – Door adjustment	– Fuse(s) – Wiring harness – Electrical connector(s) – Instrument cluster – Light emitting diode(s) (LED)(s) – Central junction box (CJB)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.
5. If the cause is still evident, refer to the WDS.

Symptom Chart

Symptom	Possible Sources	Action
• The fuel gauge is inoperative or erratic	• Circuit(s) • Fuel level sensor (vehicles with diesel engine) • Fuel pump and sender unit (all except vehicles with diesel engine) • Instrument cluster • CJB	• GO to Pinpoint Test A.

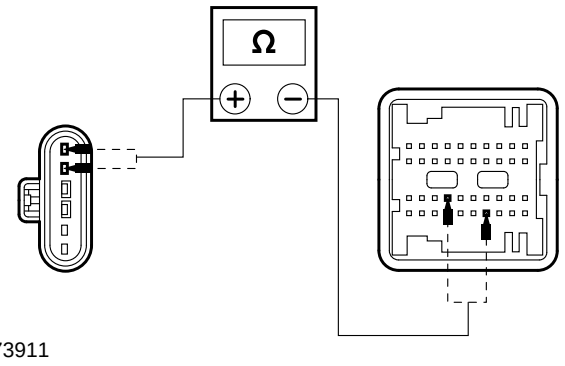
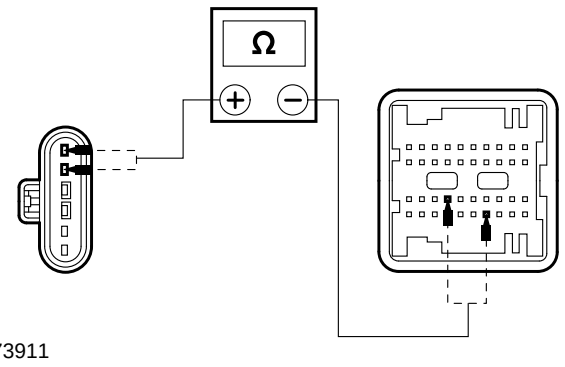
Pinpoint Tests

NOTE: Use a digital multimeter for all electrical measurements.

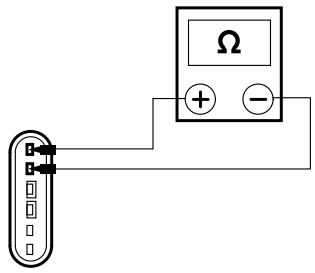
PINPOINT TEST A : THE FUEL GAUGE IS INOPERATIVE OR ERRATIC

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK CIRCUITS VMC23 (GN/OG) AND VMC11 (YE/VT) FOR OPEN CIRCUIT - (VEHICLES WITH DIESEL ENGINE)	
	1 Disconnect CJB CBP02C.
	2 Disconnect Fuel Level Sensor CE515.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73911	3 Measure the resistance between: • the CJB CBP02C pin 27, circuit VMC23 (GN/OG), harness side and the fuel level sensor CE515 pin 1, circuit VMC23 (GN/OG), harness side. • the CJB CBP02C pin 34, circuit VMC11 (YE/VT), harness side and the fuel level sensor CE515 pin 2, circuit VMC11 (YE/VT), harness side. • Are the resistances less than 1 ohm? → **Yes** GO to A3. → **No** REPAIR circuit VMC23 (GN/OG) or VMC11 (YE/VT) as necessary. TEST the system for normal operation.
A2: CHECK CIRCUITS VMC23 (GN/OG) AND VMC11 (YE/VT) FOR OPEN CIRCUIT - (ALL EXCEPT VEHICLES WITH DIESEL ENGINE)	
	1 Disconnect Fuel Pump and Sender Unit CE226
 E73911	2 Measure the resistance between: • the CJB CBP02C pin 27, circuit VMC23 (GN/OG), harness side and the fuel pump and sender unit CE226 pin 1, circuit VMC23 (GN/OG), harness side. • the CJB CBP02C pin 34, circuit VMC11 (YE/VT), harness side and the fuel pump and sender unit CE226 pin 2, circuit VMC11 (YE/VT), harness side. • Are the resistances less than 1 ohm? → **Yes** GO to A3. → **No** REPAIR circuit VMC23 (GN/OG) or VMC11 (YE/VT) as necessary. TEST the system for normal operation.
A3: CHECK THE OPERATION OF THE FUEL LEVEL SENSOR OR THE FUEL PUMP AND SENDER UNIT	
	1 Remove the fuel level sensor (vehicles with diesel engine) or the fuel pump and sender unit (all except vehicles with diesel engine).

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73909	2 Measure the resistance between the fuel level sensor or the fuel pump and sender unit pin 1, component side and the fuel level sensor or the fuel pump and sender unit pin 2, component side while moving the rigid wire lever from the empty to the full positions. • Is the resistance approximately 300 ohms +/- 3.5 ohms at the empty position and approximately 10 ohms +/- 1 ohm at the full position? → **Yes** REFER to the WDS to diagnose the instrument cluster. → **No** MOVE the rigid wire lever from empty to full a minimum of 10 times. CARRY OUT the resistance check again. If the concern persists, INSTALL a new fuel level sensor (vehicles with diesel engine) or fuel pump and sender unit (all except vehicles with diesel engine). TEST the system for normal operation.

Configuration of the Instrument Cluster

The instrument cluster is a programmable module, which must be configured by selecting the Programmable Module Installation Routine on the WDS.

The following feature will need to be configured when a new instrument cluster is installed:

- Tachograph

REMOVAL AND INSTALLATION

Instrument Cluster

General Equipment

Worldwide Diagnostic System (WDS)

General Equipment

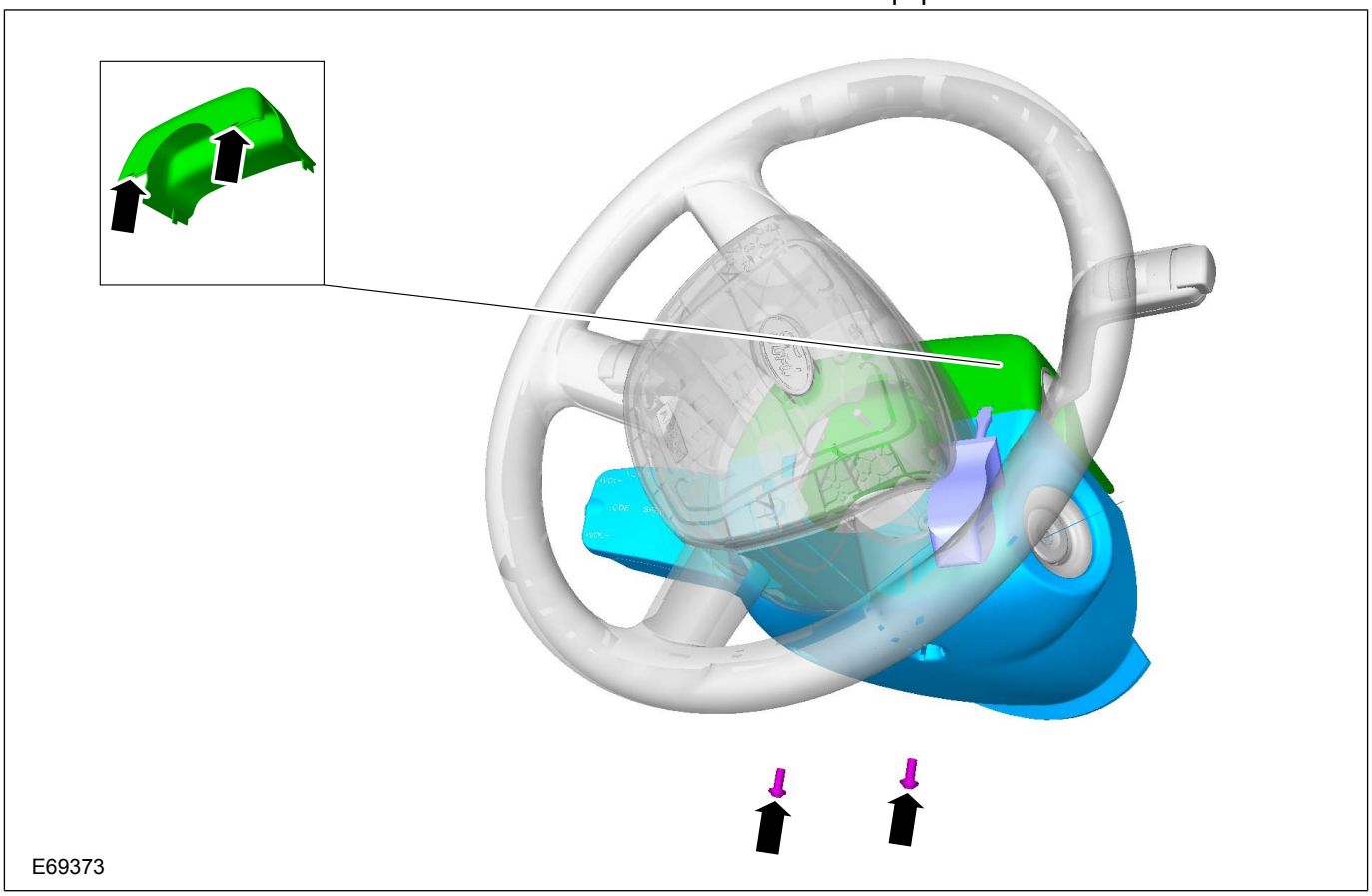
Flat-bladed screwdriver

Removal

1. If a new instrument cluster is to be installed, upload the instrument cluster configuration information using the programmable modules installation routine, prior to commencing the removal of the instrument cluster.

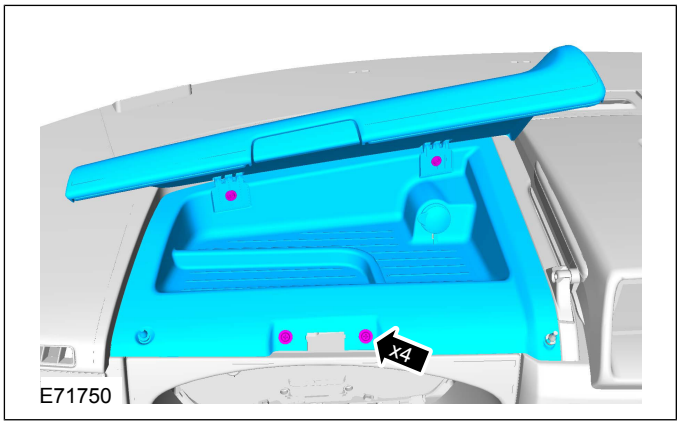
   General Equipment: Worldwide Diagnostic System (WDS)

2. If a new instrument cluster is to be installed, the odometer value must be recorded from the original instrument cluster before removal, as this will be required when configuring the new instrument cluster. If the odometer value cannot be obtained from the instrument cluster due to display failure, the customer should supply the approximate value.
3. General Equipment: Flat-bladed screwdriver

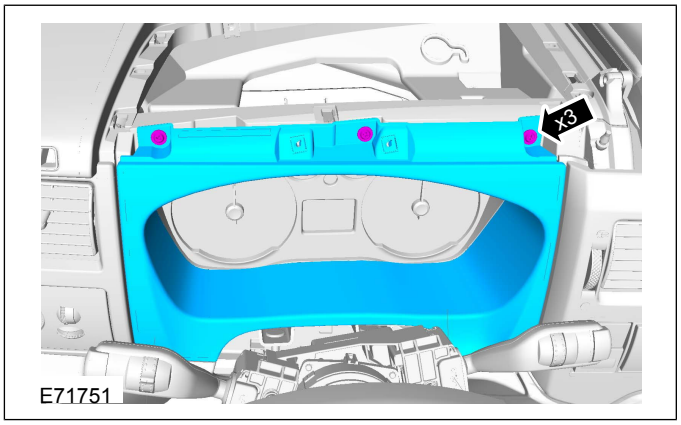


REMOVAL AND INSTALLATION

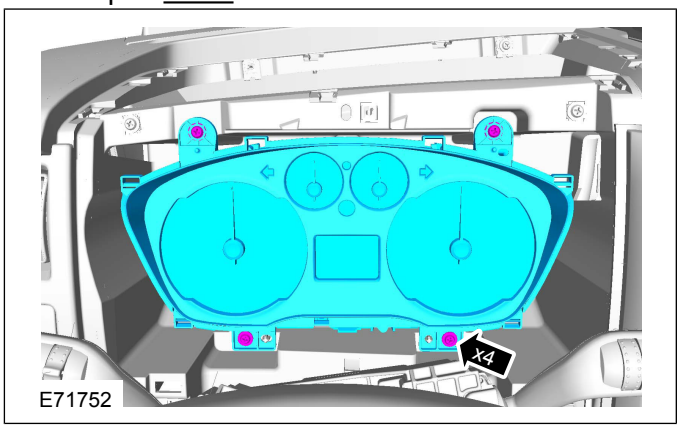
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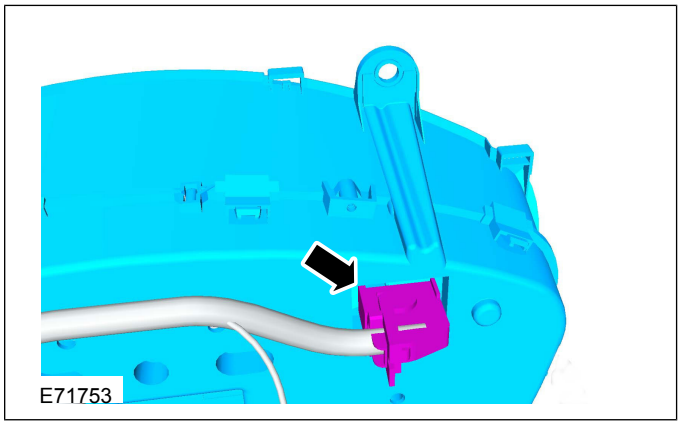
5.



6. Torque: 2 Nm



7.



Installation

1. To install, reverse the removal procedure.
2. If a new instrument cluster is being installed, download the instrument cluster configuration information using the programmable modules installation routine.

   General Equipment: Worldwide Diagnostic System (WDS)

SECTION 413-06 Horn

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Horn 413-06-2
Inspection and Verification 413-06-2
Symptom Chart 413-06-2
Pinpoint Tests 413-06-2

DIAGNOSIS AND TESTING

Horn

Refer to Wiring Diagrams Section413-06,for schematic and connector information.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical damage.

Visual Inspection Chart

Electrical
Fuse(s)
Wiring harness
Electrical connector(s)

Electrical
Horn relay
Horn switch
Horn
Clockspring
Central junction box (CJB)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• The horn is inoperative	• Fuse(s). • Circuit(s). • Horn. • Horn relay. • Horn switch. • Clockspring. • CJB.	• GO to Pinpoint Test A.
• The horn is always on	• Horn switch. • Circuit(s). • Clockspring. • CJB.	• GO to Pinpoint Test B.

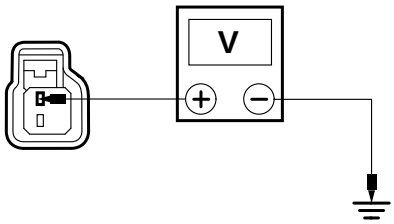
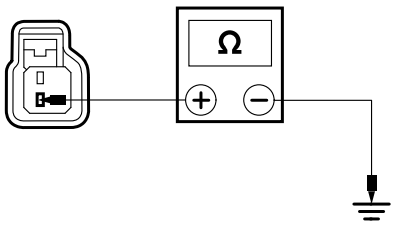
Pinpoint Tests

NOTE: Use a digital multimeter for all electrical measurements.

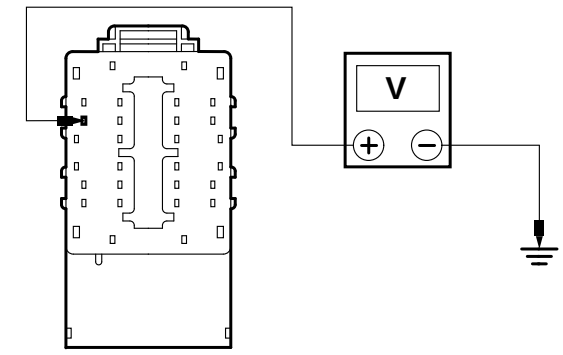
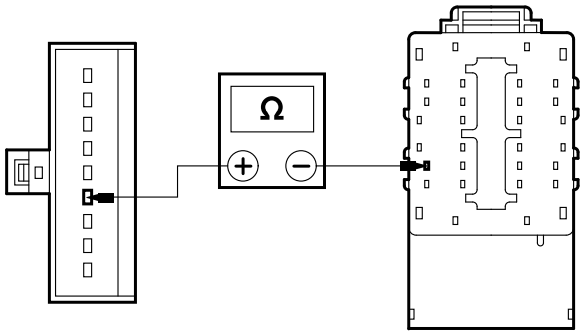
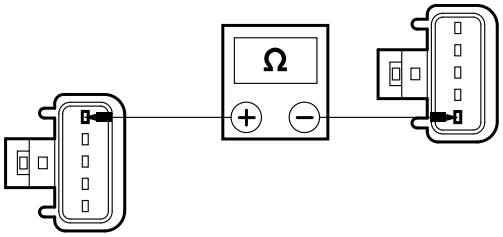
PINPOINT TEST A : THE HORN IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK THE HORN FOR POWER	
	1 Disconnect Dual Horn CRH01.
	2 Disconnect Low Pitch Horn CRH02.

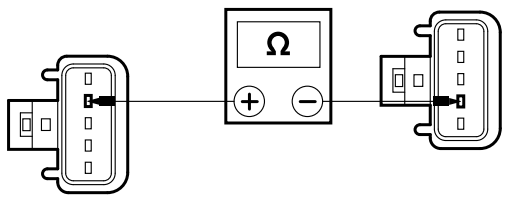
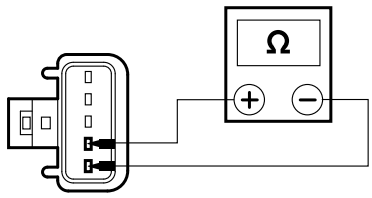
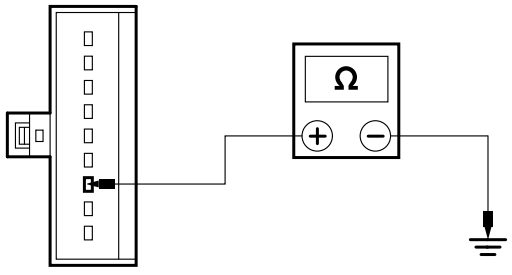
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69794	3 Measure the voltage between: • the dual horn CRH01 pin 1, circuit CB114 (VT), harness side and ground while pressing the horn switch or • the low pitch horn CRH02 pin 1, circuit CB114 (VT), harness side and ground while pressing the horn switch • Is the voltage greater than 10 volts? → **Yes** GO to A2. → **No** GO to A4.
A2: CHECK THE HORN FOR GROUND	
 E69795	1 Measure the resistance between: • the dual horn CRH01 pin 2, circuit GD131 (BK/GY), harness side and ground or • the low pitch horn CRH02 pin 2, circuit GD131 (BK/RD), harness side and ground or • Is the resistance less than 1 ohm? → **Yes** INSTALL a new horn. TEST the system for normal operation. → **No** REPAIR circuit GD131 (BK/GY) or circuit GD131 (BK/RD). TEST the system for normal operation.
A3: CHECK CIRCUIT CB114 (VT) FOR OPEN CIRCUIT	
	1 Disconnect Horn Relay R14.
	2 Measure the resistance between: • the dual horn CRH01 pin 1, circuit CB144 (VT), harness side and the horn relay R14 pin 3, harness side or • the low pitch horn CRH02 pin 1, circuit CB144 (VT), harness side and the horn relay R14 pin 3, harness side. • Is the resistance less than 1 ohm? → **Yes** Install a new horn relay. If the concerns persists, GO to A4. → **No** REPAIR the circuit. TEST the system for normal operation.

DIAGNOSIS AND TESTING

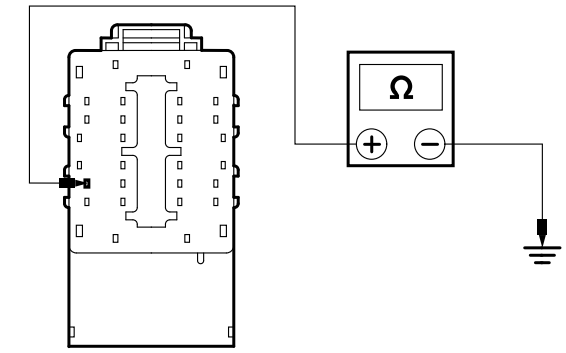
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A4: CHECK THE CJB FOR POWER	
	1 Disconnect CJB CBP02B.
 E69802	2 Measure the voltage between the CJB CBP02B pin 21, circuit ZA224 (OG), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A5. → **No** REPAIR circuit ZA224 (OG). TEST the system for normal operation.
A5: CHECK CIRCUIT CRH02 FOR OPEN CIRCUIT	
	1 Disconnect Clockspring CR115A.
 E69801	2 Measure the resistance between the CJB CBP02E pin 9, circuit CRH02 (BU/WH), harness side and the clockspring CR115A pin 6. circuit CRH02 (BU/WH), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to A6. → **No** REPAIR circuit CRH02 (BU/WH). TEST the system for normal operation.
A6: CHECK CIRCUIT ZA226 (OG/YE) FOR OPEN CIRCUIT	
	1 Disconnect Horn Switch CRH03. 2 Disconnect Clockspring CR115B.
 E69798	3 Measure the resistance between the horn switch CRH03 pin 1, circuit ZA226 (OG/YE), harness side and the clockspring CR115B pin 5. circuit ZA226 (OG/YE), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to A7. → **No** REPAIR the circuit. TEST the system for normal operation.

DIAGNOSIS AND TESTING

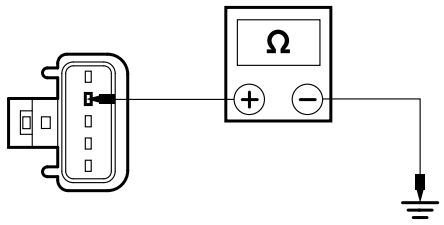
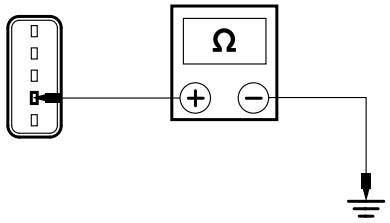
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A7: CHECK CIRCUIT ZA225 (OG) FOR OPEN CIRCUIT	
 E69799	1 Measure the resistance between the horn switch CRH03 pin 2, circuit ZA225 (OG), harness side and the clockspring CR115B pin 4. circuit ZA225 (OG), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to A8. → **No** REPAIR the circuit. TEST the system for normal operation.
A8: CHECK THE HORN SWITCH CIRCUIT FOR OPEN	
	1 Disconnect ClockspringCR115B.
 E70266	2 Measure the resistance between the clockspring CR115B pin 4, circuit ZA225 (OG), harness side and the clockspring CR115B pin 5, circuit ZA226 (OG/YE) while pressing the horn switch. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new horn switch. TEST the system for normal operation. → **No** GO to A9.
A9: CHECK THE CLOCKSPRING GROUND CIRCUIT	
 E69800	1 Measure the resistance between the clockspring CR115A pin 7, circuit GD116 (BK/VT), harness side and ground. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new clockspring. TEST the system for normal operation. → **No** REPAIR circuit circuit GD116 (BK/VT). TEST the system for normal operation.

DIAGNOSIS AND TESTING

PINPOINT TEST B : THE HORN IS ALWAYS ON

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK THE HORN SWITCH CIRCUIT FOR SHORT TO GROUND	
	1 Disconnect CJB CBP02E. • Does the horn stop sounding with CBP02E disconnected? → **Yes** GO to B2. → **No** INSTALL a new CJB. TEST the system for normal operation.
B2: CHECK CIRCUIT CRH02 (BU/WH) FOR SHORT TO GROUND	
WARNING:To deactivate the driver air bag, refer to the procedure in section 501-20B for the correct air bag deactivation procedure. Failure to follow this instruction, may result in personal injury.	
	1 Remove the driver air bag module. REFER to:Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).
	2 Disconnect Clockspring CR115A.
 E70267	3 Measure the resistance between the CJB CBP02E pin 9, circuit CRH02 (BK/WH), harness side and ground. • Is the resistance greater than 10,000 ohms? → **Yes** GO to B3. → **No** REPAIR the circuit. TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B3: CHECK CIRCUIT ZA225 (OG) FOR SHORT TO GROUND	
 E70268	1 Measure the resistance between the horn switch CRH03 pin 2, circuit ZA225 (OG), and ground. • Is the resistance greater than 10,000 ohms? → **Yes** GO to B4. → **No** REPAIR the circuit. TEST the system for normal operation.
B4: CHECK THE CLOCKSPRING FOR SHORT TO GROUND	
 E70282	1 Measure the resistance between the clockspring CR115B pin 4 component side and ground. • Is the resistance greater than 10,000 ohms? → **Yes** INSTALL a new horn switch. TEST the system for normal operation. → **No** INSTALL a new clockspring. REFER to:Clockspring (501-20 Supplemental Restraint System, Removal and Installation). TEST the system for normal operation.

SECTION 413-09 Warning Devices

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

GENERAL PROCEDURES

Oil Change Reminder Indicator Reset..... 413-09-2

GENERAL PROCEDURES

Oil Change Reminder Indicator Reset

1. Turn the ignition key to position II without cranking the engine.
2. Simultaneously press and hold the accelerator pedal and the brake pedal for approximately 15 seconds until the oil change reminder indicator starts to flash or the "Service Oil Reset Complete" message appears in the information and message center (if equipped).
3. Release the pedals.
4. Check that the oil change reminder indicator has turned off or that there is no "Service Oil" message in the information and message center (if equipped). If the oil change reminder indicator is still illuminated or the "Service Oil" message is still displayed, turn the ignition key to position 0 and repeat the procedure from Step 1. If it has turned off or the "Service Oil" message has disappeared, proceed to Step 5.
5. Turn the ignition key to position 0 and leave it there for at least 2 minutes so that the powertrain control module (PCM) fully powers down and updates the non-volatile memory (NVM) in the PCM.
6. Turn the ignition key to position II without cranking the engine and check that the oil change reminder indicator is not illuminated or that there is no "Service Oil" message displayed.
7. Turn the ignition key to position 0.

SECTION 414-00 Charging System - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Charging System 414-00-2
Inspection and Verification 414-00-2
Symptom Chart 414-00-3
Component Tests 414-00-4

GENERAL PROCEDURES

Battery Charging ..... (31 003 0) 414-00-9

DIAGNOSIS AND TESTING

Charging System

Refer to Wiring Diagrams Section414-02,for schematic and connector information.

General Equipment

Surface charge dissipation unit (SCD²)
Micro390 battery tester

Inspection and Verification

WARNINGS:

Batteries contain sulphuric acid. Avoid contact with skin, eyes, or clothing. Also, shield your eyes when working near batteries to protect against possible splashing of the acid solution. In case of acid contact with skin or eyes, flush immediately with water for a minimum of 15 minutes and get prompt medical attention. If acid is swallowed, call a physician immediately. Failure to follow these instructions may result in personal injury.

Batteries normally produce explosive gases which can cause personal injury. Therefore, do not allow flames, sparks or lighted substances to come near the battery. When charging or working near a battery, always shield your face and protect your eyes. Always provide ventilation. Failure to follow these instructions may result in personal injury.

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Accessory drive belt – Generator – Generator decoupler (if equipped)	– Fuse(s) – Wiring harness – Electrical connector(s) – Battery junction box (BJB) – Battery – Battery cables – Charging system warning indicator

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. Check the operation of the charging system warning indicator lamp, located in the instrument cluster. Normal operation is as follows:

Normal Charging System Voltages

Ignition Switch Position	I Circuit	Generator B+ Circuit	Battery	Engine to battery ground	Charging System Warning Indicator Operation
Position 0	0V	10-12V	10-12V	0V	OFF
Position II	0V	10-12V	10-12V	0V	Illuminated
Position II with the engine running	13-15V	13-15V	13-15V	0V	OFF

5. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

DIAGNOSIS AND TESTING

Symptom Chart

Symptom	Possible Sources	Action
• The charging system warning indicator is on with the engine running (The charging system voltage does not increase)	• Accessory drive belt.	• CHECK the accessory drive belt condition, REFER to:Accessory Drive (303-05 Accessory Drive, Diagnosis and Testing).
	• Circuit. • Generator. • Voltage regulator.	• CARRY OUT the generator tests, REFER to the Generator On-Vehicle Tests in Component Tests in this section.
• The charging system warning indicator is off with the ignition switch in the RUN position and the engine off	• Bulb.	• INSTALL a new bulb.
	• Ignition switch.	• CHECK the ignition switch.
	• Circuit. • Generator.	• CARRY OUT the generator tests, REFER to the Generator On-Vehicle Tests in Component Tests in this section.
• Radio interference	• Circuit. • Generator.	• REFER to the WDS
• The generator is noisy	• Accessory drive belt.	• REFER to:Accessory Drive (303-05 Accessory Drive, Diagnosis and Testing).
	• Loose generator mounting bolts.	• TIGHTEN the generator mounting bolts.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
	• Generator.	• INSTALL a new generator. REFER to:Generator - 1.3L Duratec-8V (Rocam) (414-02, Removal and Installation) / Generator - 1.25L Duratec-16V (Sigma)/1.4L Duratec-16V (Sigma)/1.6L Duratec-16V (Sigma) (414-02, Removal and Installation) / Generator - 1.4L Duratorq-TDCi (DV) Diesel (414-02, Removal and Installation) / Generator - 2.0L Duratec-HE (MI4) (414-02, Removal and Installation) / Generator - 1.6L Duratorq-TDCi (DV) Diesel, Vehicles With: Air Conditioning (414-02, Removal and Installation) / Generator - 1.6L Duratorq-TDCi (DV) Diesel, Vehicles Without: Air Conditioning (414-02, Removal and Installation).
• Vehicle electrical systems inoperative	• Battery.	• CARRY OUT the battery test, REFER to the Battery Test in Component Tests in this section.
• The engine cranks slowly	• Battery.	• CARRY OUT the battery test, REFER to the Battery Test in Component Tests in this section.
	• Battery cable(s). • Starter motor.	• REFER to:Starting System (303-06 Starting System, Diagnosis and Testing).

Component Tests

Generator On-Vehicle Tests - No-Load Test

1. Turn off all electrical loads and the ignition switch.
2. Switch the multimeter to the voltage function.
3. Connect the leads of the multimeter across the battery terminals.
4. Read the voltage (base voltage).
5. Start the engine.
6. Run the engine at 1500 rpm with no electrical load.
7. Read the voltage. The voltage should be in the range of 14.1 volts to 15.1 volts. If the voltage increase is less than 2.5 volts above the base voltage, carry out the Load Test. If the voltage increase is greater than 2.5 volts, REFER to the WDS.

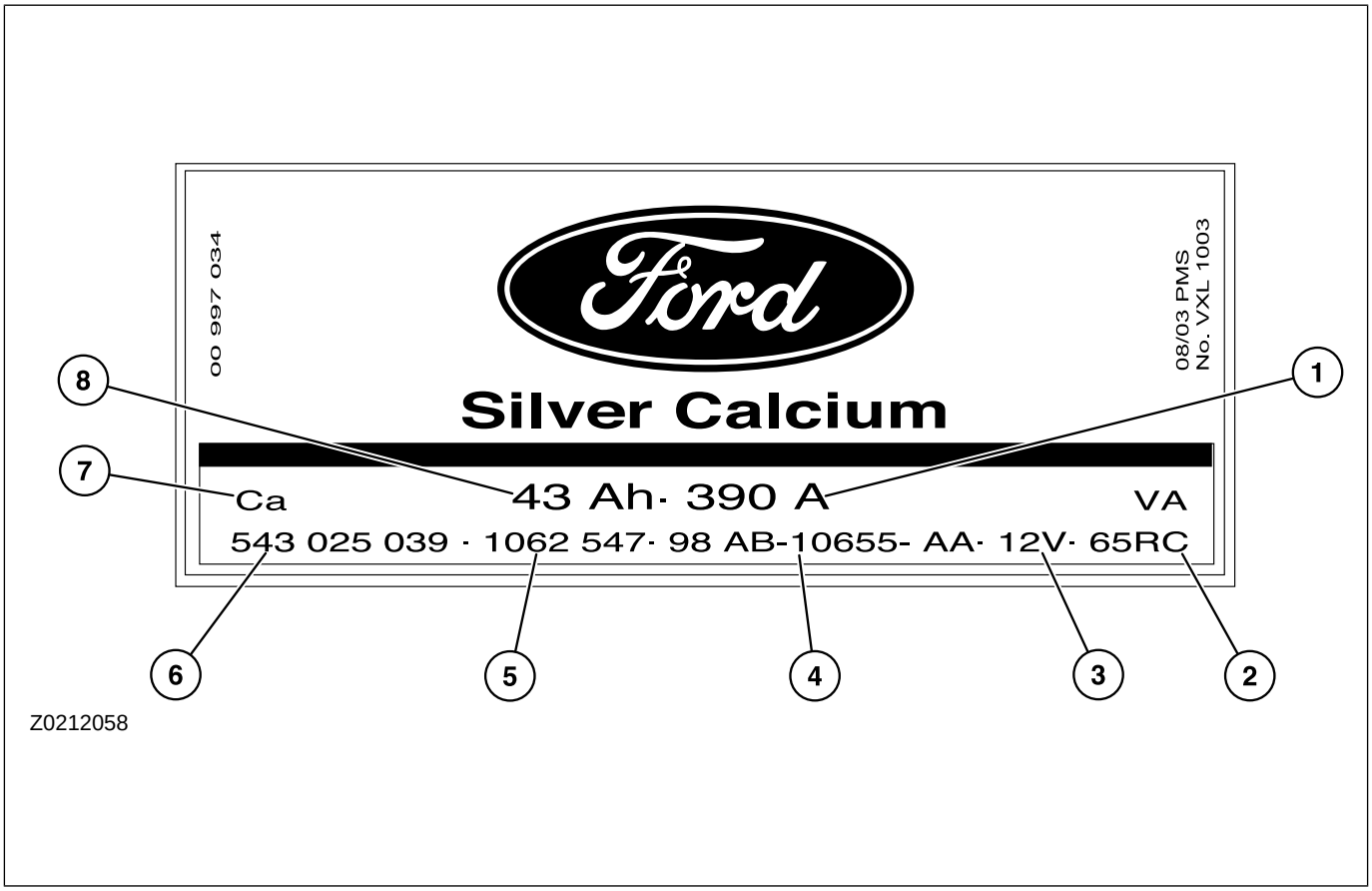
Generator On-Vehicle Tests - Load Test

1. With the engine running, turn on the air conditioning (if equipped), turn the blower motor to high speed and the headlamps to high beam.
2. Increase the engine speed to 2000 rpm. The voltage should increase a minimum of 0.5 volts above the base voltage. If the voltage does not

DIAGNOSIS AND TESTING

increase as specified, REFER to the WDS. If the voltage increases as specified, the charging system is charging correctly. REFER to the Symptom Chart.

Battery Identification



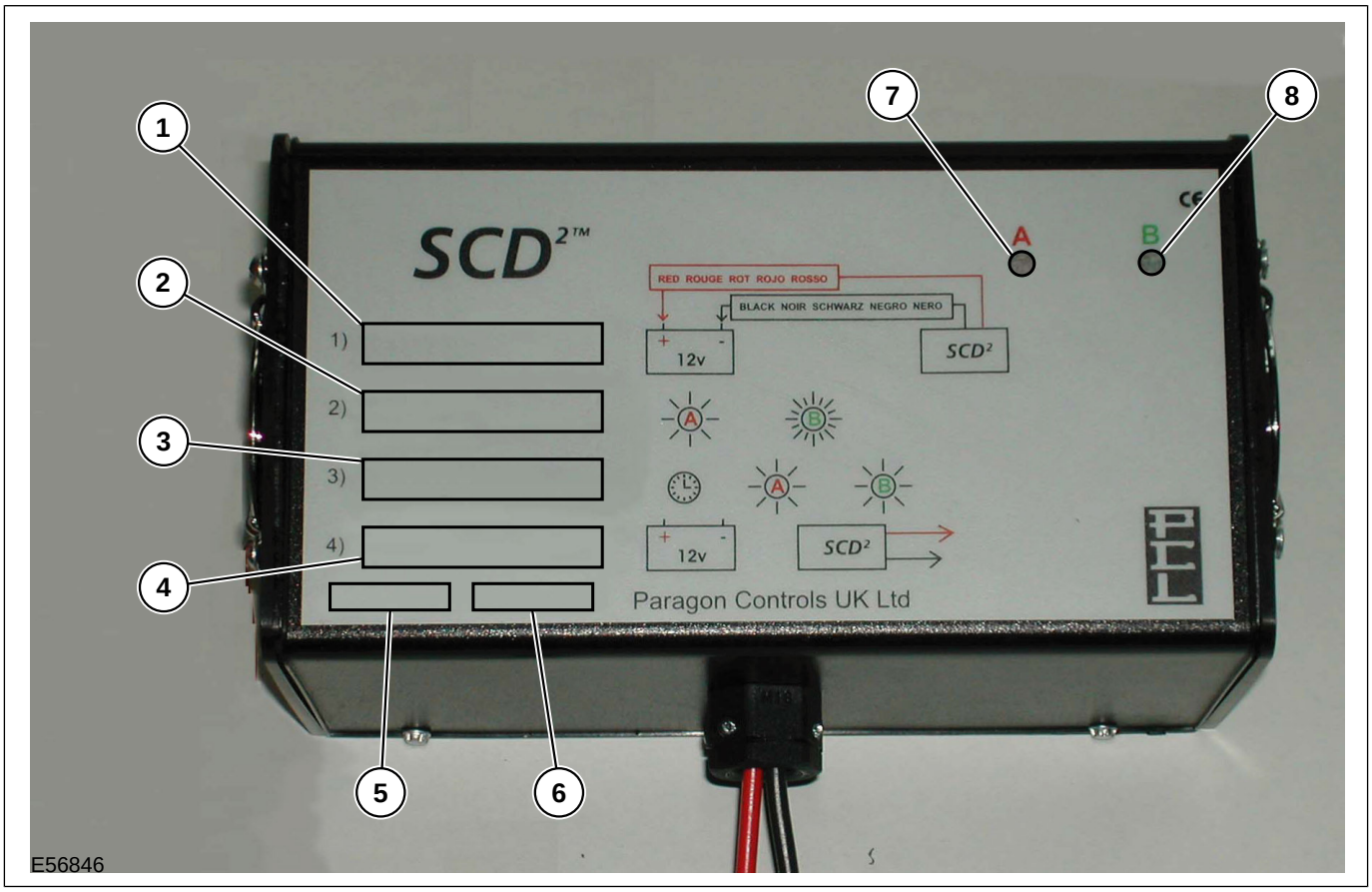
Item	Description
1	Cold crank amp (CCA) rating
2	Reserve capacity (RC) rating (minutes)
3	Battery voltage
4	Ford Part number

Item	Description
5	FINIS code
6	EN number (European Norm)
7	Battery type: Ca = Silver/Calcium; Sb = Lead/Antimony
8	Amp hour rating

DIAGNOSIS AND TESTING

Battery Surface Charge Removal

Surface charge dissipation unit (SCD²)



Item	Description
1	Connect black lead to battery - Connect red lead to battery +
2	Red A indicator illuminates and green B indicator flashes
3	Wait until green B indicator illuminates
4	Disconnect from battery
5	Max 18v
6	-20°C to +55°C
7	Red indicator (A)
8	Green indicator (B)

CAUTION:Prior to testing any battery, the surface discharge must be dissipated. This includes batteries that are returned disconnected from the vehicle. If the battery is holding a surface charge, the battery tester will give false readings.

NOTE: The SCD² tool eliminates the need to dissipate the battery's surface charge via the manual process of loading the battery via the operation of the vehicles electrical systems. It also removes the variability in the process and makes sure that the actual dissipation of the surface charge is qualified prior to testing.

1. Connect the black lead to the battery negative terminal and the red lead to the battery positive terminal.
2. The red indicator (A) illuminates and the green indicator (B) flashes.
3. Wait until the green indicator (B) fully illuminates, then disconnect from the battery.

Alternative Method To Dissipate The Battery Surface Charge

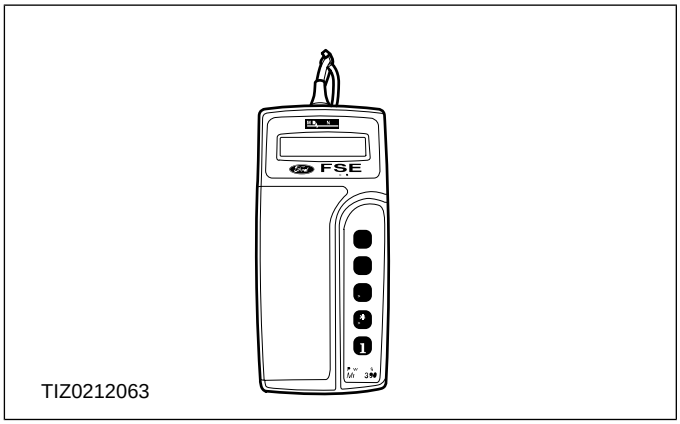
1. Leave the battery to stand for a minimum of six hours without charging or discharging or remove the surface charge through partial loading as follows:
   - Turn the ignition key to position II and switch on the headlamps (main beam), heated windshield (if equipped), heated rear window (if equipped) and the heater blower motor

DIAGNOSIS AND TESTING

(position II). Leave the vehicle in this condition for a minimum of 60 seconds to dissipate the battery surface charge.

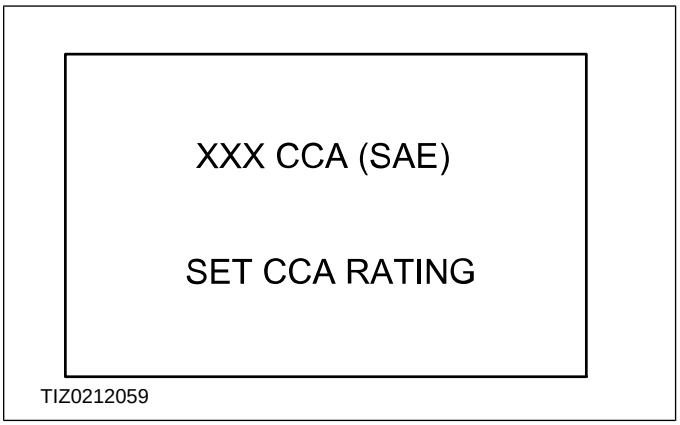
- Turn the ignition key to position 0 and switch off the headlamps, heated windshield (if equipped), heated rear window (if equipped) and the heater blower motor. Leave the vehicle in this condition for a minimum of five minutes before testing battery condition.

Battery Test



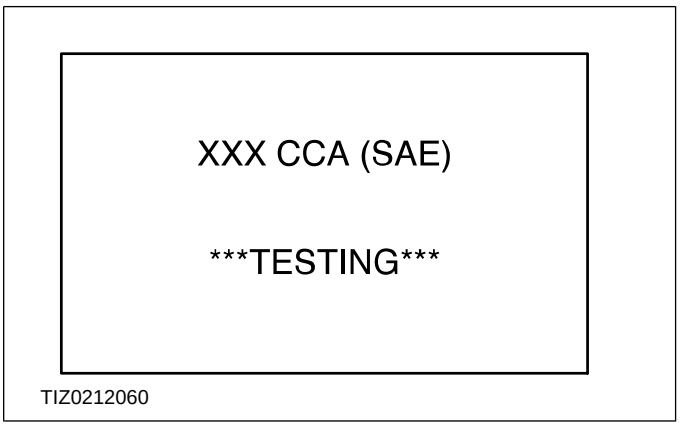
NOTE: Using the Micro390 Battery Tester: To fully determine battery condition once the surface charge has been dissipated, the Micro390 battery tester must be used. For the Micro390 battery tester to operate, it requires a minimum of 5.5 volts charge to be present on the test battery. Therefore, if the Micro390 does not operate when connected to a test battery, then a charge of less than 5.5 volts is present. In this instance, the battery must be charged in line with the battery charging instructions prior to testing. In the event of a conflict of results between the charge eye indicator and the battery tester, the battery tester result must always be used. The charge eye indicator is for guidance only.

1. Connect the battery tester to the battery.
   - Connect the red clip to the battery positive (+) terminal and the black clip to the battery negative (–) terminal.

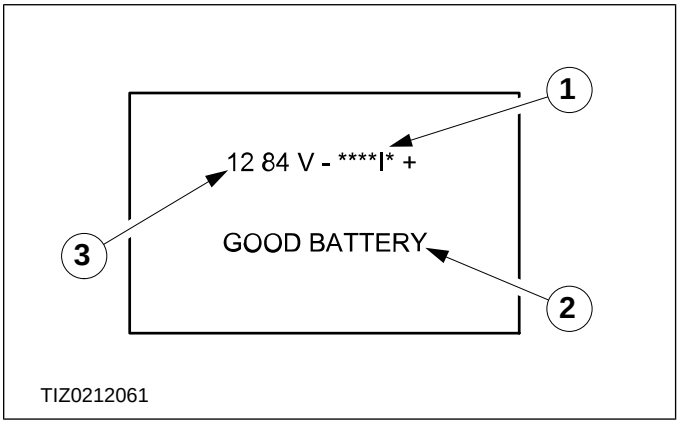


2. **NOTE:The label affixed to the top of batteries progressively from 06/1998 identifies the battery CCA rating. Remove the battery if the label is obscured.**

   Use the ”Arrow” buttons on the battery tester to scroll to the battery’s labelled CCA rating.



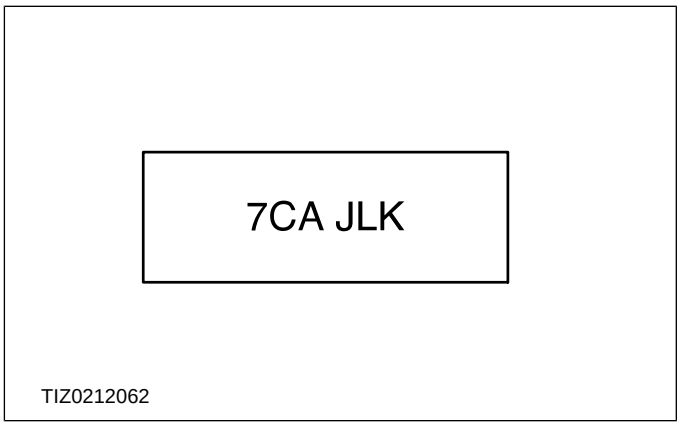
3. Press the ”Test” button that corresponds to the correct battery temperature.
   - If the battery temperature is above zero degrees centigrade: press the ”sun” button. If the battery temperature is below zero degrees centigrade: press the ”Ice-crystal” button.



4. Carry out the action based upon the test result displayed and the following table.
   1. Charge level bar graph.

DIAGNOSIS AND TESTING

2. Test result.
3. Battery voltage.



5. Press the "information" button and carefully note the six-digit "Test Code" on the job card for claim submission and audit purposes (graphic shows an example of the code only).

Battery tester results and required actions

Tester Reading	Action
GOOD BATTERY	Return to service
GOOD RECHARGE	Fully charge the battery and return to service*
CHARGE & RETEST	Fully charge the battery and retest
REPLACE BATTERY or BAD CELL BATTERY	**WARNING:Do not recharge the battery.** Make sure that the surface charge was removed. If so, disconnect the battery from the vehicle and retest. If the result remains after surface charge removal, install a new battery.
UNABLE TO TEST	Disconnect the battery from the vehicle and retest.

*In addition, it is advisable to check the vehicle electrical system. Check that the generator is functioning correctly and that all key-off loads (luggage compartment lamps, glove compartment lamp and interior lamps) are not staying on.

GENERAL PROCEDURES

Battery Charging (31 003 0)

WARNINGS:

Keep batteries out of reach of children. Batteries contain sulphuric acid, avoid contact to skin, eyes or clothing. Shield your eyes when working near the battery to protect against possible splashing of the acid solution. In case of acid contact with the skin or the eyes, flush immediately with water for a minimum of 15 minutes and seek prompt medical attention. If acid is swallowed, call a physician immediately. Failure to follow these instructions may result in personal injury.

Batteries normally produce explosive gases which can cause personal injury, therefore do not allow flames, sparks or lighted substances to come near the battery. When charging or working near the battery always shield your face and protect your eyes. Always provide adequate ventilation. Failure to follow these instructions may result in personal injury.

Always observe all manufacturers instructions when using any charging equipment. Failure to follow these instructions may result in personal injury.

Connect the charger to the battery before switching the charger on. Failure to follow these instructions may result in personal injury.

Switch the charger off before disconnecting the charger from the battery. Failure to follow this instruction may result in personal injury.

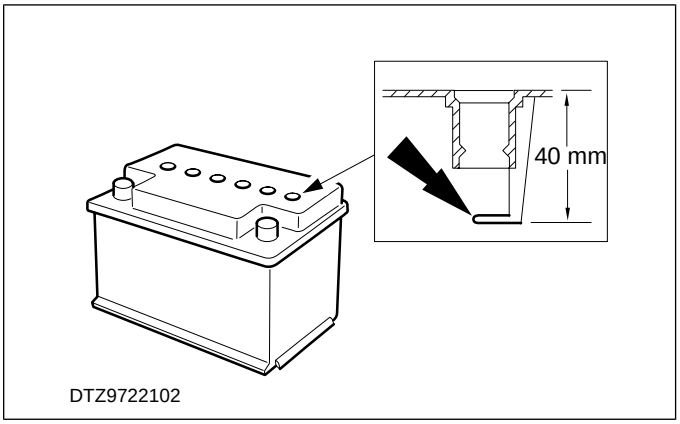
CAUTIONS:

Batteries should not be charged in the vehicle.

Do not rely on the generator to recharge a discharged battery, as it would take in excess of eight hours of continuous driving with no additional loads placed on the charging system.

1. **NOTE:The maximum level mark is approximately 40mm below the top of the battery.**

   Place the battery on a level surface and check the electrolyte level through the casing reaches the indicated maximum mark.



2. **WARNING:It is important not to overfill a battery, as this can cause acid leakage and corrosion damage to the vehicle. Failure to follow these instructions may result in personal injury.**

   If the level is below the maximum mark, remove the vent covers and top up the cell(s) to the correct level.

3. **Cold batteries will not readily accept a charge. Therefore batteries should be allowed to warm up to approximately 5°C (41°F) before charging. This may require four to eight hours at room temperature depending on the initial temperature and battery size.**

4. **A battery which has been completely discharged may be slow to accept a charge initially, and in some cases may not accept a charge at the normal charger setting. When batteries are in this condition, charging can be started by use of the dead battery switch on chargers that have this facility equipped.**

5. **To determine whether a battery is accepting a charge, follow the manufacturers instructions for the charger, for use of the dead battery switch. If the switch is the spring-loaded type, it should be held in the ON position for up to three minutes.**

6. **After releasing the dead battery switch and with the charger still on, measure the battery voltage. If it shows 12 volts or higher, the battery is accepting a charge and is capable of being recharged. However, it may require**

GENERAL PROCEDURES

up to two hours of charging, with batteries colder than 5°C (41°F) before the charge rate is high enough to show a charge on a ammeter. It has been found that all non-damaged batteries can be charged by this procedure. If a battery cannot be charged by this procedure, a new one should be installed.

7. **A rapid recharge procedure has been developed for recharging batteries that have passed the Load Test and only need a recharge. This can be due to in-service no-start battery failures (vehicle will not crank due to low battery state of charge) or battery discharged in vehicle due to key-off loads.**
8. **With the cables then disconnected, the battery can be rapidly recharged by using either of the following methods:**
   - Carry out a two hour charge using 20A constant current (manual setting on charger).
   - Carry out a two hour charge using a constant potential (automatic setting on charger).

SECTION 414-01 Battery, Mounting and Cables

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 414-01-2

DIAGNOSIS AND TESTING

Battery 414-01-3

GENERAL PROCEDURES

Battery Disconnect 414-01-4

REMOVAL AND INSTALLATION

Battery ..... (31 214 0) 414-01-6

SPECIFICATIONS

Battery Specifications

Ah Rating	Battery Type	Build date that Ca battery can be installed from
50	Silver Calcium (Ca)	08/1994
60	Silver Calcium (Ca)	08/1994
70	Silver Calcium (Ca)	08/1994

Torque Specifications

Description	Nm	lb-ft	lb-in
Battery hold down clamp retaining nuts	8	–	71
Battery terminal clamp retaining nuts	9	–	80
Jump start point retaining nut	12	9	–
Seat pedestal retaining bolts	48	35	–
Parking brake control retaining bolts	24	18	–
Jump start point to starter motor solenoid cable retaining nut	12	9	–
Starter motor ground cable retaining nut — vehicles with 2.0L diesel engine	25	18	–
Starter motor ground cable retaining nut — vehicles with 2.3L engine or 2.4L diesel engine	12	9	–
Starter motor retaining bolts — vehicles with diesel engine	25	18	–
Battery ground cable retaining bolt — vehicles with 2.3L engine or 2.0L diesel engine	12	9	–

DIAGNOSIS AND TESTING

Battery

REFER to Section 414-00 [Charging System - General Information].

GENERAL PROCEDURES

Battery Disconnect

Disconnect

WARNINGS:

Batteries normally produce explosive gases which may cause personal injury, therefore do not allow flames, sparks or lighted substances to come near the battery. When charging or working near the battery always shield your face and protect your eyes. Always provide adequate ventilation. Failure to follow these instructions may result in personal injury.

Batteries contain sulphuric acid, avoid contact with skin eyes or clothing. Shield your eyes when working near the battery to protect against possible splashing of the acid solution. In case of acid contact with the skin or eyes, flush immediately for a minimum of 15 minutes and seek prompt medical attention. If swallowed, call a physician immediately. Failure to follow these instructions may result in personal injury.

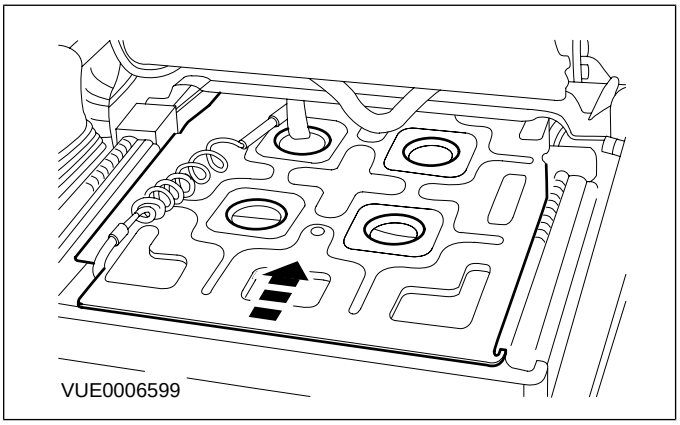
Audio unit key code saving devices must not be used when working on supplemental restraint or fuel systems. When using these devices the vehicle electrical system is still live but with a reduced current flow. Failure to follow this instruction may result in personal injury.

CAUTION:Make sure the engine is not running before disconnecting the battery ground cable to avoid damage to the vehicle electrical system.

NOTE: Before disconnecting the battery make sure that no data is required from the powertrain control module (PCM), as battery cable disconnection will erase any fault codes and idle/drive values held in the keep alive memory (KAM). It is not necessary to disconnect or remove electronic control modules.

NOTE: This procedure should be used to disconnect the battery while carrying out repairs that refer to the battery being disconnected.

1. **Obtain and record the audio unit keycode and preset radio frequencies.**
2. **Slide the driver seat forwards.**
3. **Slide the battery cover forwards.**



4. **Disconnect the battery ground cable.**

Connect

WARNINGS:

Batteries normally produce explosive gases which may cause personal injury, therefore do not allow flames, sparks or lighted substances to come near the battery. When charging or working near the battery always shield your face and protect your eyes. Always provide adequate ventilation. Failure to follow these instructions may result in personal injury.

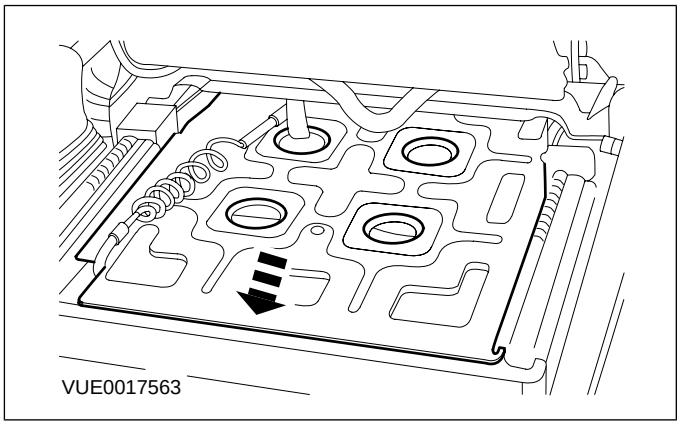
Batteries contain sulphuric acid, avoid contact with skin eyes or clothing. Shield your eyes when working near the battery to protect against possible splashing of the acid solution. In case of acid contact with the skin or eyes, flush immediately for a minimum of 15 minutes and seek prompt medical attention. If swallowed, call a physician immediately. Failure to follow these instructions may result in personal injury.

CAUTION:Make sure all electrical systems are switched OFF before connecting the battery ground cable to avoid damage to the vehicle electrical system.

1. **Connect the battery ground cable.**

GENERAL PROCEDURES

2. Slide the battery cover backwards.



3. Slide the driver seat backwards.
4. Enter the audio unit keycode and preset radio frequencies.
5. Reset the clock to the correct time.
6. NOTE:When the battery has been disconnected and connected, the stored idle and drive values contained within the powertrain control module (PCM) will have been erased. The following steps must be carried out to allow the PCM to relearn its idle and drive values.

   Start and run the engine at idle for three minutes.
7. When the engine reaches normal operating temperature, increase the engine speed to 1200 rpm and maintain for approximately two minutes.
8. Drive the vehicle for approximately five miles/eight kilometers of varied driving.

REMOVAL AND INSTALLATION

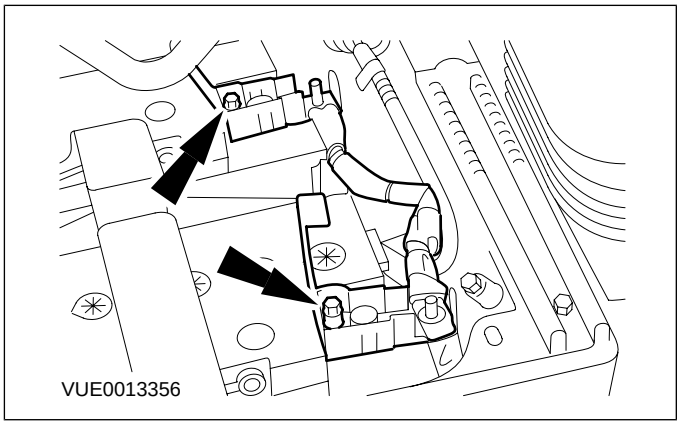
Battery (31 214 0)

Removal

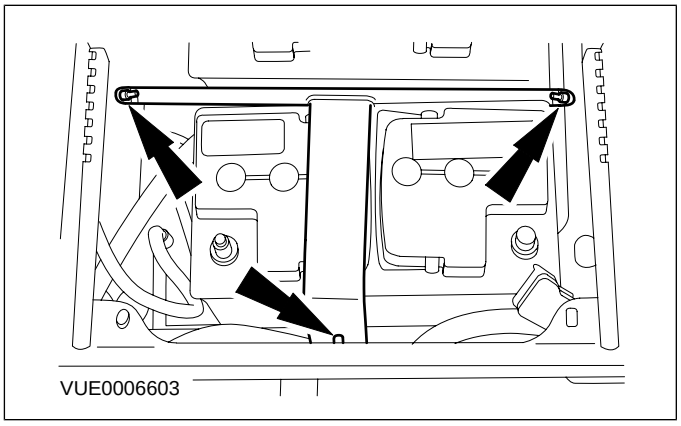
1. **Disconnect the battery ground cable.**

   For additional information, refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

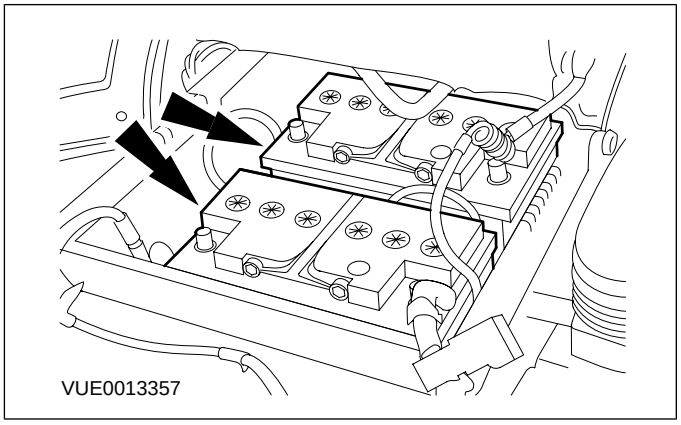
2. **Disconnect the battery positive cables (twin batteries shown).**



3. **Remove the battery retaining bracket.**



4. **Disconnect the battery breather pipes and remove the batteries (twin batteries shown).**

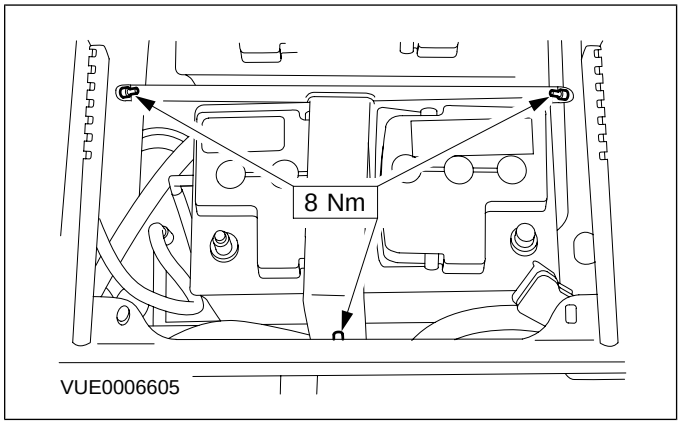


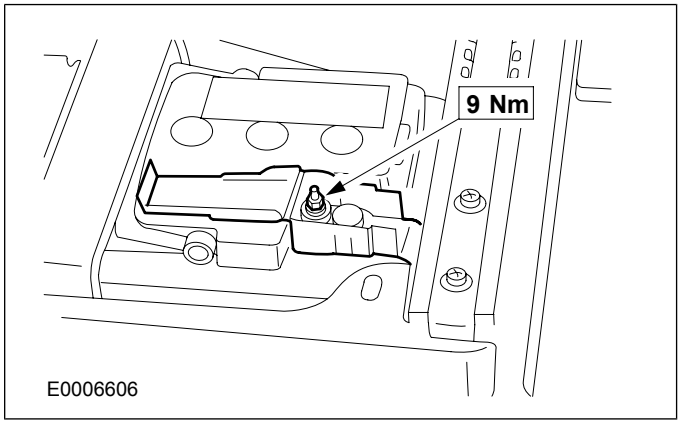
Installation

⚠ **CAUTION:If installing a new battery, only install the specified battery type.**

For additional information, refer to:Specifications (414-01 Battery, Mounting and Cables, Specifications).

1. **To install, reverse the removal procedure.**





SECTION 414-02 Generator and Regulator

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Generator 414-02-2

REMOVAL AND INSTALLATION

Generator — 2.3L Duratec-HE (MI4) 414-02-3
Generator — 2.4L Duratorq-TDCi (Puma) Diesel 414-02-4

DIAGNOSIS AND TESTING

Generator

REFER to Section 414-00 [Charging System - General Information].

REMOVAL AND INSTALLATION

Generator — 2.3L Duratec-HE (MI4)

Removal

NOTE: Removal steps in this procedure may contain installation details.

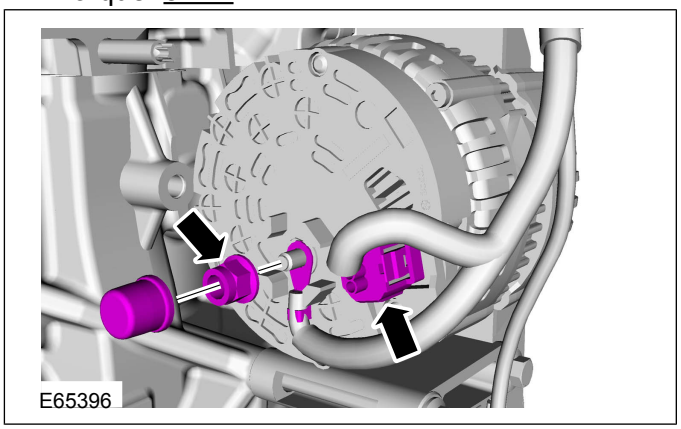
1. Disconnect the battery ground cable.

   Refer to: Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

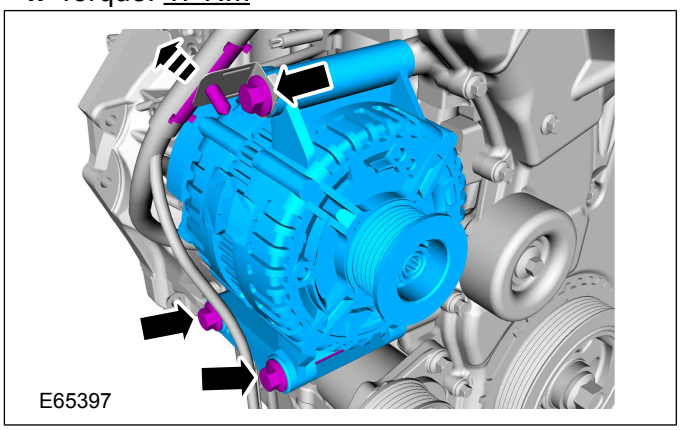
2. Remove the accessory drive belt.

   Refer to: Accessory Drive Belt - 2.3L Duratec-HE (MI4) (303-05 Accessory Drive, Removal and Installation).

3. Install a new generator electrical connector nut cover.
   Torque: 8 Nm



4. Torque: 47 Nm



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Generator — 2.4L Duratorq-TDCi (Puma) Diesel

Removal

NOTE: Removal steps in this procedure may contain installation details.

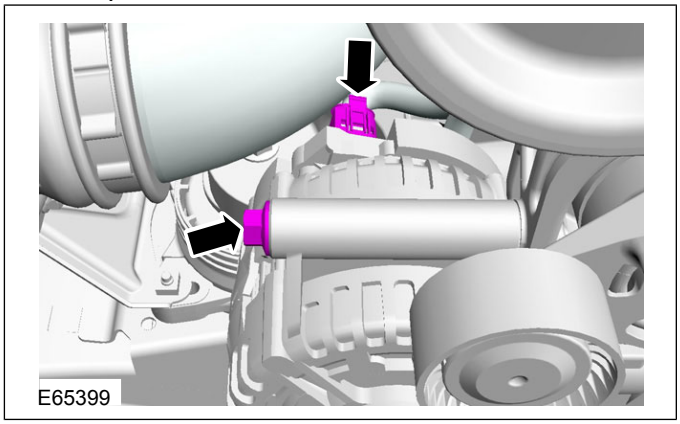
1. Disconnect the battery ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

2. Remove the accessory drive belt.

   Refer to:Accessory Drive Belt - 2.4L Duratorq-TDCi (Puma) Diesel (303-05 Accessory Drive, Removal and Installation).

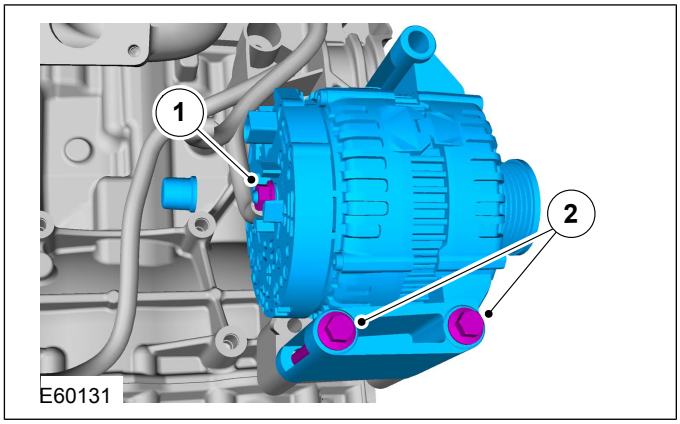
3. Torque: 48 Nm



4. Raise and support the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

5. **NOTE:**Install all the bolts finger tight before final tightening.
   1. Torque: 8 Nm
   2. Torque: 48 Nm
   3. Install a new generator electrical connector nut cover.



Installation

1. To install, reverse the removal procedure.

SECTION 415-00 Information and Entertainment System - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Audio System..... 415-00-2
Inspection and Verification..... 415-00-2
Self-Diagnostic Mode..... 415-00-2
Diagnostic Trouble Code (DTC) Index Chart..... 415-00-3
Symptom Chart..... 415-00-4
Pinpoint Tests..... 415-00-5

DIAGNOSIS AND TESTING

Audio System

Refer to Wiring Diagrams Section 415-00,for schematic and connector information.

General Equipment

Worldwide Diagnostic System (WDS)

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Audio unit – Antenna – Foreign objects contacting speaker – Trim poorly fitted/resonance – Audio control switch (if equipped)	– Fuse(s) – Wiring harness – Electrical connector(s) – Audio unit – Audio control switch (if equipped) – Central junction box (CJB)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Self-Diagnostic Mode.

Self-Diagnostic Mode

NOTE: The audio unit must be in radio mode before entering the Self-Diagnostic Mode.

1. To enter the audio unit Self-Diagnostic Mode, turn the ignition switch to position II and switch the audio unit ON.
2. Press and hold the preset buttons 3 and 5 for 2 seconds, the audio unit will enter the Self-Diagnostic Mode.
3. Release the preset buttons 3 and 6, the audio unit will cycle through the tests in the sequence shown in the Self-Diagnostic Mode tables. The duration of each test is 2 seconds.
4. To exit the Self-Diagnostic Mode, switch the audio unit OFF.

Self-Diagnostic Mode - 2 Channel System

Message Displayed	Description
2 CH COUNT XX	Number of speaker channels.
2 CH RF LOW	Right front speaker and circuit low frequency test.
2 CH RF HIGH	Right front speaker and circuit high frequency test.
2 CH LF LOW	Left front speaker and circuit low frequency test.
2 CH LF HIGH	Left front speaker and circuit high frequency test.
XX.X (frequency) SEEKING	Audio unit searching for an active FM frequency radio station.
XXXXXXXX (name of radio station)	Active FM frequency radio station found (audible for 2 seconds)

Self-Diagnostic Mode - 4 Channel System

Message Displayed	Description
4 CH COUNT XX	Number of speaker channels.
4 CH RF LOW	Right front speaker and circuit low frequency test.
4 CH RF HIGH	Right front speaker and circuit high frequency test.
4 CH LF LOW	Left front speaker and circuit low frequency test.
4 CH LF HIGH	Left front speaker and circuit high frequency test.
4 CH RR LOW	Right rear speaker and circuit low frequency test.

DIAGNOSIS AND TESTING

Message Displayed	Description
4 CH RR HIGH	Right rear speaker and circuit high frequency test.
4 CH LR LOW	Left rear speaker and circuit low frequency test.
4 CH LR HIGH	Left rear speaker and circuit high frequency test.

Message Displayed	Description
XX.X (frequency) SEEKING	Audio unit searching for an active FM frequency radio station.
XXXXXXXX (name of radio station)	Active FM frequency radio station found (audible for 2 seconds).

5. If the cause is not evident after the Self-Diagnostic Mode, connect the WDS to the data link connector (DLC).
6. Retrieve the Diagnostic Trouble Codes (DTC)s and refer to the DTC Index Chart.

Diagnostic Trouble Code (DTC) Index Chart

DTC	Description/Condition	Possible Source	Action
U3003	Battery voltage low	Charging system	REFER to:Charging System (414-00, Diagnosis and Testing).
P1628	Ignition state and Controller area network (CAN) messages do not match	CAN	REFER to:Communications Network (418-00 Module Communications Network, Diagnosis and Testing).
U3000	Audio unit failure	Audio unit	INSTALL a new audio unit. REFER to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation).
B1A01	General failure with speakers or speaker circuits	Speakers or speaker circuits	GO to Pinpoint Test C.
U2100	Initial configuration not compete	Audio unit configuration	GO to Pinpoint Test F.

DIAGNOSIS AND TESTING

DTC	Description/Condition	Possible Source	Action
U0155	Lost communication with instrument cluster	CAN	REFER to:Communications Network (418-00 Module Communications Network, Diagnosis and Testing).
U0238	Lost communication with digital audio control module	CAN	REFER to:Communications Network (418-00 Module Communications Network, Diagnosis and Testing).
U0140	Lost communication with body control module	CAN	REFER to:Communications Network (418-00 Module Communications Network, Diagnosis and Testing).
B10BC	Audio control switch voltage out of range	Audio unit control switch or circuits	GO to Pinpoint Test E.

1. If the cause is still evident, refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• The audio unit is inoperative/does not operate correctly	• Circuit. • Audio unit.	• GO to Pinpoint Test A.
• The display is blank - radio and CD player operate	• Audio unit.	• INSTALL a new audio unit. REFER to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation). TEST the system for normal operation.
• Poor reception	• Antenna. • Antenna cable. • Audio unit.	• GO to Pinpoint Test B.
• Poor quality/distorted sound from one or more speakers (not all speakers)	• Speaker(s). • Circuit. • Audio unit.	• GO to Pinpoint Test C.
• No sound from all speakers	• Audio unit.	• INSTALL a new audio unit. REFER to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation). TEST the system for normal operation.

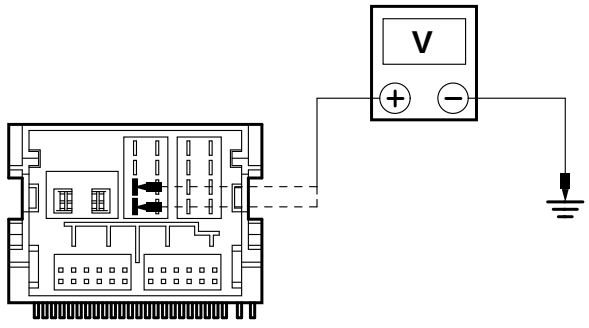
DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• No sound from one or more of the speakers (not all speakers)	• Speaker(s). • Circuit. • Audio unit.	• GO to Pinpoint Test D.
• The audio control switch is inoperative/does not operate correctly.	• Circuit. • Audio control switch. • Audio unit.	• GO to Pinpoint Test E.
• The audio unit illumination is inoperative	• Fuse(s). • Circuit(s). • Audio unit. • Central junction box (CJB).	• REFER to:Instrument Cluster and Panel Illumination (413-00 Instrument Cluster and Panel Illumination, Diagnosis and Testing).
• The audio unit clock is not displayed	• Audio unit connector. • Audio unit. • Instrument cluster.	• REFER to:Instrument Cluster (413-01 Instrument Cluster, Diagnosis and Testing).

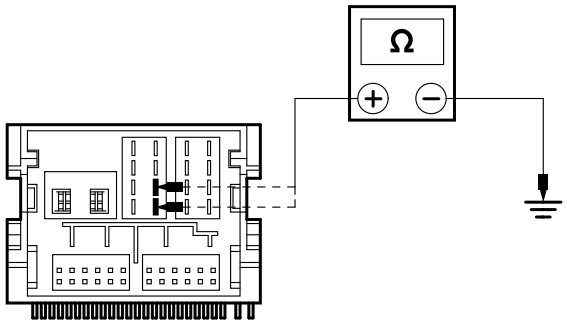
Pinpoint Tests

NOTE: Use a digital multimeter for all electrical measurements.

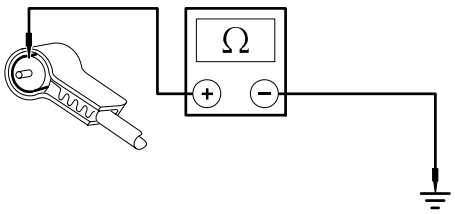
PINPOINT TEST A : THE AUDIO UNIT IS INOPERATIVE/DOES NOT OPERATE CORRECTLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK FOR POWER TO THE AUDIO UNIT	
	1 Disconnect Audio Unit CME03B.
	2 Ignition switch in position I.
 E42130	3 Measure the voltage between the audio unit CME03B pin 15, circuit SBP73C (RD), harness side and ground, and between the audio unit CME03B pin 16, circuit SBP82J (RD/BK), harness side and ground. • Are the voltages greater than 10 volts? → **Yes** GO to A2. → **No** REPAIR circuit SBP73C (RD) or circuit SBP82J (RD/BK). TEST the system for normal operation.
A2: CHECK THE AUDIO UNIT GROUND CIRCUITS FOR GROUND	
	1 Ignition switch in position 0.

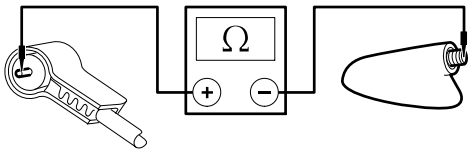
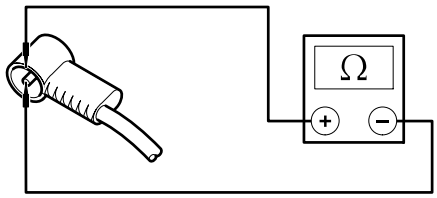
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E42131	2 Measure the resistance between the audio unit CME03B pin 11, circuit GD114J (BK/OG), harness side and ground, and between the audio unit CME03B pin 12, circuit GD114H (BK/OG), harness side and ground. • Are the resistances less than 1 ohm? → **Yes** INSTALL a new audio unit. REFER to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit GD114J (BK/OG) or circuit GD114H (BK/OG). TEST the system for normal operation.

PINPOINT TEST B : POOR RECEPTION

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK THE ANTENNA CABLE SHIELD	
	1 Ignition switch in position 0.
	2 Disconnect the antenna cable from the audio unit.
 TIW3801009	3 Measure the resistance between the antenna cable ground connector (shield), and ground. • Is the resistance less than 1 ohm? → **Yes** GO to B2. → **No** CLEAN and TIGHTEN the antenna base connection to the body. If the concern persists, INSTALL a new antenna cable. TEST the system for normal operation.
B2: CHECK THE ANTENNA CENTER CONDUCTOR FOR OPEN CIRCUIT	
	1 Remove the antenna mast.

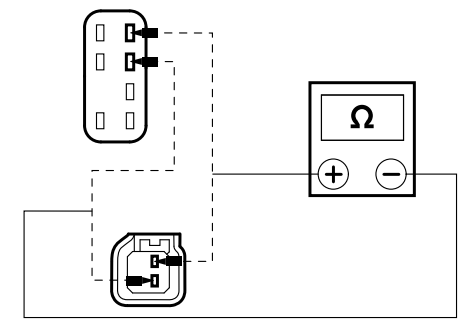
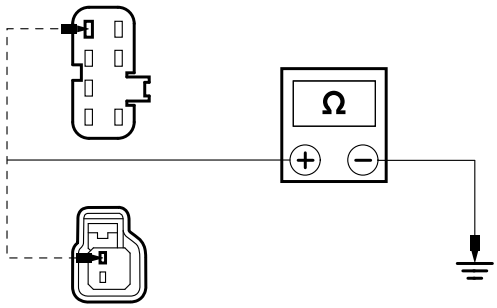
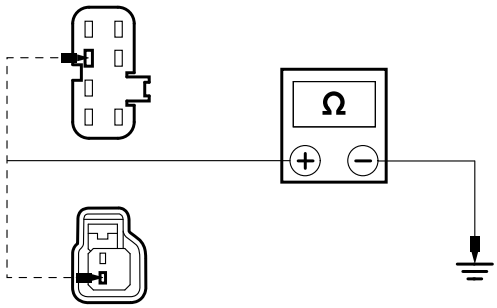
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIW3801010	2 Measure the resistance of the center conductor between the ends of the antenna cable. • Is the resistance less than 1 ohm? → **Yes** GO to B3. → **No** INSTALL a new antenna cable. TEST the system for normal operation.
B3: CHECK ANTENNA CABLE FOR SHORT	
 V3801158	1 Measure the resistance between the antenna center conductor and the antenna ground (shield). • Is the resistance greater than 10,000 ohms (open circuit)? → **Yes** CLEAN and TIGHTEN the ground connections at the base of the antenna and battery negative cable to the body. If concern the persists, INSTALL a new audio unit. REFER to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation). TEST the system for normal operation. → **No** INSTALL a new antenna cable. TEST the system for normal operation. If the concern persists, INSTALL a new audio unit. REFER to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation).

PINPOINT TEST C : POOR QUALITY/DISTORTED SOUND FROM ONE OR MORE SPEAKERS (NOT ALL SPEAKERS)

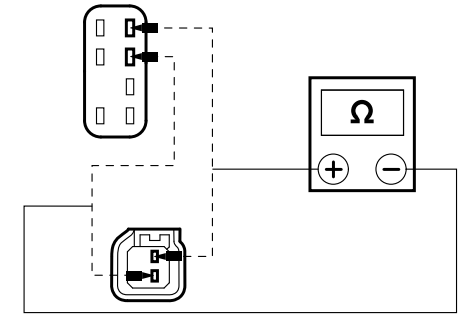
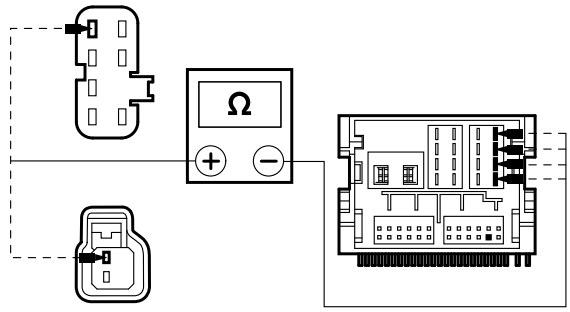
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CHECK THE SPEAKER RESISTANCE	
	1 Disconnect Affected Speaker.

DIAGNOSIS AND TESTING

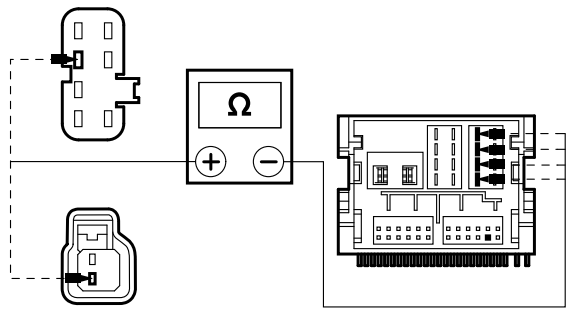
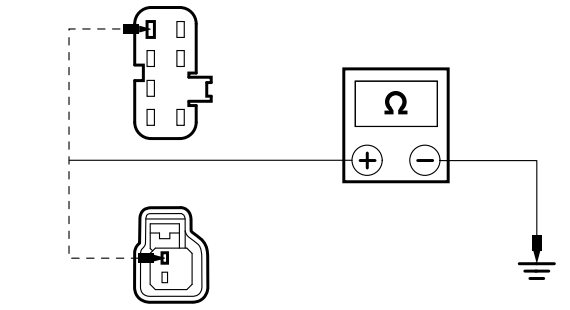
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E72091	2 Measure the resistance between the affected speaker pin 1 and pin 2, component side. • Is the resistance approximately 4.0 ohms? → **Yes** GO to C2. → **No** INSTALL a new speaker. TEST the system for normal operation.
C2: CHECK SPEAKER INPUT FOR SHORT TO GROUND	
	1 Disconnect Audio Unit CME03A.
 E72096	2 Measure the resistance between the affected speaker connector pin 1, harness side and ground. • Is the resistance greater than 10,000 ohms (open circuit)? → **Yes** GO to C3. → **No** REPAIR speaker input circuit. TEST the system for normal operation.
C3: CHECK SPEAKER RETURN FOR SHORT TO GROUND	
 E72093	1 Measure the resistance between the affected speaker connector pin 2, harness side and ground. • Is the resistance greater than 10,000 ohms (open circuit)? → **Yes** INSTALL a new speaker. TEST the system for normal operation. If the concern persists, INSTALL a new audio unit. REFER to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation). → **No** REPAIR speaker return circuit. TEST the system for normal operation.

DIAGNOSIS AND TESTING

PINPOINT TEST D : NO SOUND FROM ONE OR MORE OF THE SPEAKERS (NOT ALL SPEAKERS)

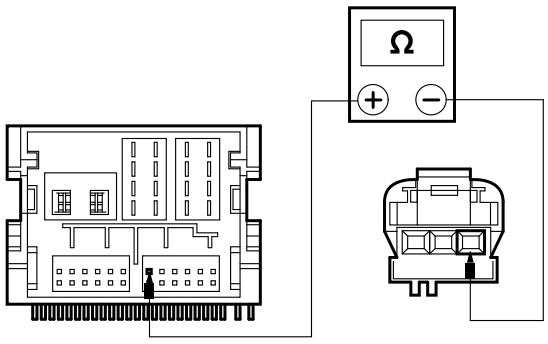
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: CHECK THE SPEAKER RESISTANCE	
	1 Disconnect Inoperative Speaker.
 E72091	2 Measure the resistance between the inoperative speaker pin 1 and pin 2, component side. • Is the resistance approximately 4.0 ohms? → **Yes** GO to D2. → **No** INSTALL a new speaker(s). TEST the system for normal operation.
D2: CHECK THE INOPERATIVE SPEAKER(S) CONNECTOR PIN 1 CIRCUIT	
	1 Disconnect Audio Unit CME03A.
 E72094	2 Measure the resistance between the following audio unit CME03A pins, harness side and the inoperative speaker(s) connector pin 1, harness side: – (Left front speaker) CME07 pin 1, circuit VME07C (GN/BK) to CME03A pin 3, circuit VME07H (GN/BK). – (Left rear speaker) CME09 pin 1, circuit VME09F (BN/GN) to CME03A pin 4, circuit VME09E (BN/GN). – (Right front speaker) CME10 pin 1, circuit VME10C (VT/BK) to CME03A pin 2, circuit VME10J (VT/BK). – (Right rear speaker) CME12 pin 1, circuit VME12D (BN/WH) to CME03A pin 1, circuit VME12H (BN/WH). • Is the resistance less than 1 ohm? → **Yes** GO to D3. → **No** REPAIR the circuit in question. TEST the system for normal operation.

DIAGNOSIS AND TESTING

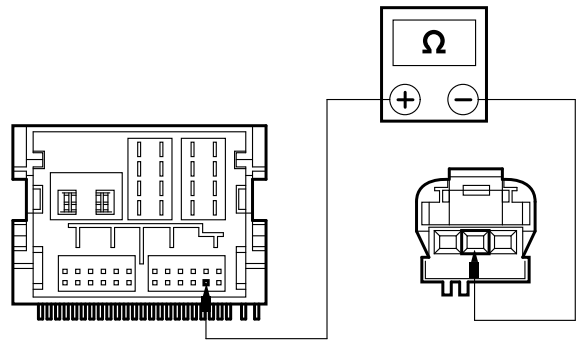
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D3: CHECK THE INOPERATIVE SPEAKER(S) CONNECTOR PIN 2 CIRCUIT	
 E72095	1 Measure the resistance between the following audio unit CME03A pins, harness side and the inoperative speaker(s) connector pin 2, harness side: – (Left front speaker) CME07 pin 2, circuit RME07A (WH/BN) to CME03A pin 7, circuit RME07D (WH/BN). – (Left rear speaker) CME09 pin 2, circuit REM09F (BN/YE) to CME03A pin 8, circuit RME09E (BN/YE) – (Right front speaker) CME10 pin 2, circuit RME10C (WH/OG) to CME03A pin 6, circuit RME10E (WH/OG). – (Right rear speaker) CME12 pin 2, circuit RME12D (BN/BU) to CME03A pin 5, circuit RME12E (BN/BU). • Is the resistance less than 1 ohm? → **Yes** GO to D4. → **No** REPAIR the circuit in question. TEST the system for normal operation.
D4: CHECK THE INOPERATIVE SPEAKER(S) CIRCUIT FOR SHORT TO GROUND	
 E72096	1 Measure the resistance between the following inoperative speaker(s) connector pin 1, harness side and ground: – (Left front speaker) CME07 pin 1, circuit VME07A (WH), to ground. – (Left rear speaker) CME09 pin 1, circuit VME09F (BN/GN), to ground. – (Right front speaker) CME10 pin 1, circuit VME10C (WH/VT), to ground. – (Right rear speaker) CME12 pin 1, circuit VME12D (BN/WH), to ground. • Is the resistance greater than 10,000 ohms (open circuit)? → **Yes** INSTALL a new speaker. TEST the system for normal operation. → **No** REPAIR the circuit in question. TEST the system for normal operation.

DIAGNOSIS AND TESTING

PINPOINT TEST E : THE AUDIO CONTROL SWITCH IS INOPERATIVE/DOES NOT OPERATE CORRECTLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: CHECK THE AUDIO UNIT OPERATES CORRECTLY USING THE AUDIO UNIT CONTROLS	
	1 Operate the audio unit using the audio unit controls. • Does the audio unit operate correctly using the audio unit controls? → **Yes** If the auxiliary audio control switch is inoperative, GO to E2. → **No** INSTALL a new audio unit. REFER to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation). TEST the system for normal operation.
E2: CHECK THE CIRCUIT VME14A (GY/YE) FOR OPEN	
	1 Disconnect Audio Unit CME03C.
	2 Disconnect Audio Control Switch CME14.
 E42139	3 Measure the resistance between the audio unit CME03C pin 6, circuit VME14A (GY/YE) harness side and the audio control switch CME14 pin 1, circuit VME14B (GY/YE) harness side. • Is the resistance less than 1 ohm? → **Yes** GO to E3. → **No** REPAIR the circuit. TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E3: CHECK CIRCUIT RME24A (BU/WH) FOR OPEN	
 E42140	1 Measure the resistance between the audio unit CME14 pin 8, circuit RME24A (BU/WH) harness side and the auxiliary audio control switch CME14 pin 2, circuit RME24B (BU/WH) harness side. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new auxiliary audio control switch. TEST the system for normal operation. If the concern persists, INSTALL a new audio unit. REFER to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation). → **No** REPAIR the circuit. TEST the system for normal operation.

PINPOINT TEST F : AUDIO UNIT CONFIGURATION INCOMPLETE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F1: CONFIGURE THE AUDIO UNIT TO THE VEHICLE	
	1 Ignition switch in position III.
	2 WAIT for 10 seconds. During this time the audio unit will receive the central configuration data.
	3 Ignition switch in position 0.
	4 WAIT for 10 seconds.
	5 Ignition switch in position III.
	6 Using the WDS, CHECK the audio unit for DTC U2100. • Is DTC U2100 present? → **Yes** REPEAT the audio unit configuration procedure. If the concern persists, REFER to:Communications Network (418-00 Module Communications Network, Diagnosis and Testing). → **No** TEST the system for normal operation.

SECTION 415-01 Information and Entertainment System

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Information and Entertainment System..... 415-01-2

REMOVAL AND INSTALLATION

Audio Unit..... 415-01-3
Handset Holder..... 415-01-4
Portable Support Electronics (PSE) Module..... 415-01-5

DIAGNOSIS AND TESTING

Information and Entertainment System

1. REFER to:(415-00 Information and Entertainment System - General Information)

   Audio System (Diagnosis and Testing),
   Cellular Phone (Diagnosis and Testing),
   Navigation System (Diagnosis and Testing).

REMOVAL AND INSTALLATION

Audio Unit

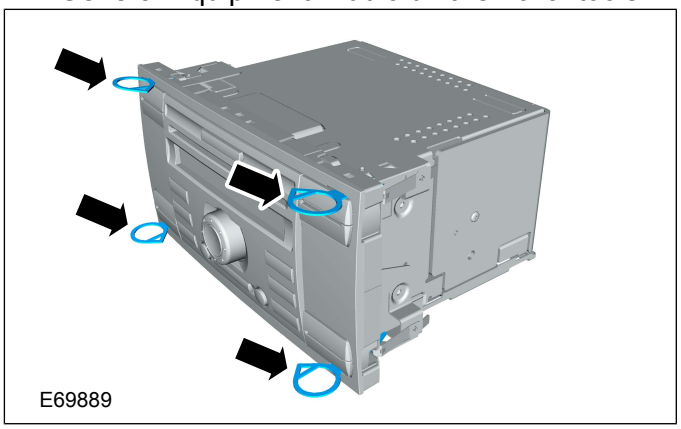
General Equipment

Audio unit removal tools

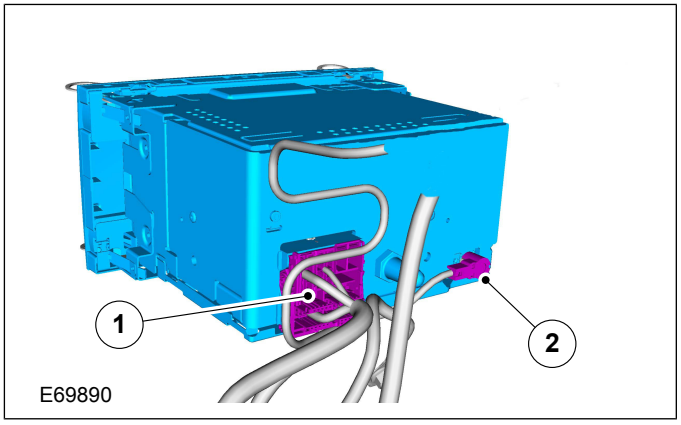
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. If a new audio unit is to be installed, connect the WDS and upload the audio unit configuration information using the Programmable Modules Installation Routine, prior to commencing the removal of the audio unit.
2. General Equipment: Audio unit removal tools



3. **CAUTION:Make sure that the wiring harness does not catch when installing the component.**



4. Remove the audio unit removal tools from the audio unit.

Installation

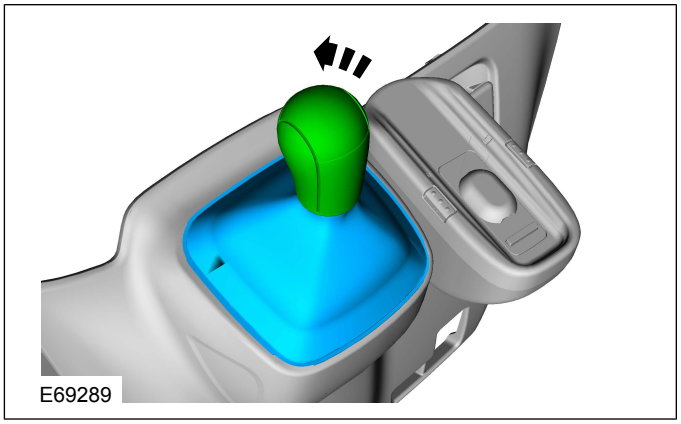
1. **NOTE:**New audio units must be configured using the Programmable Module Installation Routine in the Worldwide Diagnostic System (WDS).
2. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

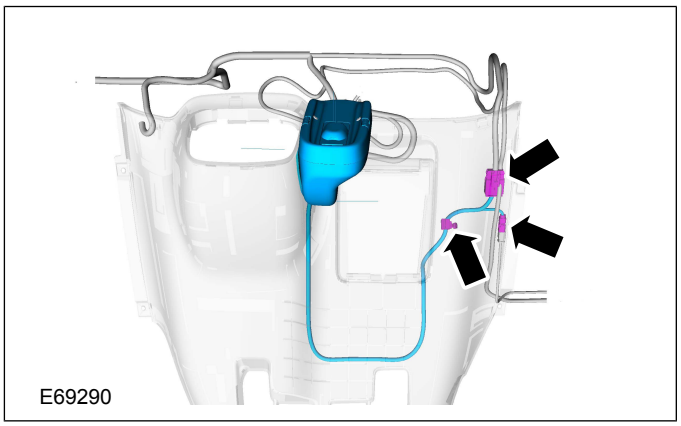
Handset Holder

Removal

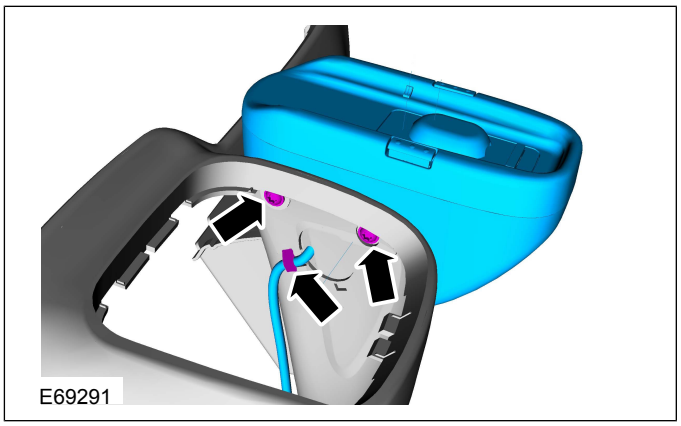
1.



2.



3.



Installation

1. To install, reverse the removal procedure.

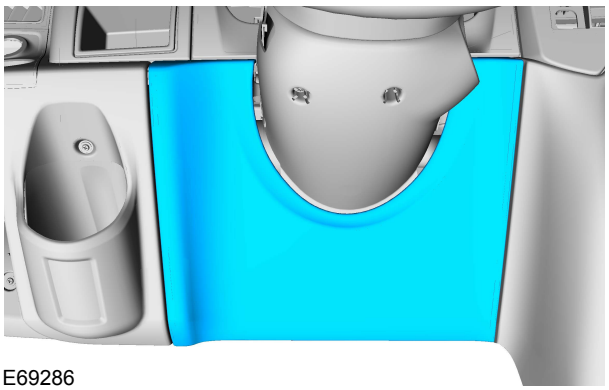
REMOVAL AND INSTALLATION

Portable Support Electronics (PSE) Module

Removal

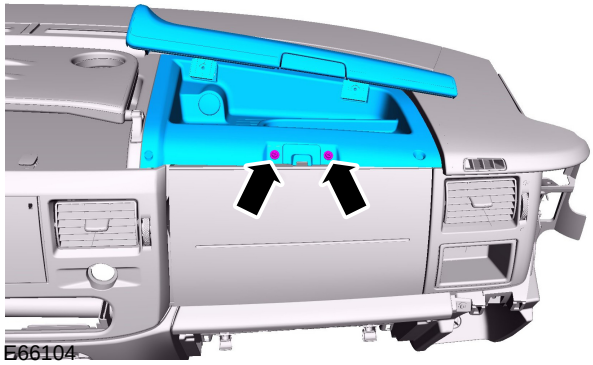
Left-hand drive vehicles

1.

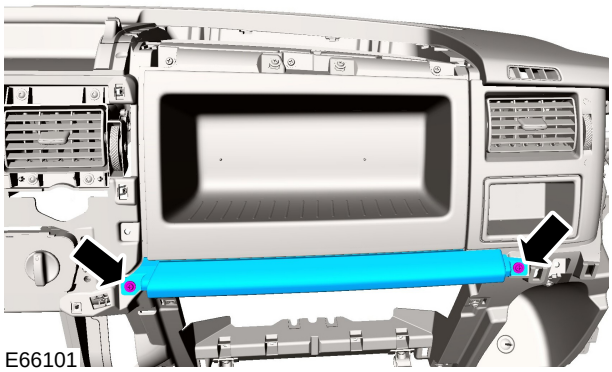

E69286

Right-hand drive vehicles

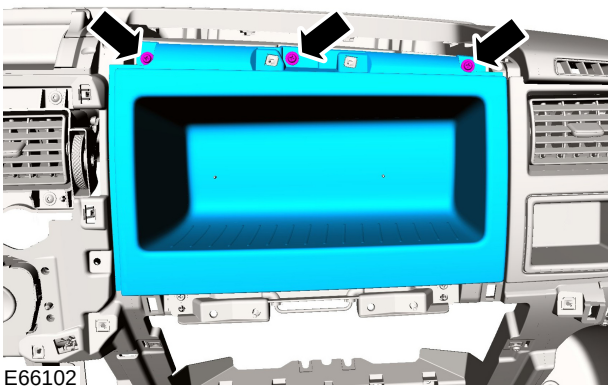
2.


E66104

3.

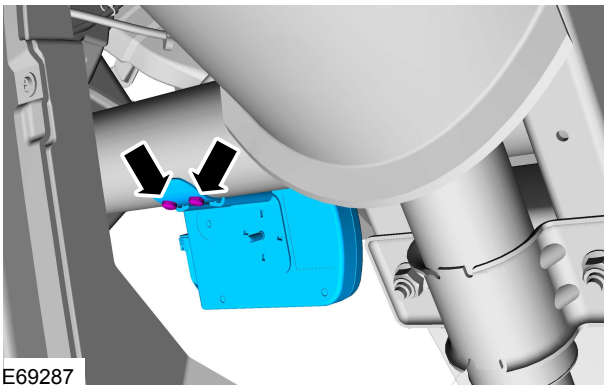

E66101

4.

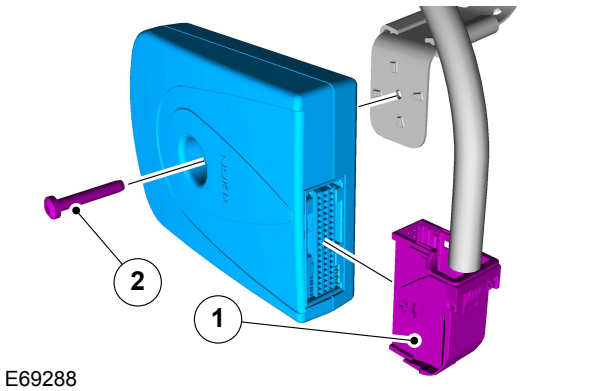

E66102

All vehicles

5.


E69287

6.



E69288

Installation

1. To install, reverse the removal procedure.

SECTION 417-01 Exterior Lighting

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 417-01-3

DESCRIPTION AND OPERATION

Exterior Lighting 417-01-4
- Headlamp 417-01-4
- Headlamp leveling system 417-01-4
- Automatic headlamps 417-01-5
- Headlamp switch-off delay 417-01-5
- Combined rain sensor/light sensor 417-01-5
- Rear lighting 417-01-6

DIAGNOSIS AND TESTING

Headlamps 417-01-7
- Inspection and Testing 417-01-7
- Symptom chart 417-01-7
- System Checks 417-01-8
- Component Tests 417-01-53

Stoplamps 417-01-56
- Inspection and Testing 417-01-56
- Symptom chart 417-01-56
- Pinpoint test 417-01-57

Turn Signal and Hazard Lamps 417-01-69
- Inspection and Testing 417-01-69
- Symptom chart 417-01-69
- Pinpoint test 417-01-70

Parking, Rear and License Plate Lamps 417-01-112
- Inspection and Testing 417-01-112
- Symptom Chart 417-01-112
- System Checks 417-01-113

Fog Lamps 417-01-154
- Inspection and Testing 417-01-154
- Symptom Chart 417-01-154
- System Checks 417-01-155

Reversing Lamps 417-01-190
- Inspection and Testing 417-01-190
- Symptom chart 417-01-190
- Pinpoint test 417-01-190

Trailer Lamps 417-01-200
- Inspection and Testing 417-01-200
- Symptom chart 417-01-200
- Pinpoint Test 417-01-200

Headlamp Leveling 417-01-219
- Inspection and Testing 417-01-219

Symptom chart..... 417-01-219
Pinpoint Test..... 417-01-219

GENERAL PROCEDURES

Headlamp Adjustment..... (32 113 0) 417-01-227
Front Fog Lamp Adjustment..... 417-01-228
Headlamp Masking..... 417-01-229

REMOVAL AND INSTALLATION

Headlamp Assembly..... 417-01-236
Headlamp Leveling Motor..... 417-01-237
Headlamp Switch..... 417-01-238
Stoplamp Switch..... 417-01-239
Front Fog Lamp..... 417-01-240

SPECIFICATIONS

Headlamp adjustment

	Adjust
Headlamp	X = 12 cm/10 m = 0 degrees, 41 minutes = 1.2%

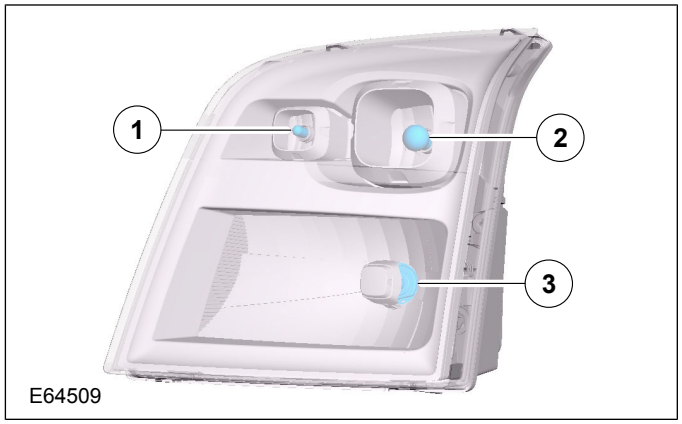
Front fog lamp adjustment

	Adjust
Front fog lamps	X = 22 cm/10 m = 1 16' = 2.2 %

DESCRIPTION AND OPERATION

Exterior Lighting

Headlamp



Item	Description
1	Side light
2	Turn signal lamp
3	Dipped beam headlamps/main beam headlamps

The headlamp units are primarily made of plastic and make use of free-form reflectors in order to optimize light distribution.

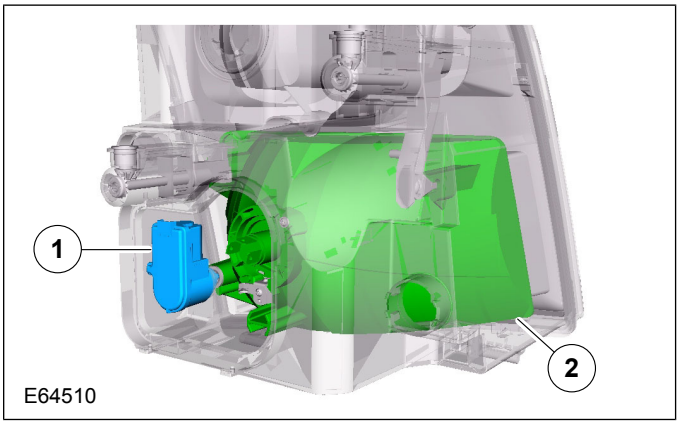
The transparent plastic cover is made from polycarbonate, which is coated for protection against scratches and cracks.

In the event of damage to the cover the entire headlamp unit needs to be replaced.

The turn signal lamps and side lights are also integrated in the headlamp unit.

For conventional headlamps, adapting the vehicle to conform to country-specific traffic situations (left/right-hand side traffic) during travel is accomplished by affixing punched adhesive strips to specific areas of the headlamp.

Headlamp leveling system



Item	Description
1	Headlamp leveling system servo motor
2	Reflector

The headlamp leveling system is operated by means of voltage controlled DC motors and is actuated by the headlamp leveling switch.

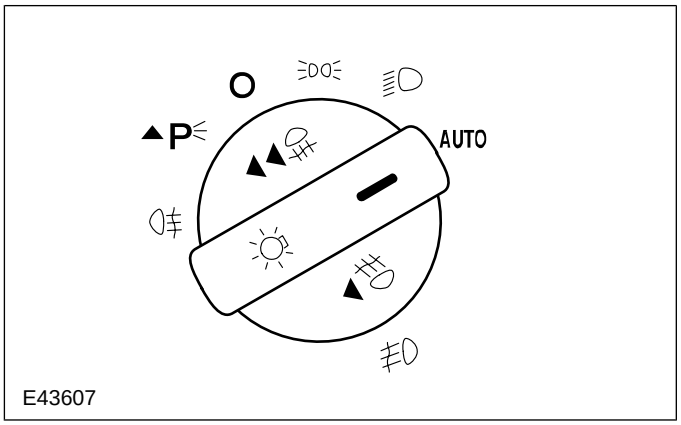
Each headlamp unit is equipped with a headlamp leveling positioning motor which adjusts the swiveling reflector via an adjusting spindle until the required setting is attained.

A potentiometer inside the headlamp leveling switch is used to adjust a voltage (required value). Following the same principle, the actuator in the motor produces a voltage according to the position of the adjustment spindle (actual value).

The electronic system compares the required value (setting of the switch) with the actual value (adjustment spindle setting). Depending on the voltage difference, the reflector is moved upwards or downwards until the voltages are identical.

DESCRIPTION AND OPERATION

Automatic headlamps



E43607

The dipped beam headlamps, side lights and license plate lamps are switched on automatically if all of the following conditions are satisfied:

- Ignition switch in the "II" or "III" position
- Light switch in the "AUTO" position
- Detected ambient light conditions below a stored threshold value

The dipped beam, the side lights and the license plate lamps are switched on or off by the generic electronic module (GEM) according to the input signals of the combined rain sensor/light sensor. This takes place in the generic electronic module (GEM) by activating the dipped beam relay and the automatic headlamps relay (side lights/license plate lamps).

Headlamp switch-off delay

The headlamp switch-off delay function uses the dipped beam headlamps to illuminate the area surrounding the vehicle. The side lights and the license plate lamps are also switched on.

The function is activated by switching on the main beam headlamps with the ignition key removed from the lock.

The headlamp switch-off delay function is active for 30 seconds and then switches off automatically.

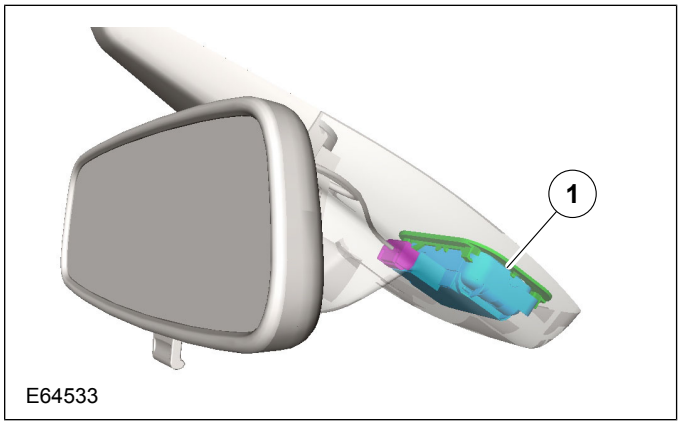
When a door or the tailgate is open, the switch-off time is extended to 180 seconds. After the last door has been closed, the switch-off time is reset to 30 seconds.

The headlamp switch-off delay can be deactivated prematurely by operating the high beam lever again or by switching on the ignition.

The switch-off time is set at the factory and can be reprogrammed to a maximum of 180 seconds using WDS.

Combined rain sensor/light sensor

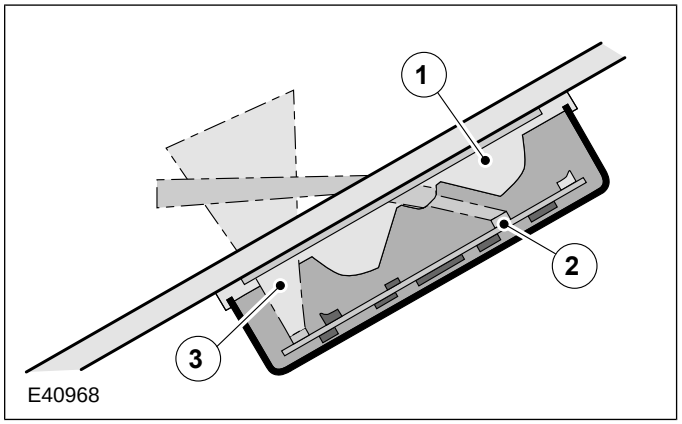
The combined rain sensor/light sensor (1) is attached to the windshield, near to the interior rear view mirror.



E64533

The ambient light sensor determines the general light intensity. For this purpose, it records the light over as wide an angle as possible, without taking the direction of incidence into account.

The front light sensor determines the light intensity directly in front of the vehicle.



E40968

Item	Description
1	Lens
2	Front light sensor
3	Ambient light sensor

If both the ambient light sensor and the front light sensor detect a sudden reduction in light intensity at the same time, then an algorithm-based calculation is used to determine the fact that the vehicle has entered a tunnel, a multi-storey car park or a long underpass.

In this case, the request for switching on the exterior lighting and the indicator light in the instrument cluster is transmitted to the generic electronic module (GEM.

DESCRIPTION AND OPERATION

If the vehicle enters into the shade thrown by a large truck, the two sensors will register different light intensities.. In this case, the algorithm-based calculation will not result in the lights being switched on.

Rear lighting

The rear lamp clusters incorporate all of the rear lighting functions except the license plate lamp and the additional high-mounted stop lamp.

The rear lamp assemblies are replaced as a complete unit during servicing.

The rear lamp assemblies need to be removed in order to change a bulb.

The individual bulb holders and circuits are integrated into the lamp holder.

A compact connector connects the lamp holder to the wiring harness.

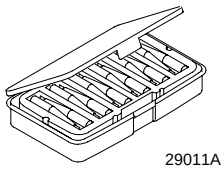
On vehicles equipped with a liftgate, the high mounted stoplamp is installed in the center of the liftgate. On vehicles with rear doors it is positioned in the left-hand rear door.

DIAGNOSIS AND TESTING

Headlamps

Refer to Wiring Diagrams Section 417-01,for schematic and connector information.

Special Tool(s)

 29011A	Set of adapter plugs for test probes 29-011A

Inspection and Testing

NOTE: The generic electronic module (GEM) forms part of the central junction box (CJB).

NOTE: If the generic electronic module (GEM) is changed, the new one must be reinitialized. For this purpose, the vehicle-specific data is read out of the module to be replaced using WDS and is transferred to the new module. REFER to:

Communications Network (418-00 Module Communications Network, Diagnosis and Testing),
Generic Electronic Module (GEM) (419-10 Multifunction Electronic Modules, Diagnosis and Testing).

NOTE: Before reading out the vehicle-specific data, remake all the electrical connections to the module to be removed, so that communication between the module and WDS is ensured.

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical or mechanical damage.

Visual Inspection Chart

Mechanical	Electrical
• Check the windshield for damage/cracks in the vicinity of the rain sensor. • Check that the rain sensor retaining frame is correctly attached to the wind-shield.	• Fuse(s) • Bulb(s) • Connector(s) • Switch • Wiring loom

3. Resolve any obvious causes or concerns found during the visual inspection before carrying out any further tests.
4. If the cause of the concern cannot be found by visual inspection, continue with the symptom chart.

Symptom chart

Symptom chart

Symptom	Possible Sources	Action
• Dipped beam and main beam are inoperative	• Fuse(s) • Circuit(s) • Central junction box (CJB) • Standard relay box (SRB)	• GO to Pinpoint Test A.
• Dipped beam is inoperative	• Fuse(s) • Circuit(s) • Dipped beam relay • Headlight switch • Central junction box (CJB) • Standard relay box (SRB)	• GO to Pinpoint Test B.
• Dipped beam does not switch on, the automatic headlamp system is inoperative	• Circuit(s) • Headlight switch • Rain sensor • Central junction box (CJB)	• GO to Pinpoint Test C.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Main beam not functioning	• Fuse(s) • Circuit(s) • Main beam relay • Steering column multifunction switch • Central junction box (CJB) • Headlamp switch	• GO to Pinpoint Test D.
• One dipped beam inoperative	• Fuse(s) • Circuit(s) • Steering column multifunction switch • Central junction box (CJB) • Headlamp	• GO to Pinpoint Test E.
• One main beam inoperative	• Fuse(s) • Circuit(s) • Dipped beam relay • Steering column multifunction switch • Central junction box (CJB) • Headlamp	• GO to Pinpoint Test F.
• Dipped or main beam on permanently	• Fuse • Circuit(s) • Steering column multifunction switch • Instrument cluster • Main beam relay • Dipped beam relay • Central junction box (CJB)	• GO to Pinpoint Test G.
• Dipped and main beam on permanently	• Generic Electronic Module (GEM)	• RENEW the generic electronic module (GEM). CHECK the operation of the system.
• Headlamp flasher not functioning	• Fuse • Circuit(s) • Central junction box (CJB) • Steering column multifunction switch	• GO to Pinpoint Test D.

System Checks

NOTE: Use a digital multimeter for all electrical measurements.

PINPOINT TEST A : DIPPED BEAM AND MAIN BEAM ARE INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK FUSE F54 (30 A) (SRB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F54 (30 A) (SRB).

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK Fuse F54 (30 A) (SRB). • Is the fuse OK? → **Yes** GO to A2. → **No** RENEW fuse F54 (30 A) (SRB) CHECK the operation of the system. If fuse blows again, LOCATE and REMEDY the short to ground with the aid of the wiring diagrams. CHECK the operation of the system.
A2: CHECK THE VOLTAGE SUPPLY TO FUSE F54 (30A) (SRB) FOR OPEN CIRCUIT	
	1 Connect Fuse F54 (30 A) (SRB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F54 (30 A) (SRB) and ground. • Does the meter display battery voltage? → **Yes** GO to A3. → **No** LOCATE AND RECTIFY the break in the voltage supply of fuse F54 (30 A) (SRB) using the Wiring Diagrams. CHECK SRB and RENEW if necessary. CHECK the operation of the system.
A3: CHECK FUSE F48 (5 A) (SRB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F48 (5 A) (SRB).
	3 CHECK Fuse F48 (5 A) (SRB). • Is the fuse OK? → **Yes** GO to A4. → **No** RENEW fuse F48 (5 A) (SRB). CHECK the operation of the system. If fuse blows again, LOCATE and REMEDY the short to ground with the aid of the wiring diagrams. CHECK the operation of the system.
A4: CHECK THE VOLTAGE SUPPLY TO FUSE F48 (5 A) (SRB) FOR OPEN CIRCUIT	
	1 Connect Fuse F48 (5 A) (SRB).
	2 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between fuse F48 (5 A) (SRB) and ground. • Does the meter display battery voltage? → **Yes** INSTALL a new CJB. CHECK the operation of the system. → **No** LOCATE AND RECTIFY the break in the voltage supply of fuse F48 (5 A) (SRB) using the Wiring Diagrams. CHECK SRB and RENEW if necessary. CHECK the operation of the system.

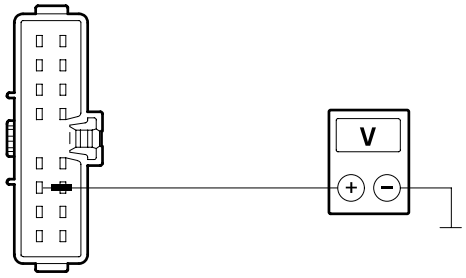
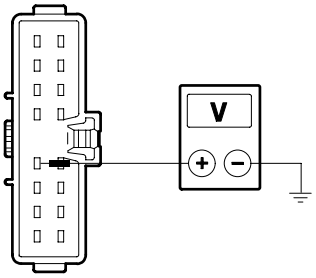
PINPOINT TEST B : DIPPED BEAM IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK FUSE F71 (5 A) (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F71 (5 A) (CJB).
	3 CHECK Fuse F71 (5 A) (CJB). • Is the fuse OK? → **Yes** GO to B2. → **No** RENEW fuse F71 (5 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK the operation of the system.
B2: CHECK THE VOLTAGE SUPPLY TO FUSE F71 (5 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F71 (5 A) (CJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F71 (5 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** GO to B3. → **No** LOCATE AND RECTIFY the break in the voltage supply of fuse F71 (5 A) (CJB) using the Wiring Diagrams. CHECK the operation of the system.

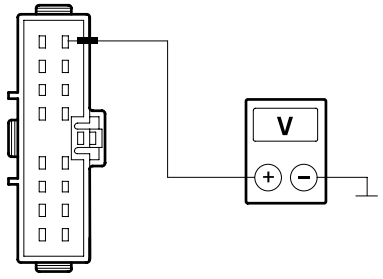
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B3: CHECK FUSE F42 (5 A) (SRB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F42 (5 A) (SRB).
	3 CHECK Fuse F42 (5 A) (SRB). • Is the fuse OK? → **Yes** GO to B4. → **No** RENEW fuse F42 (5 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK the operation of the system.
B4: CHECK THE VOLTAGE SUPPLY TO FUSE F42 (5 A) (SRB)	
	1 Connect Fuse F42 (5 A) (SRB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F42 (5 A) (SRB) and ground. • Does the meter display battery voltage? → **Yes** GO to B5. → **No** LOCATE AND RECTIFY the break in the voltage supply of fuse F42 (5 A) (SRB) using the Wiring Diagrams. CHECK the operation of the system.
B5: RULE OUT THE HEADLAMP SWITCH AS A CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Headlight switch from connector CLF23.
	3 CHECK the headlamp switch according to the component check at the end of this section. • Is the headlight switch OK? → **Yes** GO to B6. → **No** RENEW headlight switch. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B6: CHECK THE VOLTAGE SUPPLY TO THE HEADLIGHT SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position II.
 VFE0016145	
	2 Measure the voltage between the light switch, connector CLF23, pin 11, circuit SBP71A (WH/RD), wiring harness side and ground.
 VFE0003169	

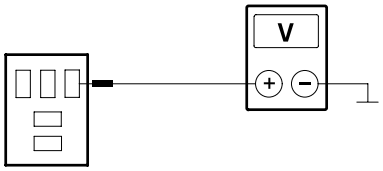
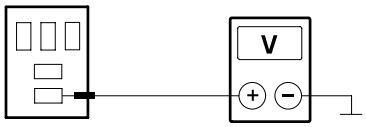
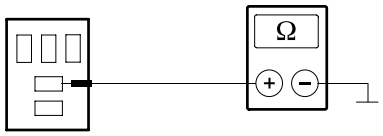
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between the light switch, connector CLF23, pin 12, circuit SBP71B (WH/RD), wiring harness side and ground. • Is battery voltage measured in both cases? → **Yes** GO to B7. → **No** - No voltage measured at both pins: LOCATE and RECTIFY the break in the circuits between fuse F71 (5 A) (SRB) and soldered connection S2BP71 using the wiring diagrams. CHECK the operation of the system. - If no voltage is measured during one of the measurements: LOCATE and RECTIFY the break in the corresponding circuit between the headlight switch and soldered connection S2BP71 using the wiring diagrams. CHECK the operation of the system.
B7: CHECK THE VOLTAGE SUPPLY TO THE HEADLIGHT SWITCH FOR OPEN CIRCUIT	
 VFE0029340	
	1 Measure the voltage between the headlamp switch, connector CLF23, pin 8, circuit CB142B (GN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B8. → **No** LOCATE and RECTIFY the break in the circuit between fuse F42 (5 A) (SRB) and the headlamp switch using the Wiring Diagrams. CHECK the operation of the system.
B8: CHECK THE CONTROL CIRCUIT OF THE DIPPED BEAM RELAY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Central junction box (CJB). – Box van / Bus / Combi: from connector C2BP02D – Platform truck: from connector CBP02D
	3 Connect a fused bridging cable (5 A) to the central junction box (CJB): – Box van / Bus / Combi: Connector C2BP02D between pin 4, circuit CLF09A (BU/GY), wiring harness side and ground. – Platform truck: Connector CBP02D between pin 4, circuit CLF09A (BU/GY), wiring harness side and ground.
	4 Ignition switch in position II.
	5 CHECK the dipped beam. • Does dipped beam come on? → **Yes** - Van, bus, combi: GO to B13. - Platform truck: GO to B14. → **No** GO to B9.
B9: ELIMINATE THE STANDARD RELAY BOX (SRB) AS CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Dipped beam relay from socket R11.
	3 Measure the resistance between the dipped beam relay, socket R11, pin 2, circuit CLF09A (BU/GY), socket side and the central junction box (CJB): – Box van / Bus / Combi: Connector C2BP02D, pin 4, circuit CLF09A (BU/GY), wiring harness side. – Platform truck: Connector CBP02D, pin 4, circuit CLF09A (BU/GY), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to B10. → **No** LOCATE and RECTIFY the break in the circuit(s) between the dipped beam relay and the central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system.
B10: CHECK VOLTAGE SUPPLY OF DIPPED BEAM RELAY (CONTROL CIRCUIT) FOR OPEN CIRCUIT	
	1 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0016104	2 Measure the voltage between the dipped beam relay, socket R11, pin 1, circuit SB148G (VT/RD), socket side and ground. • Does the meter display battery voltage? → **Yes** GO to B11. → **No** LOCATE and RECTIFY the break in the circuit(s) between fuse F48 (5 A) (SRB) and the dipped beam relay using the wiring diagrams. CHECK the operation of the system.
B11: CHECK VOLTAGE SUPPLY OF DIPPED BEAM RELAY (LOAD CIRCUIT) FOR OPEN CIRCUIT	
 VFE0016103	1 Measure the voltage between the dipped beam relay, socket R11, pin 3, circuit SB154B (BN/RD), socket side and ground. • Does the meter display battery voltage? → **Yes** GO to B12. → **No** LOCATE and RECTIFY the break in the circuit(s) between fuse F54 (30 A) (SRB) and the dipped beam relay using the wiring diagrams. CHECK the operation of the system.
B12: CHECK COMMON VOLTAGE SUPPLY OF THE DIPPED BEAM HEADLAMPS FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 VFE0019863	2 Measure the resistance between the dipped beam relay, socket R11, pin 5, circuit A_CB148A (GY/YE), socket side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** LOCATE and RECTIFY the break in the circuit(s) between the dipped beam relay and fuse F41/F39 (10 A) (SRB) using the wiring diagrams. CHECK the operation of the system. → **No** INSTALL a new low beam relay. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B13: CHECK CONTROL CIRCUITS BETWEEN HEADLIGHT SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector C2BP02F.
	3 Measure the resistance between the headlight switch connector CLF23, pin 6, circuit CLF18B (BU/WH), wiring harness side and the central junction box (CJB), connector C2BP02F, pin 38, circuit CLF18A (BU/WH), wiring harness side.
	4 Measure the resistance between the headlight switch connector CLF23, pin 4, circuit CLF19A (VT/GN), wiring harness side and the central junction box (CJB), connector C2BP02F, pin 34, circuit CLF19A (VT/GN), wiring harness side.
	5 Measure the resistance between the headlight switch connector CLF23, pin 16, circuit ZA104A (OG/GN), wiring harness side and the central junction box (CJB), connector C2BP02F, pin 39, circuit ZA104A (OG/GN), wiring harness side.
	6 Measure the resistance between the light switch, connector CLF23, pin 13, circuit ZA105A (OG/GY), wiring harness side and central junction box (CJB), connector C2BP02F, pin 37, circuit ZA105A (OG/GY), wiring harness side. • Is a resistance of less than 2 Ohms measured in all of the cases? → **Yes** INSTALL a new CJB. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the affected circuit using the Wiring Diagrams. CHECK the operation of the system.
B14: CHECK CONTROL CIRCUITS BETWEEN HEADLIGHT SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02F.

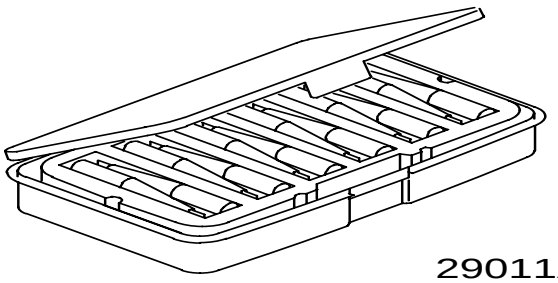
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the resistance between the headlight switch connector CLF23, pin 6: – Vehicles without side parking lamp/turn signal lamp: circuit CLF18B (BU/WH), wiring harness side and central junction box (CJB), connector CBP02F, pin 38, circuit CLF18D (BU/WH), wiring harness side. – Vehicles with side parking lamp/turn signal lamp: circuit CLF18A (BU/WH), wiring harness side and central junction box (CJB), connector CBP02F, pin 38, circuit CLF18A (BU/WH), wiring harness side.
	4 Measure resistance between headlight switch connector CLF23, pin 4, circuit CLF19A (VT/GN), wiring harness side and central junction box (CJB), connector CBP02F, pin 34, circuit CLF19A (VT/GN), Kabelstrangseite.
	5 Measure resistance between headlight switch connector CLF23, pin 16, circuit ZA104A (OG/GN), wiring harness side and central junction box (CJB), connector CBP02F, pin 39, circuit ZA104A (OG/GN), Kabelstrangseite.
	6 Measure the resistance between the light switch, connector CLF23, pin 13, circuit ZA105A (OG/GY), wiring harness side and central junction box (CJB), connector CBP02F, pin 37, circuit ZA105A (OG/GY), wiring harness side. • Is a resistance of less than 2 Ohms measured in all of the cases? → **Yes** INSTALL a new CJB. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the affected circuit using the Wiring Diagrams. CHECK the operation of the system.

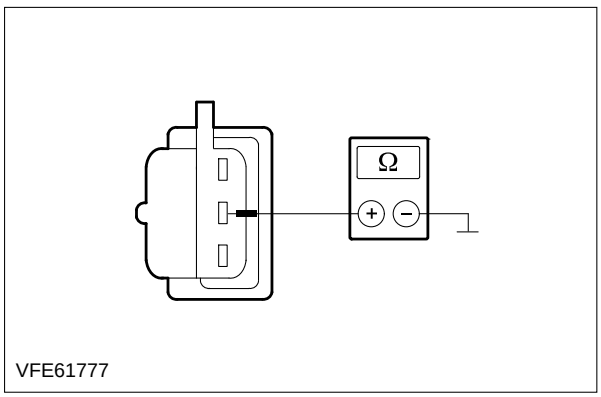
PINPOINT TEST C : DIPPED BEAM DOES NOT SWITCH ON, THE AUTOMATIC HEADLAMP SYSTEM IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CHECK FUSE F63 (5 A) (CJB)	
NOTE: The rain sensor is also responsible for the automatic headlamps function.	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F63 (5 A) (CJB).

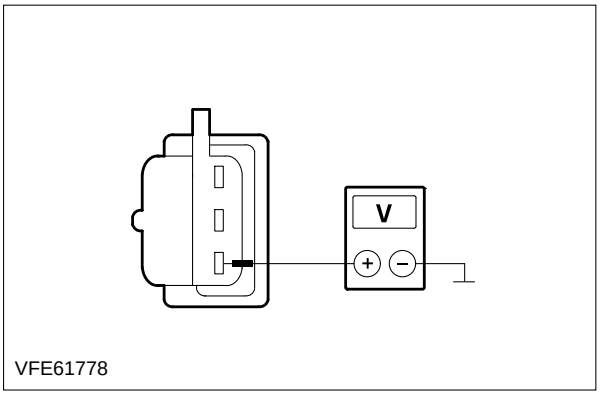
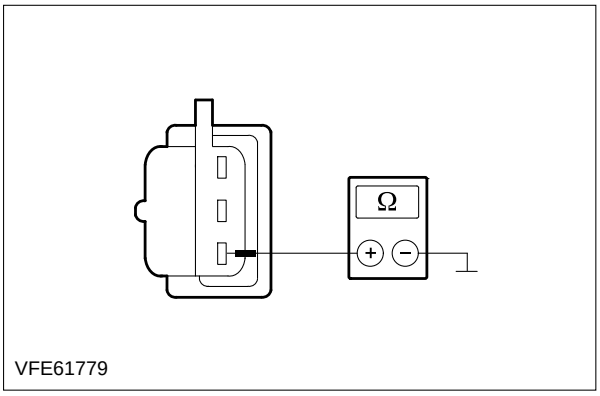
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK Fuse F63 (5 A) (CJB). • Is the fuse OK? → **Yes** GO to C2. → **No** RENEW fuse F63 (5 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK the operation of the system.
C2: CHECK THE VOLTAGE SUPPLY TO FUSE F63 (5 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F63 (5 A) (CJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F63 (5 A) (CJB) and ground. • Does meter display battery voltage? → **Yes** GO to C3. → **No** LOCATE AND RECTIFY the break in the voltage supply of fuse F63 (5 A) (CJB) using the Wiring Diagrams. CHECK the operation of the system.
C3: CHECK VOLTAGE SUPPLY TO RAIN SENSOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Rain sensor from connector CRW06.
	3 Ignition switch in position II.
 29011A	4 Measure voltage between rain sensor, connector CRW06, pin 1: – Platform truck with side parking lamp/turn signal lamp: Circuit SBP63F (WH/RD), wiring harness side and ground. – All other vehicles: circuit SBP63G (WH/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to C5. → **No** GO to C4.
C4: EXCLUDE THE CJB AS THE CAUSE OF THE FAULT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect CJB. – Box van / Bus / Combi: from connector C2BP02D – Platform truck: from connector CBP02D
	3 Measure resistance between rain sensor, connector CRW06, pin 1: – Platform truck with side parking lamp/turn signal lamp: circuit SBP63F (WH/RD), wiring harness side and the CJB, connector CBP02D, pin 11, circuit SBP63A (WH/RD), wiring harness side. – Platform truck without side parking lamp/turn signal lamp: Circuit SBP63G (WH/RD), wiring harness side and the CJB, connector CBP02D, pin 11, circuit SBP63A (WH/RD), wiring harness side. – Van: Circuit SBP63G (WH/RD), wiring harness side and the CJB, connector C2BP02D, pin 11, circuit SBP63A (WH/RD), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW THE CJB. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit(s) between the rain sensor and the CJB using the Wiring Diagrams. CHECK the operation of the system.
C5: CHECK GROUND CONNECTION OF RAIN SENSOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 VFE61777	2 Measure resistance between rain sensor, connector CRW06, pin 2: – Box van / Bus / Combi: Circuit B_GD138 (BK/WH), wiring harness side and ground. – Platform truck: Circuit B_GD138AF (BK/WH), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to C6. → **No** LOCATE and RECTIFY break in circuit between rain sensor and soldered connection S2D138C with the aid of the wiring diagrams. CHECK the operation of the system.

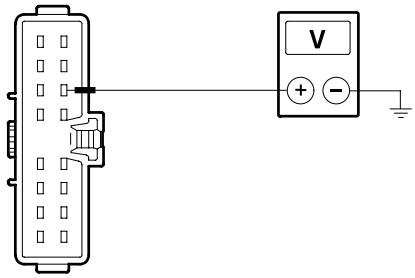
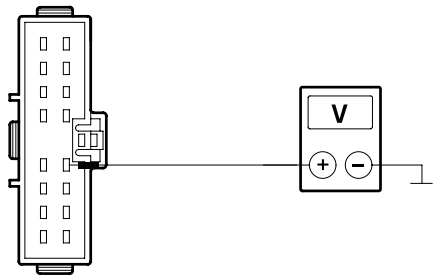
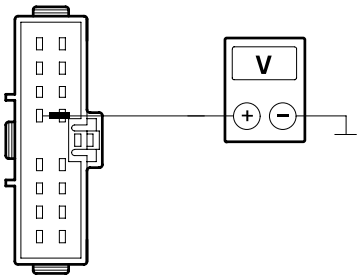
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C6: CHECK SIGNAL CIRCUIT BETWEEN RAIN SENSOR AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO BATTERY VOLTAGE	
	1 Disconnect Central junction box (CJB). – Box van / Bus / Combi: From connector C2BP02C – Platform truck: From connector CBP02C
	2 Ignition switch in position II.
 VFE61778	3 Measure the voltage between the rain sensor, connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY short to battery voltage in the circuit(s) between the rain sensor and the central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system. → **No** GO to C7.
C7: CHECK SIGNAL CIRCUIT BETWEEN RAIN SENSOR AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
 VFE61779	2 Measure the resistance between the rain sensor, connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to C8. → **No** LOCATE and RECTIFY short to ground in circuit between rain sensor and central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system.

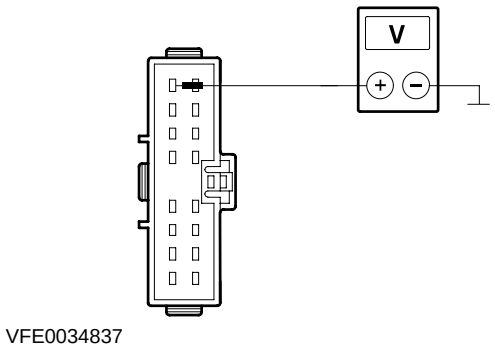
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C8: CHECK SIGNAL CIRCUIT BETWEEN RAIN SENSOR AND CENTRAL JUNCTION BOX (CJB) FOR OPEN CIRCUIT	
	1 Measure the resistance between the rain sensor, connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side and the central junction box (CJB). – Box van / Bus / Combi: Connector C2BP02C, pin 37, circuit VRW26 (BN/YE), wiring harness side. – Platform truck: Connector CBP02C, pin 37, circuit VRW26A (BN/YE), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to C9. → **No** LOCATE and RECTIFY break in circuit between rain sensor and central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system.
C9: CHECK HEADLIGHT SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Headlight switch from connector CLF23.
	3 CHECK the headlamp switch according to the component check at the end of this section. • Is the headlight switch OK? → **Yes** GO to C10. → **No** RENEW headlight switch. CHECK the operation of the system.
C10: CHECK CONTROL CIRCUIT BETWEEN HEADLAMP SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB). – Box van / Bus / Combi: from connector C2BP02F – Platform truck: from connector CBP02F
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0008729	4 Measure the voltage between the light switch, connector CLF23, pin 6: – Box van, bus, combi: circuit CLF18B (BU/WH), wiring harness side and ground. – Platform truck with side parking lamp/turn signal lamp: circuit CLF18A (BU/WH), wiring harness side and ground. – Platform truck without side parking lamp/turn signal lamp: circuit CLF18B (BU/WH), wiring harness side and ground.
 VFE0024362	5 Measure the voltage between the headlight switch, connector CLF23, pin 4, circuit CLF19A (VT/GN), wiring harness side and ground.
 VFE0034861	6 Measure the voltage between the headlight switch, connector CLF23, pin 13, circuit ZA105A (OG/GY), wiring harness side and ground.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0034837	7 Measure the voltage between the light switch, connector CLF23, pin 16, circuit ZA104A (OG/GN), wiring harness side, and ground. • Did one of those measurements show battery voltage? → **Yes** LOCATE and REPAIR the short to battery voltage in the affected circuit using the Wiring Diagrams. CHECK the operation of the system. → **No** - Van, bus, combi: GO to C11. - Platform truck: GO to C12.
C11: CHECK CONTROL CIRCUITS BETWEEN HEADLIGHT SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Measure the resistance between the headlight switch connector CLF23, pin 6, circuit CLF18B (BU/WH), wiring harness side and the central junction box (CJB), connector C2BP02F, pin 38, circuit CLF18A (BU/WH), wiring harness side.
	3 Measure the resistance between the headlight switch connector CLF23, pin 4, circuit CLF19A (VT/GN), wiring harness side and the central junction box (CJB), connector C2BP02F, pin 34, circuit CLF19A (VT/GN), wiring harness side.
	4 Measure the resistance between the headlight switch connector CLF23, pin 16, circuit ZA104A (OG/GN), wiring harness side and the central junction box (CJB), connector C2BP02F, pin 39, circuit ZA104A (OG/GN), wiring harness side.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	5 Measure the resistance between the light switch, connector CLF23, pin 13, circuit ZA105A (OG/GY), wiring harness side and central junction box (CJB), connector C2BP02F, pin 37, circuit ZA105A (OG/GY), wiring harness side. • Is a resistance of less than 2 Ohms measured in all of the cases? → **Yes** RENEW the rain sensor. CHECK the operation of the system. If the concern is not rectified, INSTALL A NEW central junction box (CJB). CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the affected circuit using the Wiring Diagrams. CHECK the operation of the system.
C12: CHECK CONTROL CIRCUITS BETWEEN HEADLIGHT SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Measure the resistance between the headlight switch connector CLF23, pin 6: – Vehicles without side parking lamp/turn signal lamp: circuit CLF18B (BU/WH), wiring harness side and central junction box (CJB), connector CBP02F, pin 38, circuit CLF18D (BU/WH), wiring harness side. – Vehicles with side parking lamp/turn signal lamp: circuit CLF18A (BU/WH), wiring harness side and central junction box (CJB), connector CBP02F, pin 38, circuit CLF18A (BU/WH), wiring harness side.
	3 Measure resistance between headlight switch connector CLF23, pin 4, circuit CLF19A (VT/GN), wiring harness side and central junction box (CJB), connector CBP02F, pin 34, circuit CLF19A (VT/GN), wiring harness side.
	4 Measure resistance between headlight switch connector CLF23, pin 16, circuit ZA104A (OG/GN), wiring harness side and central junction box (CJB), connector CBP02F, pin 39, circuit ZA104A (OG/GN), wiring harness side.

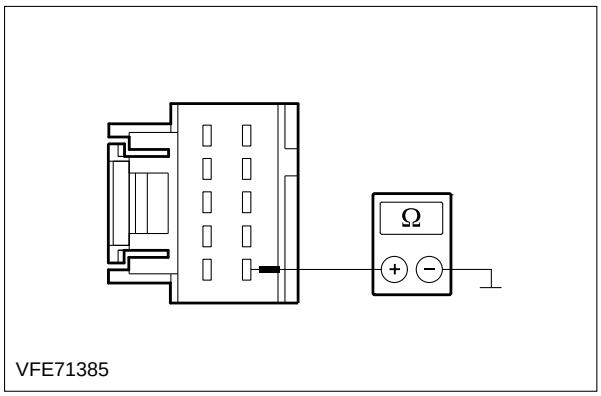
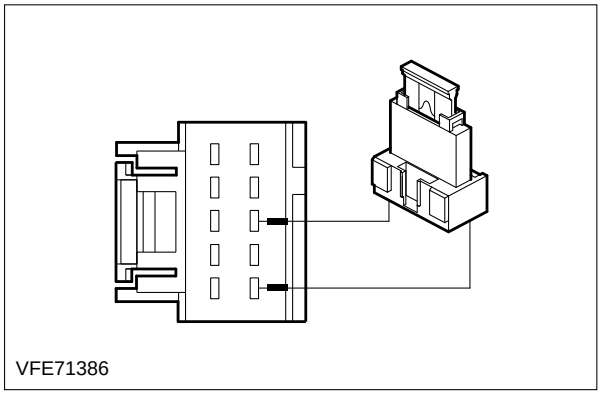
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	5 Measure the resistance between the light switch, connector CLF23, pin 13, circuit ZA105A (OG/GY), wiring harness side and central junction box (CJB), connector CBP02F, pin 37, circuit ZA105A (OG/GY), wiring harness side. • Is a resistance of less than 2 Ohms measured in all of the cases? → **Yes** RENEW the rain sensor. CHECK the operation of the system. If the concern is not rectified, INSTALL A NEW central junction box (CJB). CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the affected circuit using the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST D : MAIN BEAM INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 TURN ON dipped beam.
	3 CHECK the operation of the headlamp in all switch positions.
	4 TURN ON main beam.
	5 SWITCH OFF main beam.
	6 OPERATE headlamp flasher. • Are the high beam and headlamp flasher both inoperative? → **Yes** Main beam and headlamp flasher inoperative: GO to D2. → **No** - Headlamp flasher inoperative: GO to D9. - main beam inoperative: GO to D9.
D2: CHECK THE GROUND CONNECTION OF THE STEERING COLUMN MULTIFUNCTION SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Steering column multifunction switch from connector CLS34.

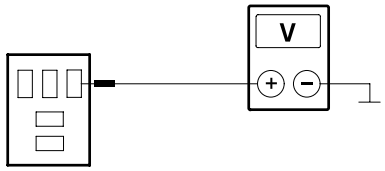
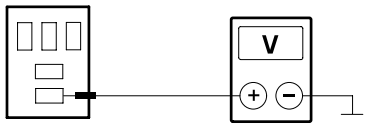
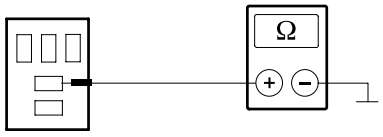
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE71385	3 Measure the resistance between the steering column multifunction switch, connector CLS34, pin 10, circuit B_GD115D (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to D3. → **No** LOCATE and RECTIFY the break in the circuit between the steering column multifunction switch and ground G15 using the Wiring Diagrams. CHECK the operation of the system.
D3: CHECK THE STEERING COLUMN MULTIFUNCTION SWITCH	
 VFE71386	1 Connect a fused jumper lead (5 A) at the multi-function switch, connector CLS34, between pin 8, circuit CLF24A (YE/BU) and pin 10, circuit B_GD115D (BK/GY), wiring harness side:
	2 Ignition switch in position II.
	3 TURN ON dipped beam.
	4 CHECK main beam. • Does main beam come on? → **Yes** RENEW steering column multifunction switch. CHECK the operation of the system. → **No** GO to D4.
D4: ELIMINATE THE CENTRAL JUNCTION BOX (CJB) AS CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB). – Box van / Bus / Combi: from connector C2BP02D – Platform truck: from connector CBP02D

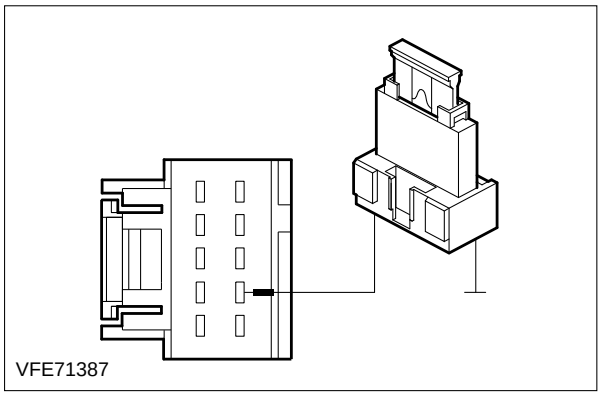
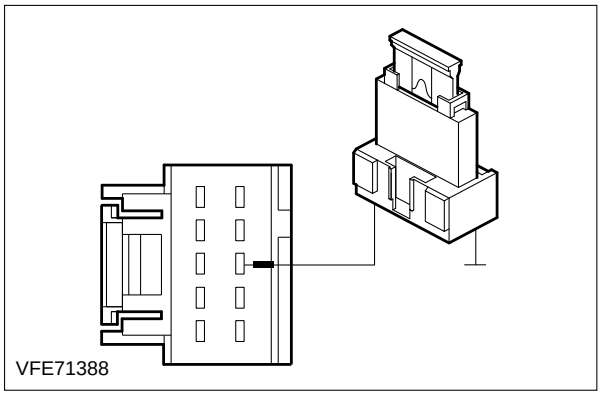
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Connect a fused bridging cable (5 A) to the central junction box (CJB): – Box van / Bus / Combi: Connector C2BP02D between pin 5, circuit CLF08A (YE/VT), wiring harness side and ground. – Platform truck: Connector CBP02D between pin 5, circuit CLF08A (YE/VT), wiring harness side and ground.
	4 Ignition switch in position II.
	5 CHECK main beam. • Does the main beam come on? → **Yes** INSTALL a new CJB. CHECK the operation of the system. → **No** GO to D5.
D5: ELIMINATE THE STANDARD RELAY BOX (SRB) AS CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Main beam relay from socket R13.
	3 Measure the resistance between the main beam relay, socket R13, pin 2, circuit CLF08A (YE/VT), socket side and the central junction box (CJB): – Box van / Bus / Combi: Connector C2BP02D, pin 5, circuit CLF08A (YE/VT), wiring harness side. – Platform truck: Connector CBP02D, pin 5, circuit CLF08A (YE/VT), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to D6. → **No** LOCATE and RECTIFY the break in the circuit(s) between the main beam relay and the central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system.
D6: CHECK VOLTAGE SUPPLY OF MAIN BEAM RELAY (CONTROL CIRCUIT) FOR OPEN CIRCUIT	
	1 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0016104	2 Measure the voltage between the main beam relay, socket R13, pin 1, circuit SB148H (VT/RD), socket side and ground. • Does the meter display battery voltage? → **Yes** GO to D7. → **No** LOCATE and RECTIFY the break in the circuit(s) between fuse F48 (5 A) (SRB) and the main beam relay using the wiring diagrams. CHECK the operation of the system.
D7: CHECK VOLTAGE SUPPLY OF MAIN BEAM RELAY (LOAD CIRCUIT) FOR OPEN CIRCUIT	
 VFE0016103	1 Measure the voltage between the dipped beam relay, socket R13, pin 3, circuit SB154C (BN/RD), socket side and ground. • Does the meter display battery voltage? → **Yes** GO to D8. → **No** LOCATE and RECTIFY the break in the circuit(s) between fuse F54 (30 A) (SRB) and the main beam relay using the wiring diagrams. CHECK the operation of the system.
D8: CHECK COMMON VOLTAGE SUPPLY OF THE MAIN BEAM HEADLAMPS FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 VFE0019863	2 Measure the resistance between the main beam relay, socket R13, pin 5, circuit B_CB148A (GY/YE), socket side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** LOCATE and RECTIFY the break in the circuit(s) between the main beam relay and fuse F51/F53 (10 A) (SRB) using the wiring diagrams. CHECK the operation of the system. → **No** INSTALL a new high beam relay. CHECK the operation of the system.
D9: ELIMINATE THE STEERING COLUMN MULTIFUNCTION SWITCH AS THE CAUSE OF THE FAULT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Steering column multifunction switch from connector CLS34.
	3 SWITCH ON the dipped beam.
 VFE71387	4 Headlamp flasher inoperative: Connect a fused (5 A) jumper lead at the multifunction switch, connector CLS34, between pin 9, circuit CLF27A (GN/BN), wiring harness side and ground.
 VFE71388	5 Main beam inoperative: Connect a fused (5 A) jumper lead at the multifunction switch, connector CLS34, between pin 8, circuit CLF24A (YE/BU), wiring harness side and ground.
	6 Ignition switch in position II.
	7 SWITCH ON the dipped beam.
	8 CHECK main beam. • Does the main beam come on? → **Yes** RENEW steering column multifunction switch. CHECK the operation of the system. → **No** - Van, bus, combi: GO to D10. - Platform truck: GO to D11.
D10: CHECK CONTROL CIRCUIT BETWEEN CENTRAL JUNCTION BOX (CJB) AND STEERING COLUMN MULTIFUNCTION SWITCH FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector C2BP02F.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Headlamp flasher inoperative: Measure resistance between steering column multifunction switch, connector CLS34, pin 9, circuit CLF27A (GN/BN), wiring harness side and central junction box (CJB), connector C2BP02F, pin 5, circuit CLF27A (GN/BN), wiring harness side.
	4 Main beam inoperative: Measure resistance between steering column multifunction switch, connector CLS34, pin 8, circuit CLF24A (YE/BU), wiring harness side and central junction box (CJB), connector C2BP02F, pin 16, circuit CLF24A (YE/BU), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** INSTALL a new CJB. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the corresponding circuit between the central junction box (CJB) and the steering column multifunction switch, using the Wiring Diagrams. CHECK the operation of the system.
D11: CHECK CONTROL CIRCUIT BETWEEN CENTRAL JUNCTION BOX (CJB) AND STEERING COLUMN MULTIFUNCTION SWITCH FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02F.
	3 Headlamp flasher inoperative: Measure resistance between steering column multifunction switch, connector CLS34, pin 9, circuit CLF27A (GN/BN), wiring harness side and central junction box (CJB), connector CBP02F, pin 5, circuit CLF27A (GN/BN), wiring harness side.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Main beam inoperative: Measure resistance between steering column multifunction switch, connector CLS34, pin 8, circuit CLF24A (YE/BU), wiring harness side and central junction box (CJB), connector CBP02F, pin 16, circuit CLF24A (YE/BU), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** INSTALL a new CJB. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the corresponding circuit between the central junction box (CJB) and the steering column multifunction switch, using the Wiring Diagrams. CHECK the operation of the system.

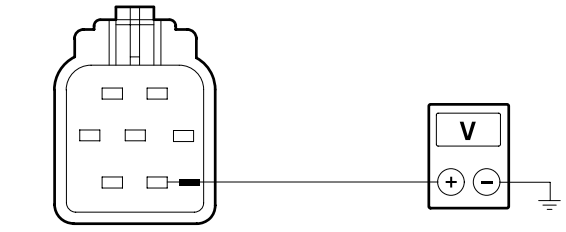
PINPOINT TEST E : ONE DIPPED BEAM INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: DETERMINE WHICH DIPPED BEAM LAMP IS INOPERATIVE	
	1 Ignition switch in position II.
	2 SWITCH ON the dipped beam.
	3 CHECK the dipped beam. • Is the left-hand dipped beam inoperative? → **Yes** Left-hand dipped beam inoperative: GO to E2. → **No** Right-hand dipped beam inoperative: GO to E6.
E2: CHECK FUSE F41 (10 A) (SRB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F41 (10 A) (SRB).

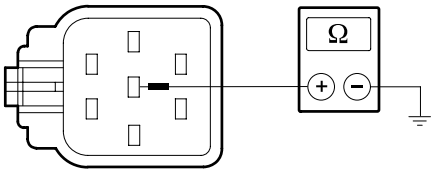
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK Fuse F41 (10 A) (SRB). • Is the fuse OK? → **Yes** GO to E3. → **No** RENEW fuse F41 (10 A) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK the operation of the system.
E3: CHECK THE VOLTAGE SUPPLY TO FUSE F41 (10 A) (SRB) FOR OPEN CIRCUIT	
	1 Connect Fuse F41 (10 A) (SRB).
	2 Ignition switch in position II.
	3 SWITCH ON the dipped beam.
	4 Measure the voltage between fuse F41 (10 A) (SRB) and ground. • Does the meter display battery voltage? → **Yes** GO to E4. → **No** LOCATE AND RECTIFY the break in the voltage supply of fuse F41 (10 A) (SRB) with the aid of the wiring diagrams. CHECK the operation of the system.
E4: CHECK THE POWER SUPPLY OF THE LEFT-HAND SIDE DIPPED BEAM FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand headlamp. – Box van / Bus / Combi: from connector C1LF08 – Platform truck: from connector CLF08
	3 Ignition switch in position II.
	4 SWITCH ON the dipped beam.

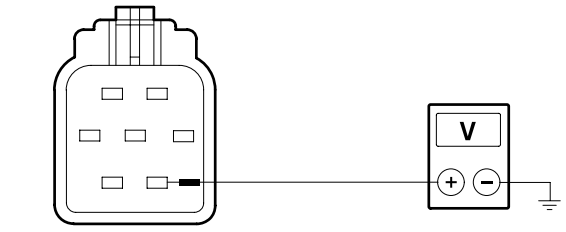
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0002208	5 Measure voltage between the left-hand headlamps: – Box van / Bus / Combi: connector C1LF08, pin 7, circuit CB141B (BU), wiring harness side and ground. – Platform truck with side parking lamp/turn signal lamp: connector CLF08, pin 7, circuit CB141B (BU), wiring harness side and ground. – Platform truck without side parking lamp/turn signal lamp: connector CLF08, pin 7, circuit CB141A (BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to E5. → **No** LOCATE and RECTIFY the break in the circuit(s) between the headlamp and fuse F41 (10 A) (SRB) using the wiring diagrams. CHECK the operation of the system.
E5: CHECK GROUND SUPPLY OF LEFT-HAND HEADLAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

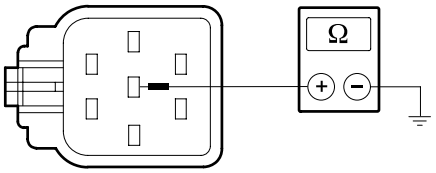
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0003175	2 Measure resistance between the left-hand headlamp: – Box van / Bus / Combi: Connector C1LF08, pin 4, circuit A_GD129T (BK/YE), wiring harness side and ground. – Platform truck with side parking lamp/turn signal lamp: Connector CLF08, pin 4, circuit A_GD129T (BK/YE), wiring harness side and ground. – Platform truck without side parking lamp/turn signal lamp: Connector CLF08, pin 4, circuit A_GD129E (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW headlamp. CHECK the operation of the system. → **No** - Box van, bus, combi: LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S1D129A using the wiring diagrams. CHECK the operation of the system. - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S2D129A using the wiring diagrams. CHECK the operation of the system.
E6: CHECK FUSE F39 (10 A) (SRB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F39 (10 A) (SRB).
	3 CHECK Fuse F39 (10 A) (SRB). • Is the fuse OK? → **Yes** GO to E7. → **No** RENEW fuse F39 (10 A) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK the operation of the system.
E7: CHECK THE VOLTAGE SUPPLY TO FUSE F39 (10 A) (SRB) FOR OPEN CIRCUIT	
	1 Connect Fuse F39 (10 A) (SRB).
	2 Ignition switch in position II.
	3 SWITCH ON the dipped beam.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between fuse F39 (10 A) (SRB) and ground. • Does meter display battery voltage? → **Yes** GO to E8. → **No** LOCATE AND RECTIFY the break in the voltage supply of fuse F39 (10 A) (SRB) with the aid of the wiring diagrams. CHECK the operation of the system.
E8: CHECK THE POWER SUPPLY OF THE RIGHT-HAND SIDE DIPPED BEAM FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Right-hand headlamp. – Box van / Bus / Combi: from connector C1LF09 – Platform truck: from connector CLF09
	3 Ignition switch in position II.
	4 SWITCH ON the dipped beam.
 VFE0002208	5 At the right-hand headlamp, measure the voltage between: – Box van / Bus / Combi: connector C1LF09, pin 7, circuit CB139B (VT/WH), wiring harness side and ground. – Platform truck with side parking lamp/turn signal lamp: connector CLF08, pin 7, circuit CB139B (VT/WH), wiring harness side and ground. – Platform truck without side parking lamp/turn signal lamp: connector CLF08, pin 7, circuit CB139A (VT/WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to E9. → **No** LOCATE and RECTIFY the break in the circuit(s) between the headlamp and fuse F39 (10 A) (SRB) using the wiring diagrams. CHECK the operation of the system.
E9: CHECK GROUND SUPPLY OF RIGHT-HAND HEADLAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0003175	2 Measure the resistance between the right-hand headlamp: – Box van / Bus / Combi: Connector C1LF09, pin 4, circuit A_GD131V (BK/GY), wiring harness side and ground. – Platform truck with side parking lamp/turn signal lamp: Connector CLF09, pin 4, circuit A_GD129T (BK/GY), wiring harness side and ground. – Platform truck without side parking lamp/turn signal lamp: Connector CLF08, pin 4, circuit A_GD129H (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW headlamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S1D131B using the wiring diagrams. CHECK the operation of the system.

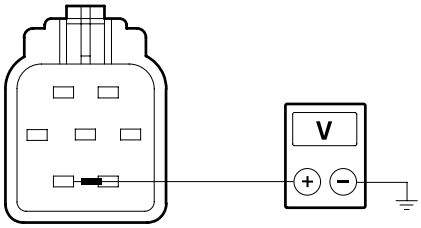
PINPOINT TEST F : ONE MAIN BEAM INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F1: DETERMINE WHICH MAIN BEAM IS INOPERATIVE	
	1 Ignition switch in position II.
	2 SWITCH ON the dipped beam.
	3 SWITCH ON main beam.
	4 CHECK main beam. • Is the left-hand main beam inoperative? → **Yes** Left-hand main beam inoperative: GO to F2. → **No** Right-hand main beam inoperative: GO to F6.
F2: CHECK FUSE F53 (10 A) (SRB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F53 (10 A) (SRB).

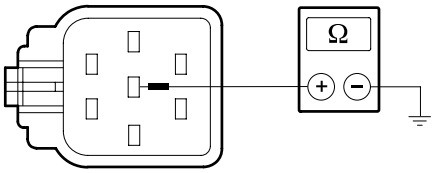
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK Fuse F53 (10 A) (SRB). • Is the fuse OK? → **Yes** GO to F3. → **No** RENEW fuse F53 (10 A) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK the operation of the system.
F3: CHECK THE VOLTAGE SUPPLY TO FUSE F53 (10 A) (SRB) FOR OPEN CIRCUIT	
	1 Connect Fuse F53 (10 A) (SRB).
	2 Ignition switch in position II.
	3 SWITCH ON the dipped beam.
	4 SWITCH ON main beam.
	5 Measure the voltage between fuse F53 (10 A) (SRB) and ground. • Does the meter display battery voltage? → **Yes** GO to F4. → **No** LOCATE AND RECTIFY the break in the voltage supply of fuse F53 (10 A) (SRB) with the aid of the wiring diagrams. CHECK the operation of the system.
F4: CHECK THE POWER SUPPLY OF THE LEFT-HAND MAIN BEAM FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand headlamp. – Box van / Bus / Combi: from connector C1LF08 – Platform truck: from connector CLF08
	3 Ignition switch in position II.
	4 SWITCH ON the dipped beam.
	5 SWITCH ON main beam.

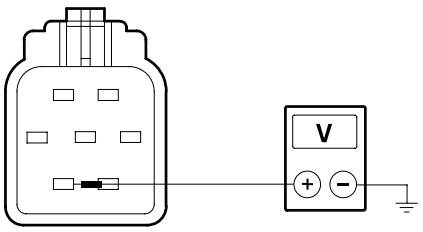
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0008747	6 Measure voltage between the left-hand headlamps: – Box van / Bus / Combi: Connector C1LF08, pin 6, circuit CB153B (GY/BN), wiring harness side and ground. – Platform truck with side parking lamp/turn signal lamp: Connector CLF08, pin 6, circuit CB153B (GY/BN), wiring harness side and ground. – Platform truck without side parking lamp/turn signal lamp: Connector CLF08, pin 6, circuit CB153A (GY/BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to F5. → **No** LOCATE and RECTIFY the break in the circuit(s) between the headlamp and fuse F53 (10 A) (SRB) using the wiring diagrams. CHECK the operation of the system.
F5: CHECK GROUND SUPPLY OF LEFT-HAND HEADLAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

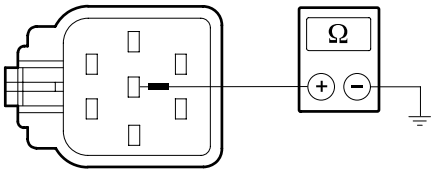
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0003175	2 Measure resistance between the left-hand headlamp: – Box van / Bus / Combi: Connector C1LF08, pin 4, circuit A_GD129T (BK/YE), wiring harness side and ground. – Platform truck with side parking lamp/turn signal lamp: Connector CLF08, pin 4, circuit A_GD129T (BK/YE), wiring harness side and ground. – Platform truck without side parking lamp/turn signal lamp: Connector CLF08, pin 4, circuit A_GD129E (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW headlamp. CHECK the operation of the system. → **No** - Box van, bus, combi: LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S1D129A using the wiring diagrams. CHECK the operation of the system. - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S2D129A using the wiring diagrams. CHECK the operation of the system.
F6: CHECK FUSE F51 (10 A) (SRB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F51 (10 A) (SRB).
	3 CHECK Fuse F51 (10 A) (SRB). • Is the fuse OK? → **Yes** GO to F7. → **No** RENEW fuse F51 (10 A) (SRB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK the operation of the system.
F7: CHECK THE VOLTAGE SUPPLY TO FUSE F51 (10 A) (SRB) FOR OPEN CIRCUIT	
	1 Connect Fuse F51 (10 A) (SRB).
	2 Ignition switch in position II.
	3 SWITCH ON the dipped beam.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 SWITCH ON main beam.
	5 Measure the voltage between fuse F51 (10 A) (SRB) and ground. • Does the meter display battery voltage? → **Yes** GO to F8. → **No** LOCATE AND RECTIFY the break in the voltage supply of fuse F51 (10 A) (SRB) with the aid of the wiring diagrams. CHECK the operation of the system.
F8: CHECK THE POWER SUPPLY OF THE RIGHT-HAND MAIN BEAM FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Right-hand headlamp. – Box van / Bus / Combi: from connector C1LF09 – Platform truck: from connector C1LF09
	3 Ignition switch in position II.
	4 SWITCH ON the dipped beam.
	5 SWITCH ON main beam.
 VFE0008747	6 Measure voltage between the right-hand headlamps: – Box van / Bus / Combi: Connector C1LF09, pin 6, circuit CB151B (BN), wiring harness side and ground. – Platform truck with side parking lamp/turn signal lamp: Connector CLF09, pin 6, circuit CB151B (BN), wiring harness side and ground. – Platform truck without side parking lamp/turn signal lamp: Connector CLF09, pin 6, circuit CB151A (BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to F9. → **No** LOCATE and RECTIFY the break in the circuit(s) between the headlamp and fuse F51 (10 A) (SRB) using the wiring diagrams. CHECK the operation of the system.
F9: CHECK GROUND SUPPLY OF RIGHT-HAND HEADLAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0003175	2 Measure the resistance between the right-hand headlamp: – Box van / Bus / Combi: Connector C1LF09, pin 4, circuit A_GD131V (BK/GY), wiring harness side and ground. – Platform truck with side parking lamp/turn signal lamp: Connector CLF09, pin 4, circuit A_GD131T (BK/GY), wiring harness side and ground. – Platform truck without side parking lamp/turn signal lamp: Connector CLF09, pin 4, circuit A_GD131H (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW headlamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S1D131B using the wiring diagrams. CHECK the operation of the system.

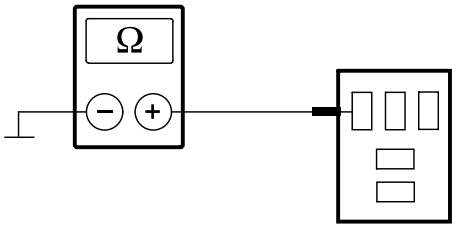
PINPOINT TEST G : DIPPED OR MAIN BEAM ON PERMANENTLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G1: DETERMINE VEHICLE EQUIPMENT LEVEL	
	1 DETERMINE vehicle equipment level. • Is the vehicle equipped with automatic headlamp system? → **Yes** GO to G2. → **No** GO to G3.
G2: DETERMINE THE FAULT CONDITION	
NOTE: Shine light at the rain sensor, enough to prevent the automatic headlamp system being activated.	
	1 Ignition switch in position II.
	2 SWITCH ON the automatic headlamp system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK the headlamps. • Is dipped beam lit continuously? → **Yes** GO to G16. → **No** GO to G3.
G3: DETERMINE THE FAULT CONDITION	
	1 Headlamp switch in OFF POSITION.
	2 Ignition switch in position II.
	3 CHECK the headlamps. • Is dipped beam lit continuously? → **Yes** Dipped beam lit continuously: GO to G4. → **No** Main beam lit continuously: GO to G10.
G4: NARROW DOWN THE LOCATION OF THE SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F39 (10 A) (SRB).
	3 Disconnect Fuse F41 (10 A) (SRB).
	4 Ignition switch in position II.
	5 CHECK the dipped beam. • Does one dipped beam illuminate? → **Yes** - Left-hand dipped beam lit: LOCATE and RECTIFY the short to battery voltage between fuse F41 (10 A) (SRB) and the left-hand headlamp using the Wiring Diagrams. CHECK the operation of the system. If the concern persists, CHECK and if necessary RENEW the standard relay box (SRB). CHECK the operation of the system. - Right-hand dipped beam lit: LOCATE and RECTIFY the short to battery voltage between fuse F39 (10 A) (SRB) and the right-hand headlamp using the Wiring Diagrams. CHECK the operation of the system. If the concern persists, CHECK and if necessary RENEW the standard relay box (SRB). CHECK the operation of the system. → **No** GO to G5.

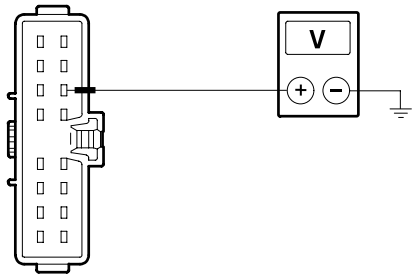
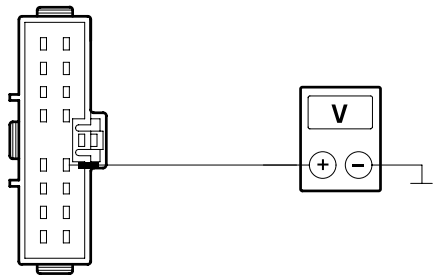
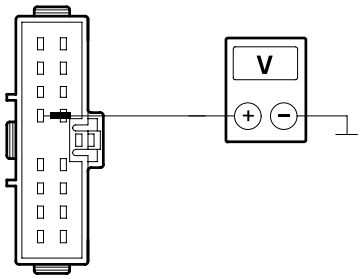
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G5: ELIMINATE THE SHARED VOLTAGE SUPPLY OF FUSES F39/F41 AS A POSSIBLE SOURCE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Connect Fuse F39 (10 A) (SRB).
	3 Connect Fuse F41 (10 A) (SRB).
	4 Disconnect Dipped beam relay from socket R11.
	5 Ignition switch in position II.
	6 CHECK the dipped beam. • Is dipped beam lit continuously? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit(s) between the dipped beam relay and fuse F41/F39 (10 A) (SRB) using the wiring diagrams. CHECK the operation of the system. → **No** GO to G6.
G6: ELIMINATE THE CONTROL CIRCUIT BETWEEN CENTRAL JUNCTION BOX (CJB) AND THE DIPPED BEAM RELAY AS A POSSIBLE SOURCE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB). – Box van / Bus / Combi: from connector C2BP02D – Platform truck: from connector CBP02D
 VFE0016108	3 Measure the resistance between the dipped beam relay, socket R11, pin 2, circuit CLF09A (BU/GY), socket side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to G7. → **No** LOCATE and RECTIFY the short to ground in the circuit(s) between the dipped beam relay and the central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system.
G7: RULE OUT THE DIPPED BEAM RELAY AS A POSSIBLE CAUSE OF THE FAULT	
	1 Connect Dipped beam relay to socket R11.
	2 Ignition switch in position II.

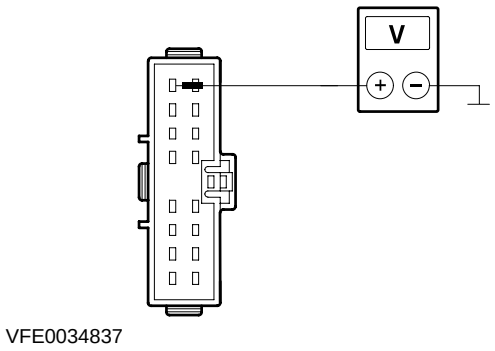
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK the dipped beam. • Is dipped beam lit continuously? → **Yes** INSTALL a new low beam relay. CHECK the operation of the system. → **No** GO to G8.
G8: RULE OUT THE HEADLAMP SWITCH AS POSSIBLE CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Connect Central junction box (CJB). – Box van / Bus / Combi: to connector C2BP02D – Platform truck: to connector CBP02D
	3 Disconnect Headlight switch from connector CLF23.
	4 Ignition switch in position II.
	5 CHECK the dipped beam. • Is dipped beam lit continuously? → **Yes** GO to G9. → **No** RENEW headlight switch. CHECK the operation of the system.
G9: CHECK CONTROL CIRCUIT BETWEEN HEADLAMP SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB). – Box van / Bus / Combi: from connector C2BP02F – Platform truck: from connector CBP02F
	3 Ignition switch in position II.

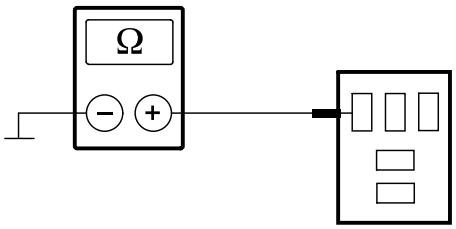
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0008729	4 Measure voltage between headlight switch, connector CLF23, pin 6: – Platform truck with side parking lamp/turn signal lamp: circuit CLF18A (BU/WH), wiring harness side and ground. – All other vehicles: circuit CLF18B (BU/WH), wiring harness side and ground.
 VFE0024362	5 Measure the voltage between the headlight switch CLF23, pin 4, circuit CLF19A (VT/GN), wiring harness side and ground.
 VFE0034861	6 Measure the voltage between the headlight switch CLF23, pin 13, circuit ZA105A (OG/GY), wiring harness side and ground.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0034837	7 Measure the voltage between the headlight switch, CLF23, pin 16, circuit ZA104A (OG/GN), wiring harness side and ground. • Did one of those measurements show battery voltage? → **Yes** LOCATE and REPAIR the short to battery voltage in the affected circuit using the Wiring Diagrams. CHECK the operation of the system. → **No** INSTALL a new CJB. CHECK the operation of the system.
G10: NARROW DOWN THE LOCATION OF THE SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F51 (10 A) (SRB).
	3 Disconnect Fuse F53 (10 A) (SRB).
	4 Ignition switch in position II.
	5 CHECK main beam. • Does one main beam illuminate continuously? → **Yes** - left-hand main beam illuminates: LOCATE and RECTIFY the short to battery voltage between fuse F53 (10 A) (SRB) and the left-hand headlamp using the Wiring Diagrams. CHECK the operation of the system. - Right-hand main beam lit: LOCATE and RECTIFY the short to battery voltage between fuse F51 (10 A) (SRB) and the right-hand headlamp using the Wiring Diagrams. CHECK the operation of the system. → **No** GO to G11.
G11: ELIMINATE THE SHARED VOLTAGE SUPPLY OF FUSES F53/F51 AS A POSSIBLE SOURCE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Connect Fuse F51 (10 A) (SRB).
	3 Connect Fuse F53 (10 A) (SRB).
	4 Disconnect Main beam relay from socket R13.
	5 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	6 CHECK main beam. • Is the main beam lit continuously? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit(s) between the main beam relay and fuse F51/53 (10 A) (SRB) using the wiring diagrams. CHECK the operation of the system. → **No** GO to G12.
G12: ELIMINATE THE CONTROL CIRCUIT BETWEEN THE CENTRAL JUNCTION BOX (CJB) AND THE MAIN BEAM RELAY AS A POSSIBLE SOURCE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB). – Box van / Bus / Combi: from connector C2BP02D – Platform truck: from connector CBP02D
 VFE0016108	3 Measure the resistance between the main beam relay, socket R13, pin 2, circuit CLF08A (YE/VT), socket side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to G13. → **No** LOCATE and RECTIFY the short to ground in the circuit(s) between the main beam relay and the central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system.
G13: RULE OUT THE MAIN BEAM RELAY AS A POSSIBLE CAUSE OF THE FAULT	
	1 Connect Main beam relay to socket R13.
	2 Ignition switch in position II.
	3 CHECK main beam. • Is the main beam lit continuously? → **Yes** INSTALL a new high beam relay. CHECK the operation of the system. → **No** GO to G14.

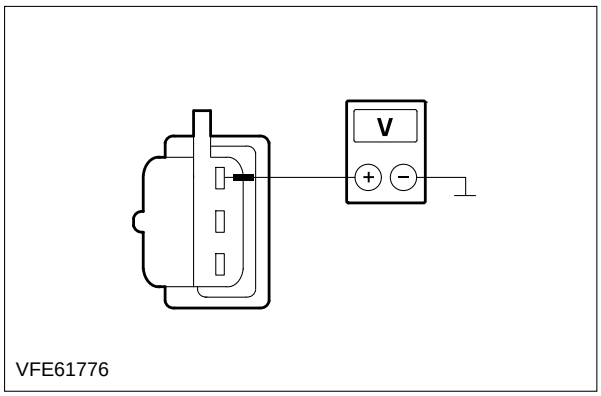
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G14: ELIMINATE THE STEERING COLUMN MULTIFUNCTION SWITCH AS POSSIBLE CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Connect Central junction box (CJB). – Box van / Bus / Combi: to connector C2BP02D – Platform truck: to connector CBP02D
	3 Disconnect Steering column multifunction switch from connector CLS34.
	4 Ignition switch in position II.
	5 CHECK main beam. • Is the main beam lit continuously? → **Yes** GO to G15. → **No** RENEW steering column multifunction switch. CHECK the operation of the system.
G15: RULE OUT CONTROL CIRCUIT BETWEEN MULTIFUNCTION SWITCH AND CENTRAL JUNCTION BOX (CJB) AS SOURCE OF FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB). – Box van / Bus / Combi: from connector C2BP02F – Platform truck: from connector CBP02F
	3 Measure the resistance between the steering column multifunction switch, connector CLS34, pin 9, circuit CLF27A (GN/BN), wiring harness side and ground.
	4 Measure the resistance between the steering column multifunction switch, connector CLS34, pin 8, circuit CLF24A (YE/BU), wiring harness side and ground. • Is a resistance greater than 10,000 Ohms measured in both cases? → **Yes** INSTALL a new CJB. CHECK the operation of the system. → **No** LOCATE and REPAIR short to ground in corresponding circuit between central junction box (CJB) and steering column multifunction switch using the Wiring Diagrams. CHECK the operation of the system.

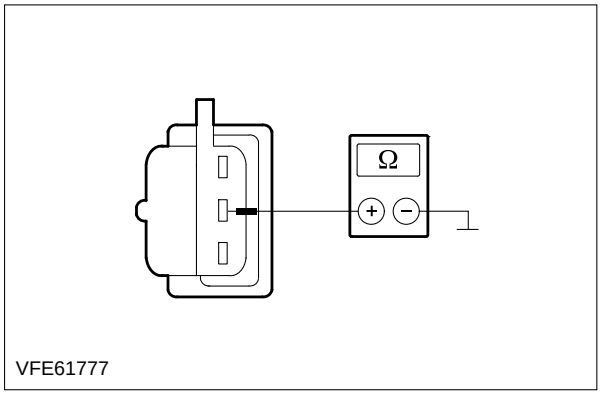
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G16: CHECK FUSE F63 (5 A) (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F63 (5 A) (CJB).
	3 CHECK Fuse F63 (5 A) (CJB). • Is the fuse OK? → **Yes** GO to G17. → **No** RENEW fuse F63 (5 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK the operation of the system.
G17: CHECK THE VOLTAGE SUPPLY TO FUSE F63 (5 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F63 (5 A) (CJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F63 (5 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** GO to G18. → **No** LOCATE AND RECTIFY the break in the voltage supply of fuse F63 (5 A) (CJB) using the Wiring Diagrams. CHECK the operation of the system.
G18: CHECK VOLTAGE SUPPLY TO RAIN SENSOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Rain sensor from connector CRW06.
	3 Ignition switch in position II.

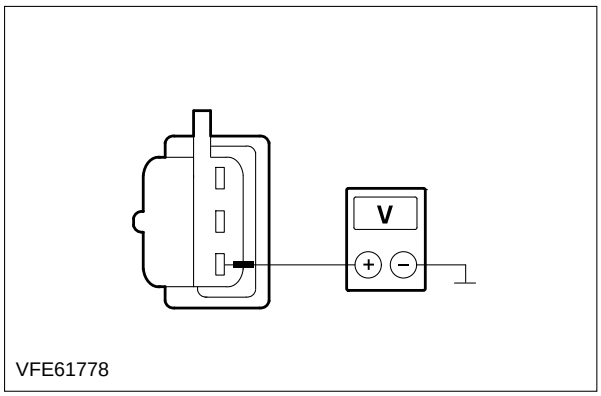
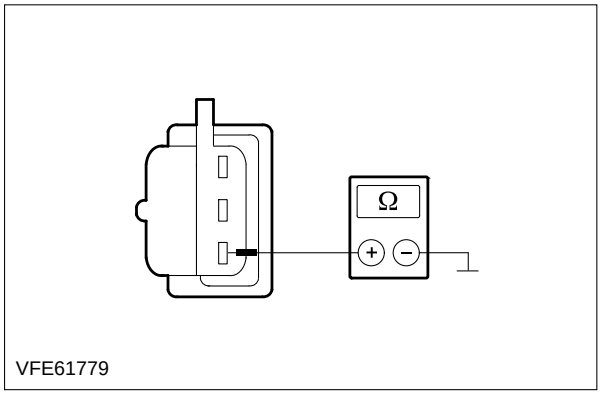
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE61776	4 Measure voltage between rain sensor, connector CRW06, pin 1: – Platform truck with side parking lamp/turn signal lamp: Circuit SBP63F (WH/RD), wiring harness side and ground. – All other vehicles: circuit SBP63G (WH/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to G21. → **No** - Van, bus, combi: GO to G19. - Platform truck: GO to G20.
G19: CHECK THE VOLTAGE SUPPLY TO THE RAIN SENSOR FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector C2BP02D.
	3 Measure the resistance between the central junction box (CJB), connector C2BP02D, pin 11, circuit SBP63A (WH/RD), wiring harness side and the rain sensor, connector CRW06, pin 1, circuit SBP63G (WH/RD), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** INSTALL a new CJB. CHECK the operation of the system. → **No** LOCATE and RECTIFY break in circuit between central junction box (CJB) and rain sensor using the Wiring Diagrams. CHECK the operation of the system.
G20: CHECK VOLTAGE SUPPLY TO RAIN SENSOR FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02D.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the resistance between the central junction box (CJB), connector CBP02D, pin 11, circuit SBP63A (WH/RD), wiring harness side and the rain sensor, connector CRW06, pin 1: – Platform truck with side parking lamp/turn signal lamp: Circuit SBP63F (WH/RD), wiring harness side. – Platform truck without side parking lamp/turn signal lamp: Circuit SBP63G (WH/RD), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** INSTALL a new CJB. CHECK the operation of the system. → **No** LOCATE and RECTIFY break in circuit between central junction box (CJB) and rain sensor using the Wiring Diagrams. CHECK the operation of the system.
G21: CHECK GROUND CONNECTION OF RAIN SENSOR FOR OPEN CIRCUIT	
 VFE61777	1 Measure resistance between rain sensor, connector CRW06, pin 2: – Box van / Bus / Combi: Circuit B_GD138 (BK/WH), wiring harness side and ground. – Platform truck: Circuit B_GD138AF (BK/WH), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to G22. → **No** LOCATE and RECTIFY break in circuit between rain sensor and soldered connection S2D138C with the aid of the wiring diagrams. CHECK the operation of the system.
G22: CHECK CONTROL CIRCUIT BETWEEN RAIN SENSOR AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO BATTERY VOLTAGE	
	1 Disconnect Central junction box (CJB). – Box van / Bus / Combi: From connector C2BP02C – Platform truck: From connector CBP02C
	2 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE61778	3 Measure the voltage between the rain sensor, connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY short to battery voltage in circuit between rain sensor and central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system. → **No** GO to G23.
G23: CHECK CONTROL CIRCUIT BETWEEN RAIN SENSOR AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
 VFE61779	1 Measure the resistance between the rain sensor, connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to G24. → **No** LOCATE and RECTIFY short to ground in circuit between rain sensor and central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system.
G24: CHECK CONTROL CIRCUIT BETWEEN RAIN SENSOR AND CENTRAL JUNCTION BOX (CJB) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

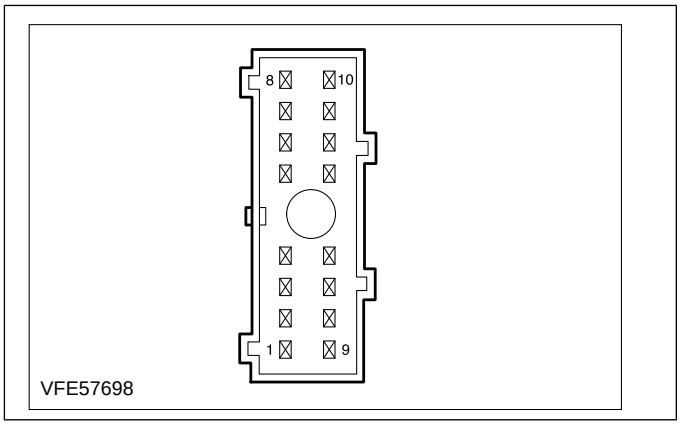
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the rain sensor, connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side and the central junction box (CJB). – Box van / Bus / Combi: Connector C2BP02C, pin 37, circuit VRW26 (BN/YE), wiring harness side. – Platform truck: Connector CBP02C, pin 37, circuit VRW26A (BN/YE), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the rain sensor. CHECK the operation of the system. → **No** LOCATE and RECTIFY break in circuit between rain sensor and central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system.

Component Tests

Headlight switch

Pin assignment:



Circuit to test	Connect ohmmeter to the following terminal pins	Set the switch to the following position	The switch is OK if
Side lamp	8 and 4	Side lamp	closed circuit
	8 and 6	Side lamp	open circuit
	11 and 13	Side lamp	open circuit
	11 and 15	Side lamp	open circuit
	11 and 16	Side lamp	open circuit
	12 and 13	Side lamp	closed circuit

DIAGNOSIS AND TESTING

Circuit to test	Connect ohmmeter to the following terminal pins	Set the switch to the following position	The switch is OK if
	12 and 15	Side lamp	open circuit
	12 and 16	Side lamp	open circuit
Neutral	8 and 4	Neutral	closed circuit
	8 and 6	Neutral	open circuit
	11 and 13	Neutral	open circuit
	11 and 15	Neutral	open circuit
	11 and 16	Neutral	open circuit
	12 and 13	Neutral	open circuit
	12 and 15	Neutral	open circuit
	12 and 16	Neutral	open circuit
Parking lamp	8 and 4	Parking lamp	open circuit
	8 and 6	Parking lamp	open circuit
	11 and 13	Parking lamp	closed circuit
	11 and 15	Parking lamp	open circuit
	11 and 16	Parking lamp	closed circuit
	12 and 13	Parking lamp	open circuit
	12 and 15	Parking lamp	open circuit
	12 and 16	Parking lamp	open circuit
Dipped beam, without automatic headlamps	8 and 4	Dipped beam	open circuit
Dipped beam, with automatic headlamps	8 and 4	Dipped beam	closed circuit
	8 and 6	Dipped beam	closed circuit
	11 and 13	Dipped beam	closed circuit
	11 and 15	Dipped beam	open circuit
	11 and 16	Dipped beam	closed circuit
	12 and 13	Dipped beam	open circuit
	12 and 15	Dipped beam	open circuit
	12 and 16	Dipped beam	open circuit
Automatic headlamps	8 and 4	Automatic headlamps	closed circuit
	8 and 6	Automatic headlamps	open circuit
	11 and 13	Automatic headlamps	open circuit
	11 and 15	Automatic headlamps	open circuit
	11 and 16	Automatic headlamps	open circuit

DIAGNOSIS AND TESTING

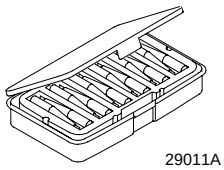
Circuit to test	Connect ohmmeter to the following terminal pins	Set the switch to the following position	The switch is OK if
	12 and 13	Automatic headlamps	open circuit
	12 and 15	Automatic headlamps	open circuit
	12 and 16	Automatic headlamps	open circuit

DIAGNOSIS AND TESTING

Stoplamps

Refer to Wiring Diagrams Section 417-01,for schematic and connector information.

Special Tool(s)

 29011A	Set of adapter plugs for test probes 29-011A

Inspection and Testing

NOTE: Before reading out the vehicle-specific data, remake all the electrical connections in the vehicle, so that communication between the module and WDS is ensured.

NOTE: If the powertrain control module (PCM) is changed, the new one must be programmed. For this purpose, the vehicle-specific data is read out of the module to be replaced using WDS and is transferred to the new module.

REFER to:Module Configuration (418-01 Module Configuration, General Procedures).

NOTE: The generic electronic module (GEM) forms part of the central junction box (CJB).

NOTE: If the generic electronic module (GEM) is changed, the new one must be reinitialized. For this purpose, the vehicle-specific data is read out of the module to be replaced using WDS and is transferred to the new module. REFER to:

Communications Network (418-00 Module Communications Network, Diagnosis and Testing),
Generic Electronic Module (GEM) (419-10 Multifunction Electronic Modules, Diagnosis and Testing).

1. Verify the customer concern.
2. Visually check for any obvious mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
• Adjustment of stoplamp switch	• Fuse(s) • Connector • Wiring loom

3. Resolve any obvious causes or concerns found during the visual inspection before carrying out any further tests.
4. If the cause of the concern cannot be found by visual inspection, continue with the symptom chart.

Symptom chart

Symptom chart

Symptom	Possible Sources	Action
• All stoplamps inoperative	• Fuse(s) • Circuit(s) • Stoplamp switch • Central junction box (CJB)	• GO to Pinpoint Test A.
• One or more stop lamps are inoperative	• Circuit(s) • Tail Lamp Assembly • Third stop light	• GO to Pinpoint Test B.
• Stop lamps continuously lit	• Circuit(s) • Stoplamp switch • Anti-lock brake system module (ABS) • Electronic stability program (ESP) module • Powertrain control module (PCM) • Trailer socket	• GO to Pinpoint Test C.

DIAGNOSIS AND TESTING

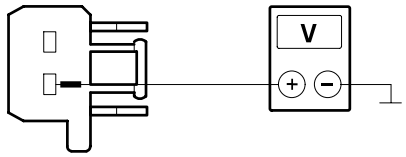
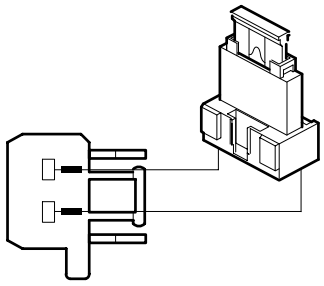
Pinpoint test

NOTE: Use a digital multimeter for all electrical measurements.

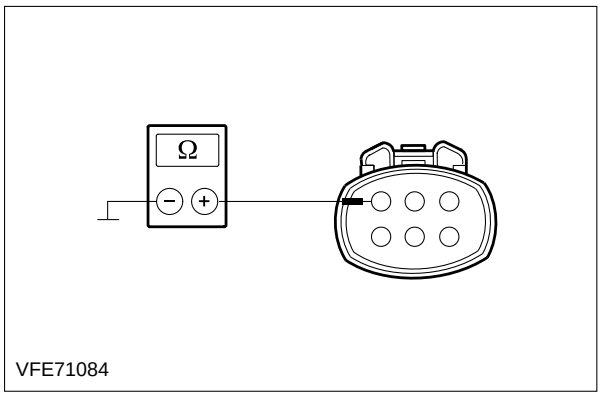
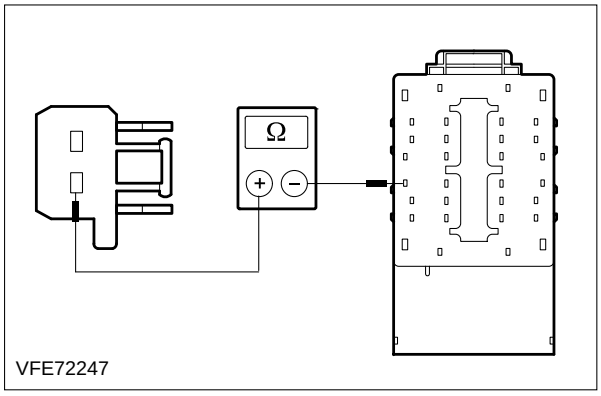
PINPOINT TEST H : ALL STOPLAMPS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK FUSE F65 (15 A) (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F65 (15 A) (CJB).
	3 CHECK Fuse F65 (15 A) (CJB). • Is the fuse OK? → **Yes** GO to A2. → **No** RENEW fuse F65 (15 A) (CJB). CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK the operation of the system.
A2: CHECK THE VOLTAGE SUPPLY TO FUSE F65 (15 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F65 (15 A) (CJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F65 (15 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** GO to A3. → **No** LOCATE AND RECTIFY the break in the voltage supply of fuse F65 (15 A) (CJB) with the aid of the wiring diagrams. CHECK the operation of the system.
A3: CHECK THE VOLTAGE SUPPLY TO THE STOP LAMP SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect stop lamp switch from connector CCB08.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

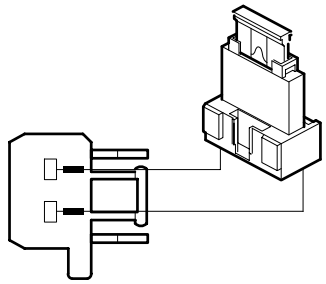
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0033865	4 Measure voltage between stop lamp switch, connector CCB08, pin 1, circuit SBP65A (RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A4. → **No** GO to A6.
A4: STOP LAMP SWITCH INSPECTION	
	1 Ignition switch in position 0.
 VFE0038423	2 Connect fused (15 A) jumper wire at stop lamp switch, connector CCB08, between pin 1, circuit SBP65A (RD) and pin 2, circuit CCB08A (VT/WH), wiring harness side.
	3 Ignition switch in position II.
	4 Check the stop lamps. • Do the stop lamps come on? → **Yes** RENEW stop light switch. CHECK the operation of the system. → **No** - Box van, bus, combi: LOCATE and RECTIFY the break in the circuit between the stop lamp switch and soldered connection S2CB08 using the Wiring Diagrams. CHECK the operation of the system. - Chassis cab vehicle: GO to A5.
A5: CHECK COMMON GROUND SUPPLY TO THE REAR LAMP CLUSTERS FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand rear lamp assembly from connector CLS35 (CLS04).

DIAGNOSIS AND TESTING

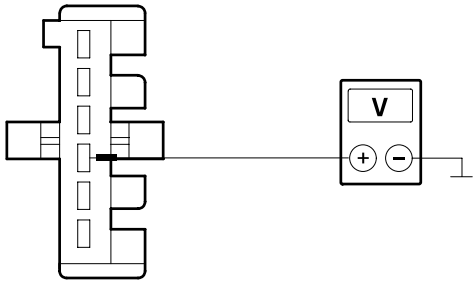
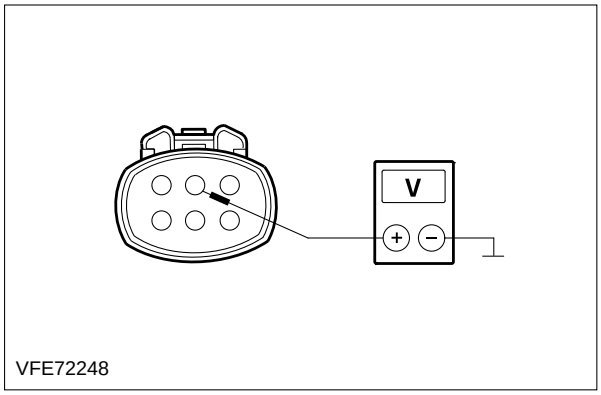
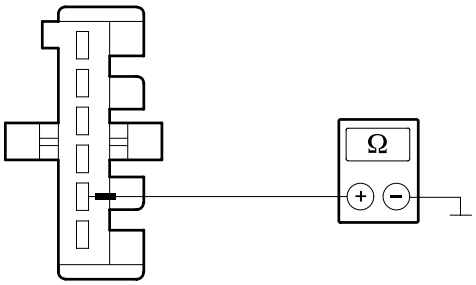
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the resistance between the left-hand rear lamp assembly, connector CLS35 (CLS04), pin 1, circuit B_GD129U (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** LOCATE and RECTIFY the break in the circuit between the stop lamp switch and soldered connection S4CB08 using the Wiring Diagrams. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S4D129G and ground connection G29 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A6: CHECK CIRCUIT BETWEEN CENTRAL JUNCTION BOX (CJB) AND BRAKE LAMP SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB). – Box van / Bus / Combi: from connector C2BP02B – Platform truck: from connector CBP02B
	3 Measure the resistance between the stop lamp switch, connector CCB08, pin 1, circuit SBP65A (RD), wiring harness side and the central junction box (CJB). – Box van / Bus / Combi: Connector C2BP02B, pin 13, circuit SBP65A (RD), wiring harness side. – Platform truck: Connector CBP02B, pin 13, circuit SBP65A (RD), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary RENEW the central junction box (CJB). CHECK the operation of the system. → **No** LOCATE and RECTIFY break in circuit between central junction box (CJB) and stop lamp switch using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

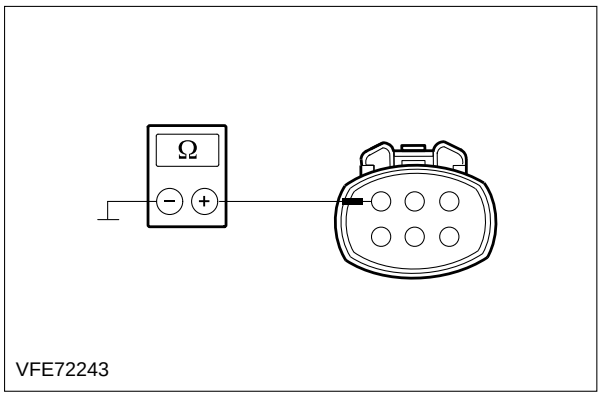
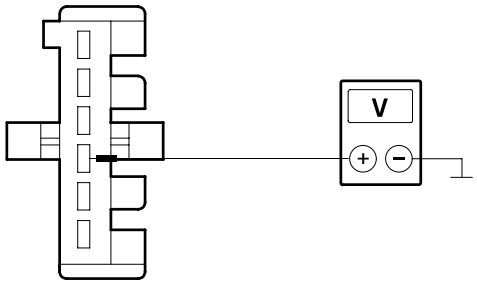
PINPOINT TEST I : ONE OR MORE STOP LAMPS ARE INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: DETERMINE THE INOPERATIVE STOP LAMP(S)	
NOTE: The fused jumper wire remains connected in the following test steps.	
	1 Ignition switch in position II.
	2 Disconnect stop lamp switch from connector CCB08.
 VFE0038423	3 Connect fused (15 A) jumper wire at stop lamp switch, connector CCB08, between pin 1, circuit SBP65A (RD) and pin 2, circuit CCB08A (VT/WH), wiring harness side.
	4 Ignition switch in position II.
	5 Check the stop lamps. • Is the right-hand stoplamp inoperative? → **Yes** GO to B2. → **No** - Left-hand stoplamp inoperative: GO to B4. - Additional high-mounted stop lamp inoperative: GO to B6. - Left-hand stoplamp and additional high-mounted stoplamp inoperative: GO to B8.
B2: CHECK THE VOLTAGE SUPPLY TO THE RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Right-hand rear lamp assembly. – Box van / Bus / Combi: from connector CLS26 – Platform truck: from connector CLS36
	3 Ignition switch in position II.

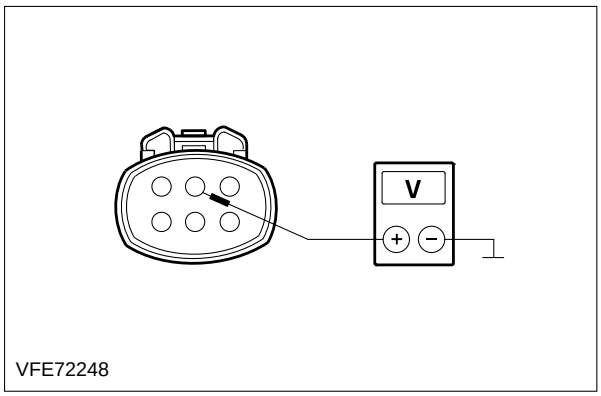
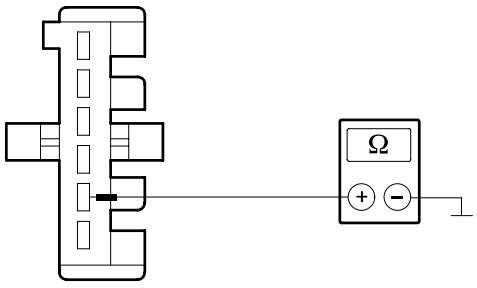
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0018114	4 Box van, bus, combi: Measure voltage between right-hand rear lamp assembly, connector CLS26: – Vehicles without tailgate or without trailer socket: pin 4, circuit CCB08G (VT/WH), wiring harness side and ground. – Vehicles with tailgate or with trailer socket: pin 4, circuit CCB08AB (VT/WH), wiring harness side and ground.
 VFE72248	5 Platform truck: Measure the voltage between right-hand rear lamp assembly, connector CLS36, pin 2, circuit CCB08G (VT/WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B3. → **No** - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between soldered connection S4CB08 and rear lamp assembly using the Wiring Diagrams. CHECK the operation of the system. - All other models: LOCATE and RECTIFY the break in the circuit between soldered connection S2CB08 and rear lamp assembly using the Wiring Diagrams. CHECK the operation of the system.
B3: CHECK THE GROUND CONNECTION TO THE RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 E0018115	2 Box van, bus, combi: Measure resistance between right-hand rear lamp assembly, connector CLS26: – vehicles without tailgate, pin 5, circuit A_GD151H (BK/GN), wiring harness side and ground. – Vehicles with tailgate or with trailer socket: pin 5, circuit A_GD151AB (BK/GN), wiring harness side and ground.

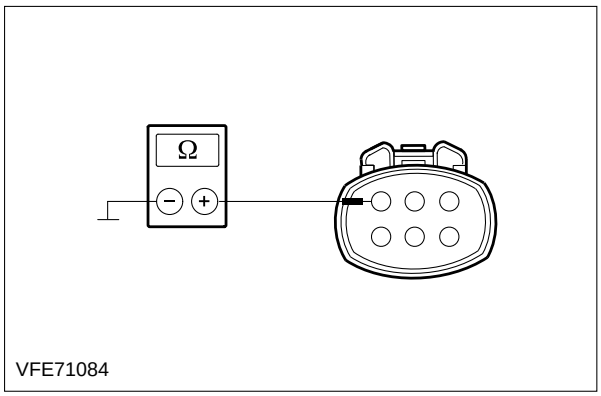
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72243	3 Platform truck: Measure the resistance between the right-hand rear lamp assembly, connector CLS36, pin 1, circuit B_GD129V (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the rear lamp assembly. CHECK the operation of the system. → **No** - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between rear lamp assembly and soldered connection S4D129G using the Wiring Diagrams. CHECK the operation of the system. - All other vehicles: LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and ground connection G51 using the Wiring Diagrams. CHECK the operation of the system.
B4: CHECK THE VOLTAGE SUPPLY TO THE LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect left-hand rear lamp assembly:. – Box van, bus, combi: from connector CLS22 – Platform truck: from connector CLS35
	3 Ignition switch in position II.
 E0018114	4 Box van, bus, combi: Measure voltage between left-hand rear lamp assembly, connector CLS22, pin 4: – Vehicles with double doors: circuit CCB08L (VT/WH), wiring harness side and ground. – All other vehicles: circuit CCB08Z (VT/WH), wiring harness side and ground.

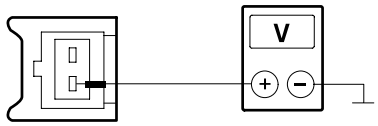
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72248	5 Platform truck: Measure the voltage between left-hand rear lamp assembly, connector CLS35, pin 2, circuit CCB08H (VT/WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B5. → **No** - Van, bus, combi with double doors: LOCATE and RECTIFY the break in the circuit between soldered connection S4CB08A and rear lamp assembly using the Wiring Diagrams. CHECK the operation of the system. - Box van, bus, combi vehicles with tailgate or with trailer socket: LOCATE and RECTIFY the break in the circuit between soldered connection S2CB08A and rear lamp assembly using the Wiring Diagrams. CHECK the operation of the system. - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between soldered connection S4CB08 and rear lamp assembly using the Wiring Diagrams. CHECK the operation of the system.
B5: CHECK THE GROUND CONNECTION TO THE LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 E0018115	2 Box van, bus, combi: Measure resistance between left-hand rear lamp assembly, connector CLS22, pin 5: – Vehicles without tailgate: circuit A_GD149N (BK/GY), wiring harness side and ground. – All other vehicles: circuit A_GD149C (BK/GY), wiring harness side and ground.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE71084	3 Platform truck: Measure the resistance between the left-hand rear lamp assembly, connector CLS35, pin 1, circuit B_GD129U (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the left-hand rear lamp assembly. CHECK the operation of the system. → **No** - Box van, bus, combi vehicles with tailgate or with tow bar socket: LOCATE and RECTIFY the break in the circuit between rear lamp assembly and soldered connection S4D149A, using the Wiring Diagrams. CHECK the operation of the system. - Van, bus, combi, all other variants: LOCATE and RECTIFY the break in the circuit between rear lamp assembly and soldered connection S4D149B using the Wiring Diagrams. CHECK the operation of the system. - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between rear lamp assembly and soldered connection S4D149G, using the Wiring Diagrams. CHECK the operation of the system.
B6: CHECK THE VOLTAGE SUPPLY OF THE ADDITIONAL HIGH-MOUNTED STOPLAMP FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Disconnect Additional high-mounted stoplamp from connector CLS17(L).
	3 Ignition switch in position II.

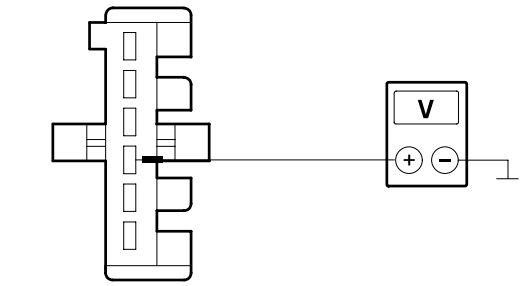
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0022789	4 Measure the voltage between high mounted stoplamp: – Vehicles without tailgate, without trailer socket: Connector CLS17, pin 1, circuit CCB08N (VT/WH), wiring harness side and ground. – All other vehicles: Connector CLS17L, pin 1, circuit CCB08AG (VT/WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B7. → **No** - Vehicles without tailgate, without trailer socket: LOCATE and RECTIFY the break in the circuit between soldered connection S4CB08A and the additional high-mounted stoplamp using the wiring diagrams. CHECK the operation of the system. - All other vehicles: LOCATE and RECTIFY the break in the circuit(s) between soldered connection S4CB08 and the additional high-mounted stop lamp using the Wiring Diagrams. CHECK the operation of the system.
B7: CHECK THE GROUND CONNECTION OF THE ADDITIONAL HIGH-MOUNTED STOPLAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0022920	2 Measure the resistance between high mounted stoplamp: – Vehicles without tailgate, without trailer socket: Connector CLS17, pin 2, circuit A_GD149AE (BK/GY), wiring harness side and ground. – All other vehicles: connector CLS17L, pin 2, circuit A_GD151BE (BK/GN), wiring harness side, and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW additional high-mounted stop lamp. CHECK the operation of the system. → **No** - Vehicles without tailgate, without trailer socket: LOCATE and RECTIFY the break in the circuit between the additional high-mounted stop lamp and soldered connection S4D149B using the Wiring Diagrams. CHECK the operation of the system. - All other vehicles: LOCATE and RECTIFY the break in the circuit between the additional high-mounted stop lamp and soldered connection S4D149A using the Wiring Diagrams. CHECK the operation of the system.
B8: CHECK COMMON VOLTAGE SUPPLY OF REAR LEFT-HAND LAMP CLUSTER AND ADDITIONAL HIGH-MOUNTED STOP LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand rear lamp assembly from connector CLS22.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0018114	4 Measure the voltage between left-hand rear lamp assembly, connector CLS22, pin 4, circuit CCB08L (VT/WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY the break in the circuit between soldered connection S4D149B and ground connection G49 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2CB08 and soldered connection S4CB08A using the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST J : STOP LAMPS CONTINUOUSLY LIT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: STOP LAMP SWITCH INSPECTION	
	1 Ignition switch in position 0.
	2 Disconnect stop lamp switch from connector CCB08.
	3 Ignition switch in position II.
	4 Check the stop lamps. • Do the stoplamps light up continuously? → **Yes** GO to C2. → **No** RENEW brake light switch. CHECK the operation of the system.
C2: DETERMINE THE EQUIPMENT LEVEL OF THE VEHICLE	
	1 Determine the equipment level of the vehicle. • Does the vehicle have ABS/ESP? → **Yes** GO to C3. → **No** GO to C4.
C3: ELIMINATE THE ABS MODULE/ESP MODULE AS CAUSE FOR THE SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

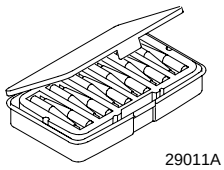
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect fuse F13 (40 A) (EJB).
	3 Disconnect fuse F20 (10 A) (EJB).
	4 Disconnect fuse F21 (25 A) (EJB).
	5 Ignition switch in position II.
	6 Check the stop lamps. • Do the stoplamps light up continuously? → **Yes** GO to C4. → **No** RENEW anti-lock braking system (ABS) module or electronic stability program (ESP) module. CHECK the operation of the system.
C4: RULE OUT THE POWERTRAIN CONTROL MODULE (PCM) AS POSSIBLE CAUSE FOR A SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Connect fuse F13 (40 A) (EJB).
	3 Connect fuse F20 (10 A) (EJB).
	4 Connect fuse F21 (25 A) (EJB).
	5 Disconnect fuse F26 (15 A) (EJB).
	6 Disconnect fuse F37 (5 A) (EJB).
	7 Disconnect Deisel vehicles only: fuse F27 (10 A) (EJB).
	8 Ignition switch in position II.
	9 Check the stop lamps. • Do the stoplamps light up continuously? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuits connected to soldered connection S2CB08 using the Wiring Diagrams. CHECK the operation of the system. Vehicles with trailer socket: CHECK and if necessary RENEW the tow bar socket. CHECK the operation of the system. → **No** RENEW the PCM. CHECK the operation of the system.

DIAGNOSIS AND TESTING

Turn Signal and Hazard Lamps

Refer to Wiring Diagrams Section 417-01,for schematic and connector information.

Special Tool(s)

 29011A	Set of adapter plugs for test probes 29-011A

Inspection and Testing

NOTE: Before reading out the vehicle-specific data, remake all the electrical connections to the module to be removed, so that communication between the module and WDS is ensured.

NOTE: The generic electronic module (GEM) forms part of the central junction box (CJB).

NOTE: If the generic electronic module (GEM) is changed, the new one must be reinitialized. For this purpose, the vehicle-specific data is read out of the module to be replaced using WDS and is transferred to the new module. REFER to:

Communications Network (418-00 Module Communications Network, Diagnosis and Testing),
Generic Electronic Module (GEM) (419-10 Multifunction Electronic Modules, Diagnosis and Testing).

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical or mechanical damage.

Visual Inspection Chart

Electrical
– Fuse(s) – Bulb(s) – Connector(s) – Switch – Wiring loom

3. Resolve any obvious causes for a concern found during the visual inspection before carrying out any further tests.
4. If the cause of the concern cannot be found by visual inspection, continue with the symptom chart.

Symptom chart

Symptom chart

Symptom	Possible Sources	Action
• All turn signal lamps are inoperative	• Fuse(s) • Circuit(s) • Generic Electronic Module (GEM) • Steering column multifunction switch	• GO to Pinpoint Test A.
• All hazard warning lamps are inoperative	• Circuit(s) • Generic Electronic Module (GEM) • Hazard warning lamp switch	• GO to Pinpoint Test B.

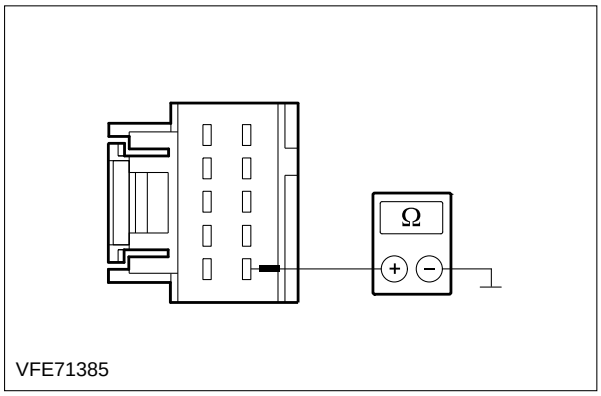
DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• One or more turn signal lamps inoperative	• Circuit(s) • Hazard warning lamp switch • Turn signal lamp • Generic Electronic Module (GEM)	• GO to Pinpoint Test C.
• All turn signal lamps flashing continuously	• Generic Electronic Module (GEM) • Hazard warning lamp switch	• GO to Pinpoint Test D.
• One or more turn signal lamps flashing continuously	• Hazard warning lamp switch • Steering column multifunction switch • Generic Electronic Module (GEM)	• GO to Pinpoint Test E.
• The turn signal lamps are permanently lit	• Circuit(s) • Generic Electronic Module (GEM) • Steering column multifunction switch	• GO to Pinpoint Test F.

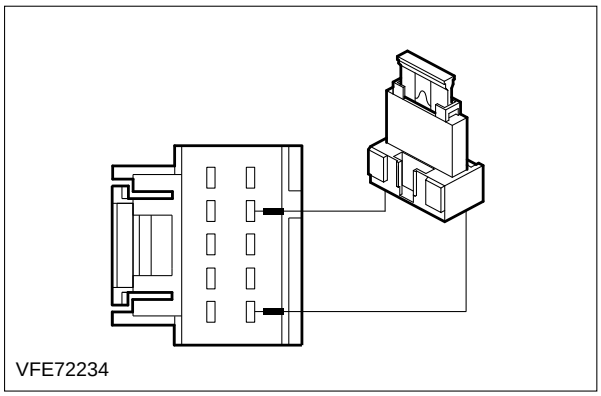
Pinpoint test

NOTE: Use a digital multimeter for all electrical measurements.

PINPOINT TEST K : ALL TURN SIGNAL LAMPS INOPERATIVE

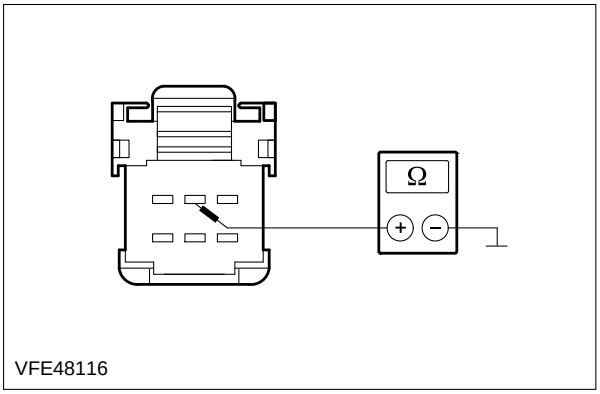
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK THE GROUND CONNECTION OF THE STEERING COLUMN MULTIFUNCTION SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Steering column multifunction switch from connector CLS34.
 VFE71385	3 Measure the resistance between the steering column multifunction switch, connector CLS34, pin 10, circuit B_GD115D (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to A3. → **No** GO to A2.

DIAGNOSIS AND TESTING

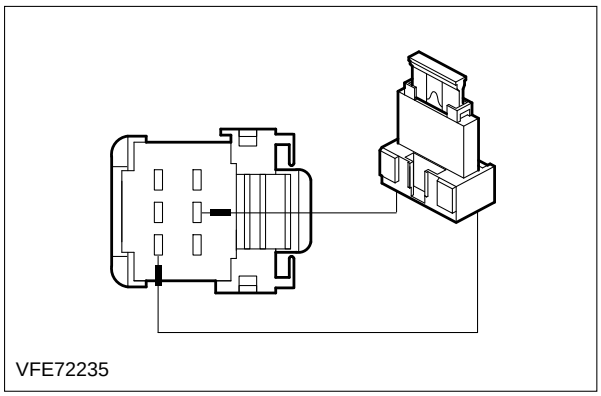
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A2: CHECK THE GROUND CONNECTION OF THE STEERING COLUMN MULTIFUNCTION SWITCH FOR OPEN CIRCUIT	
	1 SWITCH ON the hazard warning lamp switch. • Do the hazard warning lamps work? → **Yes** LOCATE and RECTIFY the break in the circuit between the steering column multifunction switch and soldered connection S2D115B using the Wiring Diagrams. CHECK the operation of the system. → **No** LOCATE and RECTIFY break in circuit between soldered connection S2D115B and ground connection G15 using the Wiring Diagrams. CHECK the operation of the system.
A3: RULE OUT THE STEERING COLUMN MULTIFUNCTION SWITCH AS A CAUSE FOR THE CONCERN	
 VFE72234	1 Connect a fused (5 A) jumper lead at steering column multifunction switch, connector CLS34, between pin 7, circuit CLS41A (GY/YE) wiring harness side and pin 10, circuit B_GD115D (BK/GY), wiring harness side:
	2 CHECK the turn signal lamps.
	3 Ignition switch in position II. • Are the right-hand turn signal lamps flashing? → **Yes** RENEW steering column multifunction switch. CHECK the operation of the system. → **No** INSTALL A NEW generic electronic module (GEM). CHECK the operation of the system.

DIAGNOSIS AND TESTING

PINPOINT TEST L : ALL HAZARD WARNING LAMPS ARE INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK THE GROUND CONNECTION OF THE HAZARD WARNING LAMP SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Hazard warning light switch from connector CLS32.
 VFE48116	3 Measure the resistance between the hazard warning lights switch, connector CLS32, pin 2, circuit B_GD115H (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to B3. → **No** GO to B2.
B2: CHECK THE GROUND CONNECTION OF THE HAZARD WARNING LAMP SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position II.
	2 Switch on the RIGHT-HAND TURN SIGNAL.
	3 CHECK the turn signal lamps. • Do the right-hand turn signal lamps work? → **Yes** LOCATE and RECTIFY the break in the circuit between the hazard warning lamp switch and soldered connection S2D115B using the Wiring Diagrams. CHECK the operation of the system. → **No** LOCATE and RECTIFY break in circuit between soldered connection S2D115B and ground G15 using the Wiring Diagrams. CHECK the operation of the system.
B3: EXCLUDE THE HAZARD WARNING LAMP SWITCH AS THE CAUSE OF THE CONCERN	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72235	2 Connect a fused jumper lead (5 A) to the hazard warning lights switch at connector CLS32, between pin 2, circuit B_GD115H (BK/GY) and pin 4, circuit CLS32A (BN/YE), wiring harness side.
	3 Ignition switch in position II. • Do the hazard warning lamps work? → **Yes** RENEW the hazard warning light switch. CHECK the operation of the system. → **No** GO to B4.
B4: CHECK CONTROL CIRCUIT BETWEEN GENERIC ELECTRONIC MODULE (GEM) AND HAZARD WARNING LIGHT SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Generic Electronic Module (GEM). – Box van / Bus / Combi: from connector C2BP02F – Platform truck: from connector CBP02F
	3 Measure the resistance between the hazard warning lights switch, connector CLS32, pin 4, circuit CLS32A (BN/YE), wiring harness side and the generic electronic module (GEM). – Box van / Bus / Combi: Connector C2BP02F, pin 19, circuit CLS32A (BN/YE), wiring harness side. – Platform truck: Connector CBP02F, pin 19, circuit CLS32A (BN/YE), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the generic electronic module (GEM). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the hazard warning lamp switch and the generic electronic module (GEM) using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

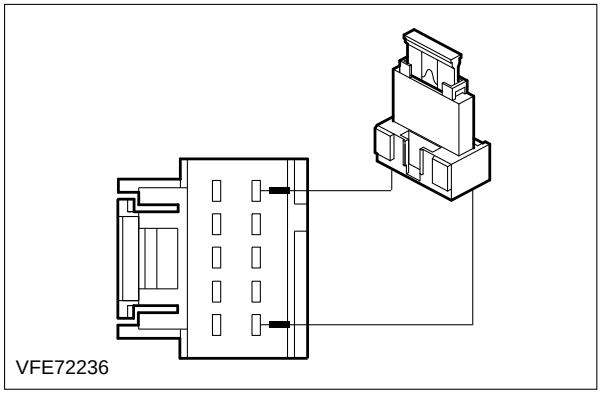
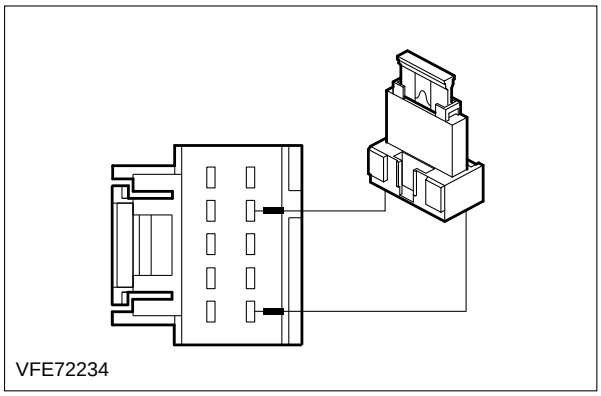
PINPOINT TEST M : ONE OR MORE TURN SIGNAL LAMPS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: DETERMINE THE INOPERATIVE TURN SIGNAL LAMP(S)	
	1 Ignition switch in position II.
	2 CHECK the turn signal lamps after each action.
	3 DETERMINE which turn signal lamp is inoperative.
	4 SWITCH ON the left-hand turn signal.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	5 SWITCH ON the right-hand turn signal. • Is a turn signal lamp on the left-hand side inoperative? → **Yes** - All turn signal lamps on left-hand side inoperative: GO to C2. - Only the front left-hand turn signal lamp is inoperative: GO to C4. - Only the left-hand turn side repeater lamp is inoperative: GO to C6. - Only the left-hand parking light/left-hand turn side repeater lamp is inoperative: GO to C8. - The front and side (side)/turn signal lamps on the left-hand side are inoperative: GO to C10. - Only the rear left turn signal lamp is inoperative; box van, bus, combi only: GO to C12. - Only the rear left-hand turn signal lamp is inoperative, platform truck only: GO to C14. → **No** - All turn signal lamps on right-hand side inoperative: GO to C2. - Only the front right turn signal lamp is inoperative; box van, bus, combi only: GO to C17. - Only the front right turn signal lamp is inoperative, platform truck only:GO toC19. - Only the side turn signal lamp on the right-hand side is inoperative: GO to C21. - Only the right-hand side light/turn signal lamp is inoperative: GO to C23. - The front and side (side)/turn signal lamps on the right-hand side are inoperative; box van, bus and combi only: GO to C25. - The front and side (side)/turn signal lamps on the right-hand side are inoperative; platform truck only: GO to C27. - Only the rear right turn signal lamp is inoperative; box van, bus, combi only: GO to C29. - Only the rear right turn signal lamp is inoperative, platform truck only: GO to C32. - Both rear turn signal lamps are inoperative, platform truck only: GO to C41. - Both rear turn signal lamps are inoperative; box van, bus, combi with trailer socket only: GO to C42.
C2: RULE OUT THE STEERING COLUMN MULTIFUNCTION SWITCH AS A CAUSE FOR THE CONCERN	
	1 Ignition switch in position 0.
	2 Disconnect Steering column multifunction switch from connector CLS34.

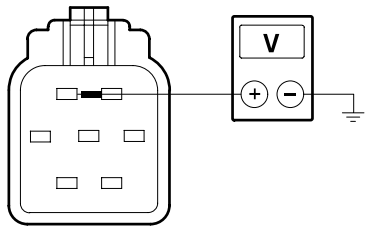
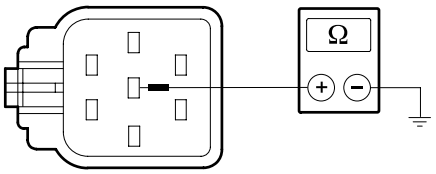
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72236	3 Left-hand turn signal lamps inoperative: Connect a fused (5 A) jumper lead at steering column multifunction switch, connector CLS34, between pin 6, circuit CLS39A (VT/WH) wiring harness side and pin 10, circuit B_GD115D (BK/GY), wiring harness side:
 VFE72234	4 Right-hand turn signal lamps inoperative: Connect a fused (5 A) jumper lead at the steering column multifunction switch, connector CLS34, between pin 7, circuit CLS41A (GY/YE) wiring harness side and pin 10, circuit B_GD115D (BK/GY), wiring harness side:
	5 Ignition switch in position II.
	6 CHECK the turn signal lamps. • Do all the turn signal lamps flash on the affected side? → **Yes** RENEW steering column multifunction switch. CHECK the operation of the system. → **No** GO to C3.
C3: CHECK THE CONTROL CIRCUIT BETWEEN THE STEERING COLUMN MULTIFUNCTION SWITCH AND THE GEM (GENERIC ELECTRONIC MODULE) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Generic Electronic Module (GEM). – Box van / Bus / Combi: from connector C2BP02F – Platform truck: from connector CBP02F

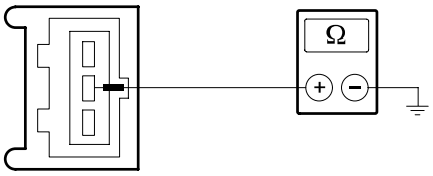
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Left-hand turn signal lamps inoperative: Measure the resistance between the steering column multifunction switch, connector CLS34, pin 6, circuit CLS39A (VT/WH), wiring harness side and the generic electronic module (GEM). – Box van / Bus / Combi: Connector C2BP02F, pin 9, circuit CLS39A (VT/WH), wiring harness side. – Platform truck: Connector CBP02F, pin 9, circuit CLS39A (VT/WH), wiring harness side.
	4 Right-hand turn signal lamps inoperative: Measure the resistance between the steering column multifunction switch, connector CLS34, pin 7, circuit CLS41A (GY/YE), wiring harness side and the generic electronic module (GEM). – Box van / Bus / Combi: Connector C2BP02F, pin 10, circuit CLS41A (GY/YE), wiring harness side. – Platform truck: Connector CBP02F, pin 10, circuit CLS41A (GY/YE), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the generic electronic module (GEM). CHECK the operation of the system. → **No** LOCATE and REPAIR open circuit between steering column multifunction switch and generic electronic module (GEM) using the Wiring Diagrams. CHECK the operation of the system.
C4: CHECK THE VOLTAGE SUPPLY OF THE LEFT-HAND HEADLAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand headlamp from. – Box van, bus, combi, without trailer socket, with side parking lamp/turn signal lamp: Connector C1LF08 – All other vehicles: Connector CLF08
	3 Ignition switch in position II.
	4 SWITCH ON the left-hand turn signal.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0011505	5 At the left-hand headlamp, measure the voltage between: – Box van, bus, combi, without trailer socket, with side parking lamp/turn signal lamp: Connector C1LF08, pin 1, circuit CLS21E (BU/GN), wiring harness side and ground. – Platform truck without side parking lamp/turn signal lamp: Connector CLF08, pin 1, circuit CLS21B (BU/GN), wiring harness side and ground. – All other vehicles: Connector CLF08, pin 1, circuit CLS21E (BU/GN), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C5. → **No** LOCATE and REPAIR break in circuit(s) between soldered connection S2LS21 and headlamp using the Wiring Diagrams. CHECK the operation of the system.
C5: CHECK GROUND SUPPLY OF LEFT-HAND HEADLAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 VFE0003175	2 Measure the resistance at the left-hand headlamp between: – Box van, bus, combi, without trailer socket, with side parking lamp/turn signal lamp: Connector C1LF08, pin 4, circuit A_GD129T (BK/YE), wiring harness side and ground. – All other vehicles: Connector CLF08, pin 4, circuit A_GD129E (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary RENEW the headlamp. CHECK the operation of the system. → **No** - Box van, bus, combi: LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S1D129A using the Wiring Diagrams. CHECK the operation of the system. - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S2D129A using the Wiring Diagrams. CHECK the operation of the system.

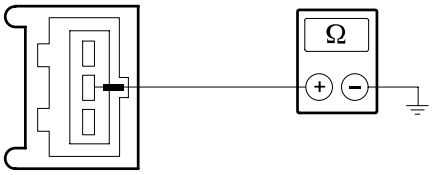
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C6: CHECK THE VOLTAGE SUPPLY TO THE LEFT-HAND TURN SIGNAL LAMP (SIDE) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect left-hand turn signal lamp (side) from connector CLS25.
	3 Ignition switch in position II.
	4 SWITCH ON the left-hand turn signal.
 VFE0016139	5 Measure the voltage between the left-hand turn signal lamp (side), connector CLS25, pin 1, circuit CLS21C (BU/GN), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C7. → **No** LOCATE and REPAIR break in circuit(s) between soldered connection S2LS21 and turn signal lamp (side) using the Wiring Diagrams. CHECK the operation of the system.
C7: CHECK THE GROUND CONNECTION OF THE LEFT-HAND (SIDE) TURN SIGNAL LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 VFE0010896	2 Measure the resistance between the left-hand turn signal lamp (side), connector CLS25, pin 2, circuit A_GD129C (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary RENEW the turn signal side lamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the (side) turn signal lamp and soldered connection S2D129A using the Wiring Diagrams. CHECK the operation of the system.
C8: CHECK THE VOLTAGE SUPPLY TO THE LEFT-HAND SIDE PARKING LAMP/TURN SIGNAL LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

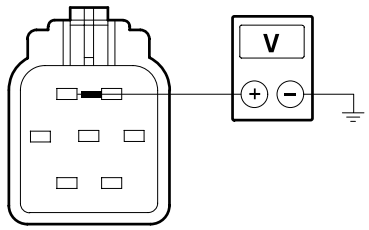
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Left-hand side parking lamp/turn signal lamp from . – Box van / bus / combi, without a trailer socket: Connector C1LS15A – Chassis cab vehicle: connector CLS25 – All other vehicles: connector CLS15A
	3 Ignition switch in position II.
	4 SWITCH ON the left-hand turn signal.
 VFE0016139	5 Measure the voltage at the left-hand side parking lamp/turn signal lamp between: – Box van / bus / combi, without a trailer socket: Connector C1LS15A, pin 1, circuit CLS21D (BU/GN), wiring harness side and ground. – Chassis cab vehicle: Connector CLS25, pin 1, circuit CLS21D (BU/GN), wiring harness side and ground. – All other vehicles: Connector CLS15A, pin 1, circuit CLS21D (BU/GN), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C9. → **No** LOCATE and REPAIR break in circuit(s) between soldered connection S2LS21 and side parking lamp/turn signal lamp using the Wiring Diagrams. CHECK operation of system.
C9: CHECK THE GROUND CONNECTION OF THE LEFT-HAND SIDE PARKING LAMP/TURN SIGNAL LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

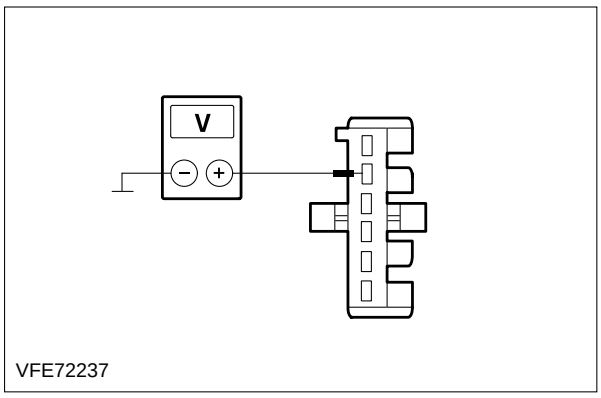
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0010896	2 Measure resistance between left-hand side parking lamp/turn signal lamp, – Box van / bus / combi, without a trailer socket: Connector C1LS15A, pin 2, circuit A_GD129S (BK/YE), wiring harness side and ground. – Chassis cab vehicle: Connector CLS25, pin 2, circuit A_GD129S (BK/YE), wiring harness side and ground. – All other vehicles: Connector CLS15A, pin 2, circuit A_GD129S (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary RENEW the side parking lamp/turn signal lamp. CHECK the operation of the system. → **No** - Box van, bus, combi: LOCATE and RECTIFY the break in the circuit between the side parking lamp/turn signal lamp and soldered connection S1D129A using the Wiring Diagrams. CHECK the operation of the system. - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between the side parking lamp/turn signal lamp and soldered connection S2D129A using the Wiring Diagrams. CHECK the operation of the system.
C10: CHECK THE COMMON GROUND OF THE FRONT LEFT-HAND TURN SIGNAL LAMPS FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand headlamp from. – Box van, bus, combi, without trailer socket, with side parking lamp/turn signal lamp: Connector C1LF08 – All other vehicles: Connector CLF08
	3 Ignition switch in position II.
	4 SWITCH ON the left-hand turn signal.

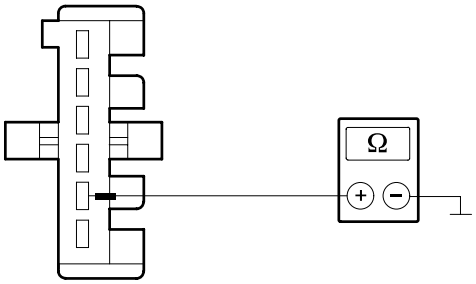
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0011505	5 At the left-hand headlamp, measure the voltage between: – Box van, bus, combi, without trailer socket, with side parking lamp/turn signal lamp: Connector C1LF08, pin 1, circuit CLS21E (BU/GN), wiring harness side and ground. – Platform truck without side parking lamp/turn signal lamp: Connector CLF08, pin 1, circuit CLS21B (BU/GN), wiring harness side and ground. – All other vehicles: Connector CLF08, pin 1, circuit CLS21E (BU/GN), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** - Box van / Bus / Combi: LOCATE and RECTIFY break in circuits between soldered connection S1D129A and ground connection G29 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform truck: LOCATE and RECTIFY break in circuits between soldered connection S2D129A and ground connection G29 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to C11.
C11: CHECK THE VOLTAGE SUPPLY TO THE FRONT LEFT-HAND TURN SIGNAL LAMPS FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Connect left-hand headlamp. – Box van, bus, combi, without trailer socket, with side parking lamp/turn signal lamp: to connector C1LF08 – All other vehicles: to connector CLF08
	3 DisconnectGeneric Electronic Module (GEM).

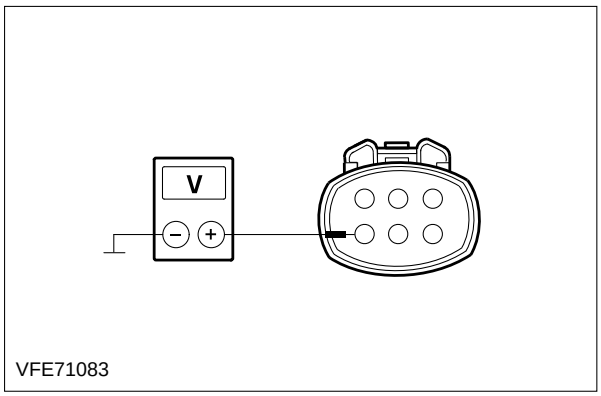
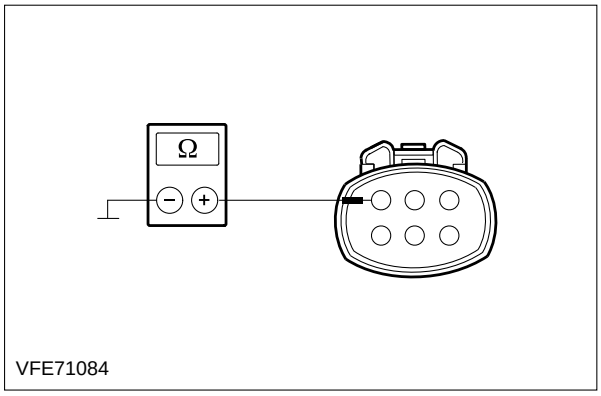
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the resistance between the generic electronic module (GEM): – Box van / Bus / Combi: Connector C2BP02D between pin 29, circuit CLS21A (BU/GN), wiring harness side and ground. – Platform truck: Connector CBP02D between pin 29, circuit CLS21A (BU/GN), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** LOCATE and RECTIFY the break in the circuits between generic electronic module (GEM) and soldered connection S2LS21 using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the generic electronic module (GEM). CHECK the operation of the system.
C12: CHECK THE VOLTAGE SUPPLY TO THE LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand rear lamp assembly from connector CLS22.
	3 Ignition switch in position II.
	4 SWITCH ON the left-hand turn signal.
 VFE72237	5 Measure the voltage between the left-hand rear lamp assembly: – Vehicles without trailer socket: connector CLS22, pin 2, circuit CLS23B (GY/OG), wiring harness side and ground. – Vehicles with trailer socket: connector CLS22, pin 2, circuit B_CLS23C (GY/OG), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C13. → **No** - Vehicles without trailer socket: GO to C16. - Vehicles with trailer socket: GO to C35.
C13: CHECK THE GROUND SUPPLY OF THE LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0018115	2 Measure the resistance between the left-hand rear lamp assembly: – Vehicles without trailer socket: Connector CLS22, pin 5, circuit A_GD149C (BK/GY), wiring harness side and ground. – Vehicles with trailer socket: Connector CLS22, pin 5, circuit A_GD149N (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary INSTALL A NEW rear lamp assembly. CHECK the operation of the system. → **No** - Vehicles without trailer socket: LOCATE and RECTIFY the break in the circuit between rear lamp assembly and soldered connection S4D149B using the Wiring Diagrams. CHECK the operation of the system. - Vehicles with a trailer socket: LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and soldered connection S4D149A with the aid of the Wiring Diagrams. CHECK the operation of the system.
C14: CHECK THE VOLTAGE SUPPLY TO THE LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Disconnect left-hand rear lamp assembly:. – Vehicles with trailer socket, with side parking lamp/turn signal lamp: from connector CLS04 – All other vehicles: from connector CLS35
	3 Ignition switch in position II.
	4 SWITCH ON the left-hand turn signal.

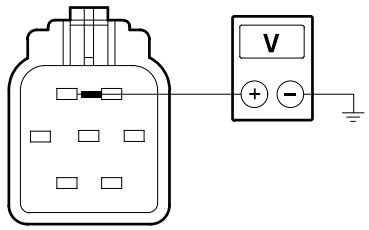
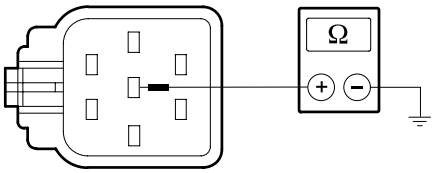
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE71083	5 Measure the voltage between the left-hand rear lamp assembly: – Vehicles without trailer socket: connector CLS35, pin 4, circuit CLS23H (GY/OG), wiring harness side and ground. – Vehicles with trailer socket: connector CLS35 (CLS04), pin 4, circuit B_CLS23C (GY/OG), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C15. → **No** - Vehicles without trailer socket: GO to C16. - Vehicles with trailer socket: GO to C38.
C15: CHECK THE GROUND SUPPLY OFTHE LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
 VFE71084	2 Measure the resistance between the left-hand rear lamp assembly, connector CLS35 (CLS04), pin 1, circuit B_GD129U (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary INSTALL A NEW rear lamp assembly. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and soldered connection S4D129G with the aid of the Wiring Diagrams. CHECK operation of system.
C16: CHECK THE VOLTAGE SUPPLY TO THE LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Connect left-hand rear lamp assembly:. – Box van / Bus / Combi: to connector CLS22 – Platform truck: to connector CLS35
	3 Disconnect Generic Electronic Module (GEM) from. – Box van / Bus / Combi: Connector C2BP02D – Platform truck: Connector CBP02D

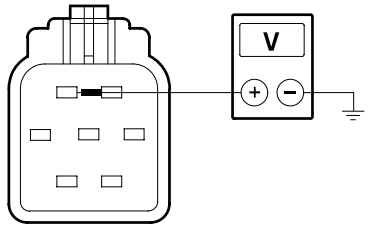
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the resistance between the generic electronic module (GEM): – Box van / Bus / Combi: connector C2BP02D, pin 30, circuit CLS23A (GY/OG), wiring harness side and ground. – Platform truck: connector CBP02D, pin 30, circuit CLS23A (GY/OG), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** LOCATE and RECTIFY the break in the circuits between the generic electronic module (GEM) and the rear lamp assembly using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the generic electronic module (GEM). CHECK the operation of the system.
C17: CHECK THE VOLTAGE SUPPLY TO THE FRONT RIGHT-HAND TURN SIGNAL LAMP FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Disconnect Right front turn signal indicator lamp. – Vehicles without trailer socket: from connector C1LF09 – Vehicles with trailer socket: from connector CLF09
	3 Ignition switch in position II.
	4 SWITCH ON the right-hand turn signal.
	5 CHECK the turn signal lamps.

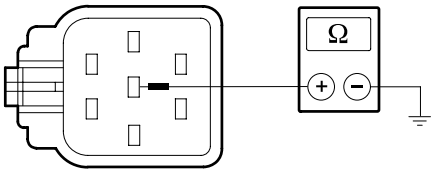
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0011505	6 At the right-hand headlamp, measure the voltage between: – Vehicles without trailer socket: Connector C1LF09, pin 1, circuit CLS25D (YE/VT), wiring harness side and ground. – Vehicles with trailer socket: Connector CLF09, pin 1, circuit CLS25D (YE/VT), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C18. → **No** LOCATE and REPAIR break in circuit(s) between soldered connection S2LS25 and headlamp using the Wiring Diagrams. CHECK the operation of the system.
C18: CHECK THE GROUND SUPPLY OF THE RIGHT-HAND HEADLAMP FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
 VFE0003175	2 Measure the resistance between the right-hand headlamp: – Vehicles without trailer socket: Connector C1LF09, pin 4, circuit A_GD131V (BK/GY), wiring harness side and ground. – Vehicles with trailer socket: Connector CLF09, pin 4, circuit A_GD131(V/Y) (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary RENEW the headlamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S1D131B using the Wiring Diagrams. CHECK the operation of the system.
C19: CHECK THE VOLTAGE SUPPLY TO THE FRONT RIGHT-HAND TURN SIGNAL LAMP FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Disconnect Right front turn signal indicator lamp. – Vehicles with trailer socket: from connector C1LF09 – Vehicles without trailer socket: from connector CLF09
	3 Ignition switch in position II.

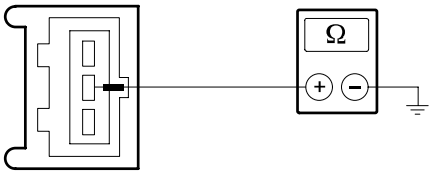
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 SWITCH ON the right-hand turn signal.
	5 CHECK the turn signal lamps.
 E0011505	6 At the right-hand headlamp, measure the voltage between: – Vehicles without trailer socket, without side parking lamp/turn signal lamp: Connector CLF09, pin 1, circuit CLS25B (YE/VT), wiring harness side and ground. – Vehicles without trailer socket, with side parking lamp/turn signal lamp: Connector CLF09, pin 1, circuit CLS25E (YE/VT), wiring harness side and ground. – Vehicles with trailer socket, without side parking lamp/turn signal lamp: Connector C1LF09, pin 1, circuit CLS25B (YE/VT), wiring harness side and ground. – Vehicles with trailer socket, with side parking lamp/turn signal lamp: Connector C1LF09, pin 1, circuit CLS25E (YE/VT), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C20. → **No** LOCATE and REPAIR break in circuit(s) between soldered connection S2LS25 and headlamp using the Wiring Diagrams. CHECK the operation of the system.
C20: CHECK THE GROUND CONNECTION TO THE RIGHT-HAND HEADLAMP FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.

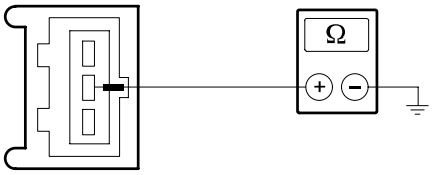
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0003175	2 Measure the resistance between the right-hand headlamp: – Vehicles without trailer socket: Connector CLF09, pin 4, circuit A_GD131(T/H) (BK/GY), wiring harness side and ground. – Vehicles with trailer socket: Connector C1LF09, pin 4, circuit A_GD131(T/H) (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary RENEW the headlamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S1D131B using the Wiring Diagrams. CHECK the operation of the system.
C21: CHECK THE VOLTAGE SUPPLY OF THE RIGHT-HAND TURN SIGNAL LAMP (SIDE) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect right-hand turn signal lamp (side) from connector CLS21.
	3 Ignition switch in position II.
	4 SWITCH ON the right-hand turn signal.
 VFE0016139	5 Measure the voltage between the right-hand turn signal lamp (side), connector CLS21, pin 1, circuit CLS25C (YE/VT), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C22. → **No** LOCATE and REPAIR break in circuit(s) between soldered connection S2LS25 and turn signal lamp (side) using the Wiring Diagrams. CHECK the operation of the system.
C22: CHECK THE GROUND CONNECTION OF THE RIGHT-HAND (SIDE) TURN SIGNAL LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0010896	2 Measure the resistance between the right-hand turn signal lamp (side), connector CLS21, pin 2, circuit A_GD131F (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary RENEW the turn signal side lamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the (side) turn signal lamp and soldered connection S1D131B using the Wiring Diagrams. CHECK the operation of the system.
C23: CHECK THE VOLTAGE SUPPLY TO THE RIGHT-HAND SIDE PARKING LAMP/TURN SIGNAL LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Right-hand side parking lamp/turn signal lamp. – Box van / Bus / Combi: from connector C1LS14B – Platform truck: from connector CLS21
	3 Ignition switch in position II.
	4 SWITCH ON the right-hand turn signal.
 VFE0016139	5 Measure the voltage between right-hand side parking lamp/turn signal lamp: – Box van / Bus / Combi: Connector C1LS14B, pin 1, circuit CLS25E (YE/VT), wiring harness side and ground. – Chassis cab vehicle: Connector CLS21, pin 1, circuit CLS25D (YE/VT), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C24. → **No** LOCATE and REPAIR break in circuit(s) between soldered connection S2LS25 and side parking lamp/turn signal lamp using the Wiring Diagrams. CHECK the operation of the system.
C24: CHECK THE GROUND CONNECTION OF THE RIGHT-HAND SIDE PARKING LAMP/TURN SIGNAL LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

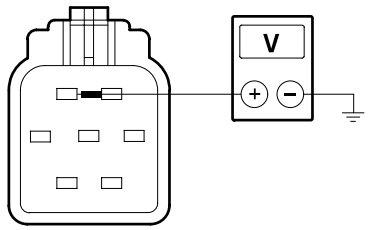
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0010896	2 Measure resistance between right-hand side parking lamp/turn signal lamp: – Box van / Bus / Combi: Connector C1LS14B, pin 2, circuit A_GD131X (BK/GY), wiring harness side and ground. – Platform truck: Connector CLS21, pin 2, circuit A_GD131S (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary RENEW the side parking lamp/turn signal lamp. CHECK the operation of the system. → **No** LOCATE and REPAIR break in circuit(s) between side parking lamp/turn signal lamp and soldered connection S1D131B using the Wiring Diagrams. CHECK the operation of the system.
C25: CHECK THE SHARED GROUND SUPPLY OF THE FRONT RIGHT TURN SIGNAL LAMPS FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Disconnect Right parking lamp (side)/turn signal lamp from connector C1LS14B.
	3 Ignition switch in position II.
	4 SWITCH ON the right-hand turn signal.
 VFE0016139	5 Measure the voltage between the right-hand parking lamp/turn signal lamp (side), connector C1LS14B, pin 1, circuit CLS25E (YE/VT), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** LOCATE and RECTIFY break in circuits between soldered connection S1D131B and ground connection G31 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to C26.
C26: CHECK THE SHARED VOLTAGE SUPPLY TO THE FRONT RIGHT TURN SIGNAL LAMPS FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Connect Right parking lamp (side)/turn signal lamp from connector C1LS14B.

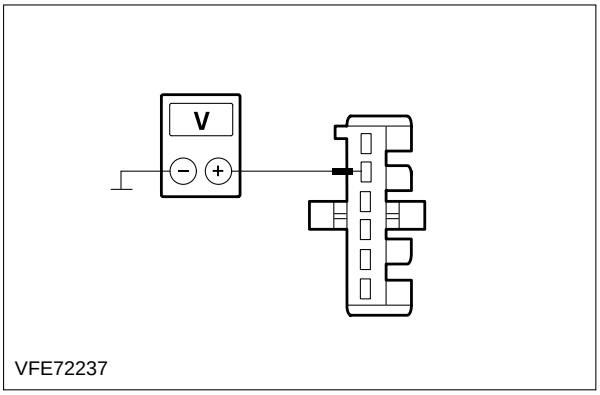
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Disconnect Generic electronic module (GEM) from connector C2BP02D.
	4 Measure the resistance between the generic electronic module (GEM), connector C2BP02D, pin 40, circuit CLS25A (YE/VT), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** LOCATE and RECTIFY the break in circuit between generic electronic module (GEM) and soldered connection S2LS25 using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the generic electronic module (GEM). CHECK the operation of the system.
C27: CHECK THE COMMON GROUND OF THE FRONT RIGHT-HAND TURN SIGNAL LAMPS FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Disconnect right-hand headlamp. – Vehicles without trailer socket: from connector CLF09 – Vehicles with trailer socket: from connector C1LF09
	3 Ignition switch in position II.
	4 SWITCH ON the right-hand turn signal.

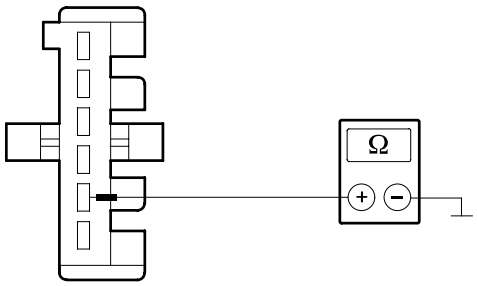
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0011505	5 At the right-hand headlamp, measure the voltage between: – Vehicles without trailer socket, without side parking lamp/turn signal lamp: Connector CLF09, pin 1, circuit CLS25B (YE/VT), wiring harness side and ground. – Vehicles without trailer socket, with side parking lamp/turn signal lamp: Connector CLF09, pin 1, circuit CLS25E (YE/VT), wiring harness side and ground. – Vehicles with trailer socket, without side parking lamp/turn signal lamp: Connector C1LF09, circuit CLS25B (YE/VT), wiring harness side and ground. – Vehicles with trailer socket, with side parking lamp/turn signal lamp: Connector C1LF09, circuit CLS25E (YE/VT), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** LOCATE and RECTIFY break in circuits between soldered connection S1D131B and ground connection G31 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to C28.
C28: CHECK THE COMMON VOLTAGE SUPPLY TO THE FRONT RIGHT-HAND TURN SIGNAL LAMPS FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Connect right-hand headlamp. – Vehicles without trailer socket: to connector CLF09 – Vehicles with trailer socket: to connector C1LF09
	3 Disconnect Generic electronic module (GEM) from connector CBP02D.

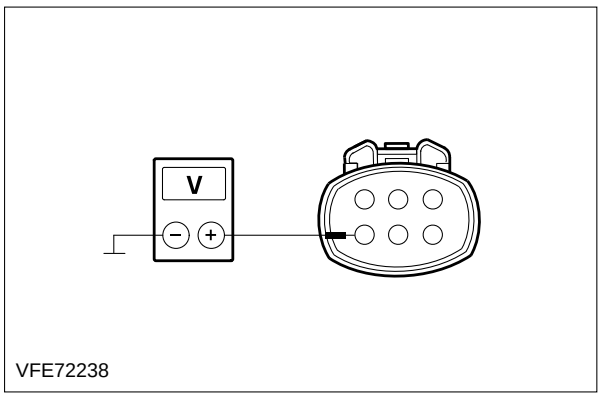
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the resistance between the generic electronic module (GEM), connector CBP02D, pin 40, circuit CLS25A (YE/VT), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** LOCATE and RECTIFY the break in circuit between generic electronic module (GEM) and soldered connection S2LS25 using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the generic electronic module (GEM). CHECK the operation of the system.
C29: CHECK THE VOLTAGE SUPPLY TO THE RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Disconnect Right-hand rear lamp assembly from connector CLS26. – Box van, bus, combi:
	3 Ignition switch in position II.
	4 SWITCH ON the right-hand turn signal.
 VFE72237	5 Measure voltage between right-hand rear lamp assembly, connector CLS26: – Vehicles without trailer socket: pin 2, circuit CLS27B (GN/OG), wiring harness side and ground. – Vehicles with trailer socket: pin 2, circuit B_CLS27C (GN/OG), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C31. → **No** - Vehicles without trailer socket: GO to C30. - Vehicles with trailer socket: GO to C35.
C30: CHECK THE VOLTAGE SUPPLY TO THE RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Disconnect Generic electronic module (GEM) from connector C2BP02D.

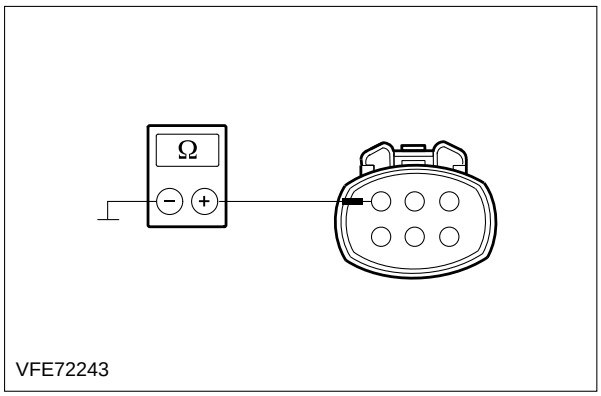
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the resistance between the generic electronic module (GEM), connector C2BP02D, pin 39, circuit CLS27A (GN/OG), wiring harness side and the rear right lamp assembly, connector CLS26, pin 2, circuit CLS27B (GN/OG), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the generic electronic module (GEM). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuits between the generic electronic module (GEM) and the rear lamp assembly using the Wiring Diagrams. CHECK the operation of the system.
C31: CHECK THE GROUND SUPPLY OF THE RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
 E0018115	2 Measure the resistance between the right-hand rear lamp assembly, connector CLS26: – Vehicles without trailer socket: pin 5, circuit A_GD151H (BK/GN), wiring harness side and ground. – Vehicles with trailer socket: pin 5, circuit A_GD151AB (BK/GN), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary INSTALL A NEW rear lamp assembly. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and ground connection G51 using the Wiring Diagrams. CHECK the operation of the system.
C32: CHECK THE VOLTAGE SUPPLY TO THE RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Disconnect right-hand rear lamp assembly. – Vehicles with trailer socket, with (side) parking lamp/turn signal lamp: from connector CLS26 – All other vehicles: connector CLS36
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 SWITCH ON the right-hand turn signal.
	5 Measure the voltage between the right-hand rear lamp assembly: – Vehicles without trailer socket: connector CLS36, pin 4, circuit CLS27H (GN/OG), wiring harness side and ground. – Vehicles with trailer socket: connector CLS36, pin 4, circuit B_CLS27C (GN/OG), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C34. → **No** - Vehicles without trailer socket: GO to C33. - Vehicles with trailer socket: GO to C38.
C33: CHECK THE VOLTAGE SUPPLY TO THE RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Disconnect Generic electronic module (GEM) from connector CBP02D.
	3 Measure the resistance between the generic electronic module (GEM), connector CBP02D, pin 39, circuit CLS27A (GN/OG), wiring harness side and the rear right lamp assembly, connector CLS36, pin 4, circuit CLS27H (GN/OG), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** RENEW the generic electronic module (GEM). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuits between the generic electronic module (GEM) and the rear lamp assembly using the Wiring Diagrams. CHECK the operation of the system.
C34: CHECK THE GROUND SUPPLY OF THE RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the right-hand rear lamp assembly, connector CLS36, pin 1, circuit B_GD129V (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary INSTALL A NEW rear lamp assembly. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and soldered connection S4D129G with the aid of the Wiring Diagrams. CHECK the operation of the system.
C35: ELIMINATE THE TRAILER CONTROL UNIT AS A POSSIBLE CAUSE FOR THE CONCERN (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Disconnect Trailer control unit from connector CAT18 (1506).
	3 Ignition switch in position II.
	4 SWITCH ON the hazard warning lamps.
	5 Left-hand turn signal lamp: Measure the voltage between the trailer control unit, connector CAT18 (1506), pin 2, circuit A_CLS23E (GY/OG), wiring harness side and ground. –
	6 Right-hand turn signal lamp: Measure the voltage between the trailer control unit, connector CAT18 (1506), pin 3, circuit A_CLS27E (GY/OG), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C36. → **No** GO to C37.
C36: ELIMINATE THE TRAILER CONTROL UNIT AS A POSSIBLE CAUSE FOR THE CONCERN (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Left-hand turn signal lamp: Connect a fused bridging cable (5 A) to the trailer control unit, connector CAT18 (1506), between pin 2, circuit A_CLS23E (GY/OG), wiring harness side and pin 9, circuit B_CLS23A (GY/OG), wiring harness side.
	3 Right-hand turn signal lamp: Connect a fused bridging cable (5 A) to the trailer control unit, connector CAT18 (1506), between pin 3, circuit A_CLS27E (GN/OG), and pin 10, circuit B_CLS27A (GN/OG), wiring harness side.
	4 Ignition switch in position II.
	5 SWITCH ON the hazard warning lamps.
	6 CHECK the turn signal lamps. • Do the affected turn signal lamps work? → **Yes** RENEW the trailer control unit. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuits between the trailer control unit and the rear lamp assembly using the Wiring Diagrams. CHECK the operation of the system.
C37: ELIMINATE THE CONTROL CIRCUIT AS A POSSIBLE CAUSE FOR THE CONCERN (BOX VAN, BUS, COMBI)	
	1 Ignition switch in position 0.
	2 Disconnect Generic electronic module (GEM) from connector C2BP02D.
	3 Left-hand turn signal lamp: Measure the resistance between the generic electronic module (GEM), connector C2BP02D, pin 30, circuit A_CLS23A (GN/OG), wiring harness side and the trailer control unit, connector CAT18 (1506), pin 2, circuit A_CLS23E (GN/OG), wiring harness side.

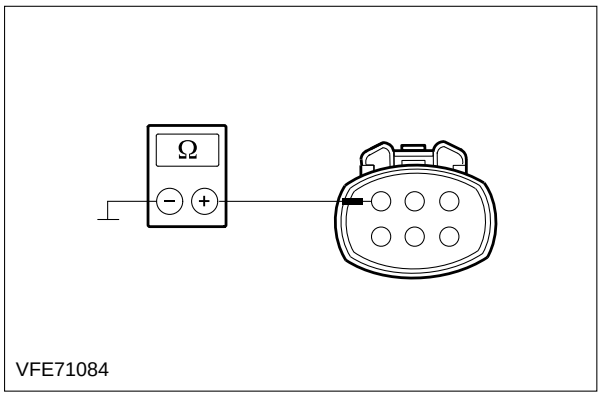
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Right-hand turn signal lamp: Measure the resistance between the generic electronic module (GEM), connector C2BP02D, pin 39, circuit A_CLS27A (GN/OG), wiring harness side and the trailer control unit, connector CAT18 (1506), pin 3, circuit A_CLS27E (GN/OG), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary INSTALL A NEW generic electronic module (GEM). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuits between the generic electronic module (GEM) and the trailer control unit using the Wiring Diagrams. CHECK the operation of the system.
C38: EXCLUDE THE TRAILER CONTROL UNIT AS THE CAUSE OF THE CONCERN (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Disconnect Trailer control unit from connector CAT18.
	3 Ignition switch in position II.
	4 SWITCH ON the hazard warning lamps.
	5 Left-hand turn signal lamp: Measure the voltage between the trailer control unit, connector CAT18, pin 2, circuit A_CLS23F (GY/OG), wiring harness side and ground.
	6 Right-hand turn signal lamp: Measure the voltage between the trailer control unit, connector CAT18, pin 3, circuit A_CLS27F (GY/OG), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** GO to C39. → **No** GO to C40.
C39: EXCLUDE THE TRAILER CONTROL UNIT AS THE CAUSE OF THE CONCERN (PLATFORM TRUCK)	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Left-hand turn signal lamp: Connect a fused bridging cable (5 A) to the trailer control unit, connector CAT18, between pin 2, circuit A_CLS23F (GY/OG), wiring harness side and pin 9, circuit B_CLS23A (GY/OG), wiring harness side.
	3 Right-hand turn signal lamp: Connect a fused bridging cable (5 A) to the trailer control unit, connector CAT18, between pin 3, circuit A_CLS27F (GN/OG), and pin 10, circuit B_CLS27A (GN/OG), wiring harness side.
	4 Ignition switch in position II.
	5 SWITCH ON the hazard warning lamps.
	6 CHECK the turn signal lamps. • Do the affected turn signal lamps work? → **Yes** RENEW the trailer control unit. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuits between the trailer control unit and the rear lamp assembly using the Wiring Diagrams. CHECK the operation of the system.
C40: EXCLUDE THE CONTROL CIRCUIT AS THE CAUSE OF THE CONCERN (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Disconnect Generic electronic module (GEM) from connector CBP02D.
	3 Left-hand turn signal lamp: Measure the resistance between the generic electronic module (GEM), connector CBP02D, pin 30, circuit A_CLS23D (GN/OG), wiring harness side and the trailer control unit, connector CAT18, pin 2, circuit A_CLS23F (GN/OG), wiring harness side.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Right-hand turn signal lamp: Measure the resistance between the generic electronic module (GEM), connector CBP02D, pin 39, circuit A_CLS27B (GN/OG), wiring harness side and the trailer control unit, connector CAT18, pin 3, circuit A_CLS27F (GN/OG), wiring harness side. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary INSTALL A NEW generic electronic module (GEM). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuits between the generic electronic module (GEM) and the trailer control unit using the Wiring Diagrams. CHECK the operation of the system.
C41: CHECK COMMON GROUND SUPPLY TO THE REAR LAMP ASSEMBLIES FOR OPEN CIRCUIT (PLATFORM TRUCK)	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand rear lamp assembly from connector CLS35.
	3 Measure the resistance between the left-hand rear lamp assembly, connector CLS35, pin 1, circuit B_GD129U (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** - Vehicles without trailer socket: RENEW the generic electronic module (GEM). CHECK the operation of the system. - Vehicles with trailer socket: GO to C42. → **No** LOCATE and RECTIFY break in circuits between soldered connection S4D129G and ground connection G29 with the aid of the Wiring Diagrams. CHECK the operation of the system.
C42: CHECK INLINE FUSE F83 (15 A)	
	1 Ignition switch in position 0.
	2 Disconnect Inline fuse F83 (15 A).

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK Inline fuse F83 (15 A). • Is the fuse OK? → **Yes** GO to C43. → **No** RENEW inline fuse F83 (15 A) and CHECK the operation of the system. If fuse blows again, LOCATE and REMEDY the short to ground with the aid of the wiring diagrams. CHECK the operation of the system.
C43: CHECK THE VOLTAGE SUPPLY TO INLINE FUSE F83 (15 A) FOR OPEN CIRCUIT	
	1 Connect Inline fuse F83 (15 A).
	2 Ignition switch in position II.
	3 Measure the voltage between inline fuse F83 (15 A) and ground. • Does the meter display battery voltage? → **Yes** GO to C44. → **No** LOCATE AND RECTIFY the break in the voltage supply of inline fuse F83 (15 A) using the Wiring Diagrams. CHECK the operation of the system.
C44: CHECK THE VOLTAGE SUPPLY TO THE TRAILER CONTROL UNIT FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Trailer control unit from connector CAT18.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between the trailer control unit, connector CAT18, pin 1: – Box van / Bus / Combi: circuit SDF02A (RD), wiring harness side and ground. – Platform truck: circuit SDF02A (BU/GN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to C45. → **No** LOCATE and RECTIFY the break in the circuits between inline fuse F83 (15 A) and the trailer control unit using the Wiring Diagrams. CHECK the operation of the system.
C45: CHECK THE GROUND CONNECTION OF THE TRAILER CONTROL UNIT FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Measure the resistance between the trailer control unit, connector CAT18, pin 5: – Box van / Bus / Combi: circuit C_GD149F (BK/GY), wiring harness side and ground. – Platform truck: circuit B_GD119F (BK/BU), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** GO to C46. → **No** - Box van / Bus / Combi: LOCATE and RECTIFY the break in the circuits between trailer control unit and soldered connection S9D149 using the Wiring Diagrams. CHECK the operation of the system. - Platform truck: LOCATE and RECTIFY the break in the circuits between trailer control unit and soldered connection S2D119 using the Wiring Diagrams. CHECK the operation of the system.
C46: EXCLUDE THE TRAILER CONTROL UNIT AS THE CAUSE OF THE CONCERN	
	1 Ignition switch in position II.
	2 SWITCH ON the hazard warning lamps.

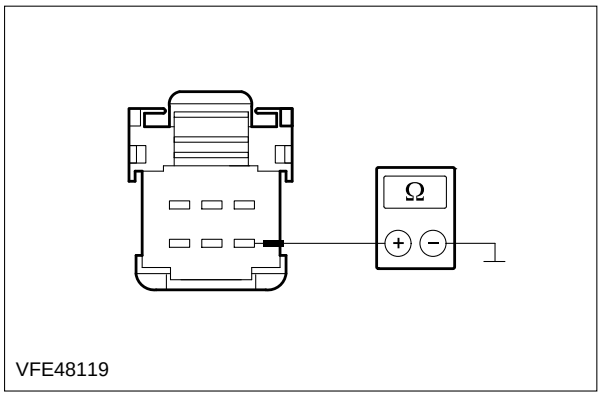
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between trailer control unit, connector CAT18, pin 2: – Box van, bus, combi: circuit A_CLS23E (GY/OG), wiring harness side and ground. – Chassis cab vehicle: circuit A_CLS23F (GY/OG), wiring harness side and ground. • Is fluctuating battery voltage measured? → **Yes** RENEW the trailer control unit. CHECK the operation of the system. → **No** RENEW the generic electronic module (GEM). CHECK the operation of the system.

PINPOINT TEST N : ALL TURN SIGNAL LAMPS FLASHING CONTINUOUSLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: EXCLUDE THE HAZARD WARNING LAMP SWITCH AS THE CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Hazard warning light switch from connector CLS32.
	3 Ignition switch in position II.
	4 CHECK the turn signal lamps. • Are all the turn signal lamps flashing? → **Yes** GO to D2. → **No** RENEW the hazard warning light switch. CHECK the operation of the system.
D2: ELIMINATE THE STEERING COLUMN MULTIFUNCTION SWITCH AS THE CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Steering column multifunction switch from connector CLS34.
	3 Ignition switch in position II.
	4 CHECK the turn signal lamps. • Are all the turn signal lamps flashing? → **Yes** GO to D3. → **No** RENEW steering column multifunction switch. CHECK the operation of the system.

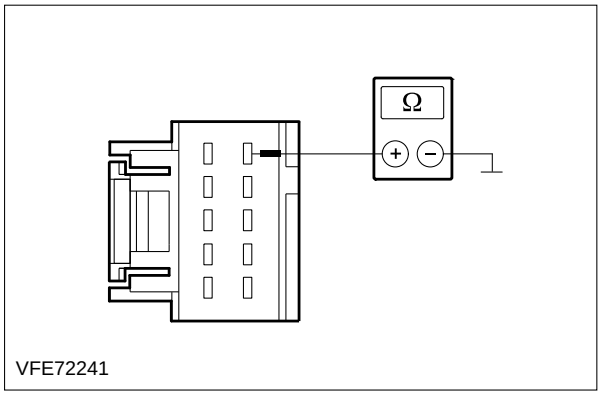
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D3: CHECK CONTROL CIRCUIT BETWEEN HAZARD WARNING LIGHT SWITCH AND GENERIC ELECTRONIC MODULE (GEM) FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Generic Electronic Module (GEM). – Box van / Bus / Combi: from connector C2BP02F – Platform truck: from connector CBP02F
 VFE48119	3 Measure the resistance between the hazard warning light switch, connector CLS32, pin 4, circuit CLS32A (BN/YE), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** RENEW the generic electronic module (GEM). CHECK the operation of the system. → **No** LOCATE AND RECTIFY the short to ground in the circuit between the hazard warning lamp switch and the generic electronic module (GEM) using the Wiring Diagrams. CHECK the operation of the system.

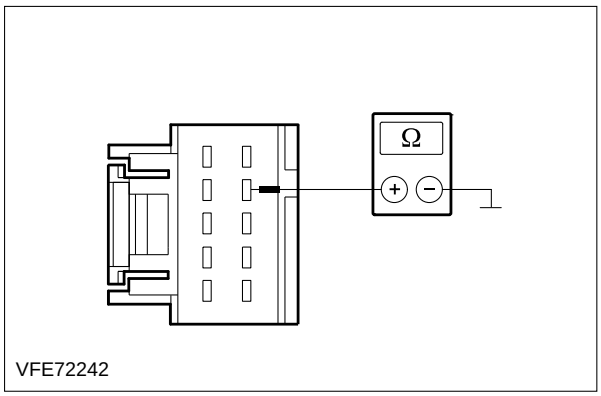
PINPOINT TEST O : ONE OR MORE TURN SIGNAL LAMPS FLASHING CONTINUOUSLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: DETERMINE THE CONDITIONS UNDER WHICH THE FAULT OCCURS	
	1 Ignition switch in position II.
	2 CHECK the turn signal lamps. • Do all the turn signals flash continuously on one side? → **Yes** GO to E2. → **No** RENEW the generic electronic module (GEM). CHECK the operation of the system.
E2: RULE OUT THE STEERING COLUMN MULTIFUNCTION SWITCH AS A CAUSE FOR THE CONCERN	
	1 Ignition switch in position 0.
	2 Disconnect Steering column multifunction switch from connector CLS34.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 CHECK the turn signal lamps. • Do all the turn signals flash continuously on one side? → **Yes** GO to E3. → **No** RENEW steering column multifunction switch. CHECK the operation of the system.
E3: CHECK CONTROL CIRCUITS BETWEEN STEERING COLUMN MULTIFUNCTION SWITCH AND GENERIC ELECTRONIC MODULE (GEM) FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Generic Electronic Module (GEM). – Box van, bus, combi: from connector C2BP02F – Platform truck: from connector CBP02F
 VFE72241	3 Left-hand turn signal lamps: Measure the resistance between the steering column multi-function switch, connector CLS34, pin 6, circuit CLS39A (VT/WH), wiring harness side and ground.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72242	4 Right-hand turn signal lamps: Measure the resistance between the steering column multi-function switch, connector CLS34, pin 7, circuit CLS41A (GY/YE), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** RENEW the generic electronic module (GEM). CHECK the operation of the system. → **No** - Left-hand turn signal lamps: LOCATE and RECTIFY the short to ground in the circuit connected to the steering column multifunction switch, connector CLS34, pin 6 using the Wiring Diagrams. CHECK the operation of the system. - Right-hand turn signal lamps: LOCATE and RECTIFY the short to ground in the circuit connected to the steering column multifunction switch, connector CLS34, pin 7 using the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST P : ONE OR MORE TURN SIGNAL LAMPS LIT CONTINUOUSLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 CHECK the turn signal lamps after each action.
	3 SWITCH ON the left-hand turn signal.
	4 SWITCH ON the right-hand turn signal.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	5 SWITCH OFF the steering column multifunction switch. • Are the turn signal lamps lit continuously when the steering column multifunction switch is in its home position? → **Yes** - All turn signal lamps permanently lit: RENEW the generic electronic module (GEM). CHECK the operation of the system. - One or more turn signal lamps lit continuously: GO to F2. → **No** Turn signal lamps only lit continuously when the steering column multifunction switch is operated: RENEW the generic electronic module (GEM). CHECK the operation of the system.
F2: EXCLUDE THE GENERIC ELECTRONIC MODULE (GEM) AS THE CAUSE OF THE CONCERN	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F2 (60 A)..
	3 Disconnect Fuse F7 (60 A)..
	4 Disconnect fuse F18 (40 A) (EJB).
	5 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	6 CHECK the turn signal lamps. • Are the turn signal lamps at the front lit up permanently? → **Yes** - Left-hand turn signal lamps: LOCATE and RECTIFY the short to battery voltage in the circuits connected to soldered connection S2LS21 using the Wiring Diagrams. CHECK the operation of the system. - Right-hand turn signal lamps: LOCATE and RECTIFY the short to battery voltage in the circuits connected to soldered connection S2LS25 using the Wiring Diagrams. CHECK the operation of the system. → **No** - Rear left turn signal lamps, box van, bus, combi, without a trailer socket: LOCATE and RECTIFY the short to battery voltage in the circuits connected to the generic electronic module (GEM), connector C2BP02D, pin 30 using the Wiring Diagrams. CHECK the operation of the system. - Turn signal lamps, rear left, platform trucks, vehicles without trailer socket: LOCATE and RECTIFY the short to battery voltage in the circuits connected to the generic electronic module (GEM), connector CBP02D, pin 30 using the Wiring Diagrams. CHECK the operation of the system. - Turn signal lamp(s), rear, vehicles with trailer socket: GO to F3. - Rear right turn signal lamps, box van, bus, combi, vehicles without a trailer socket: LOCATE and RECTIFY the short to battery voltage in the circuits connected to the generic electronic module (GEM), connector C2BP02D, pin 39 using the Wiring Diagrams. CHECK the operation of the system. - Turn signal lamps, rear right, platform trucks, vehicles without trailer socket: LOCATE and RECTIFY the short to battery voltage in the circuits connected to the generic electronic module (GEM), connector CBP02D, pin 39 using the Wiring Diagrams. CHECK the operation of the system. - none of the turn signal lamps is lit continuously: RENEW the generic electronic module (GEM). CHECK the operation of the system.
F3: EXCLUDE THE TRAILER CONTROL UNIT AS THE CAUSE OF THE CONCERN	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Trailer control unit. – Box van, bus, combi, without side parking lamp/turn signal lamp: Connector 1506 – All other vehicles: Connector CAT18
	3 Ignition switch in position II.
	4 CHECK the turn signal lamps. • Are the left-hand turn signal lamps at the rear lit up permanently? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuits connected to the trailer control unit connector CAT18 (1506), pin 9 using the Wiring Diagrams. CHECK the operation of the system. → **No** - turn signal lamps on the right-hand side permanently lit: LOCATE and RECTIFY the short to battery voltage in the circuits connected to the trailer control unit connector CAT18 (1506), pin 10 using the Wiring Diagrams. CHECK the operation of the system. - No turn signal lamp continuously lit, concern over the left-hand turn signal lamp: GO to F4. - No turn signal lamp continuously lit, concern over the right-hand turn signal lamp: GO to F5.
F4: EXCLUDE THE TRAILER CONTROL UNIT AS THE CAUSE OF THE CONCERN	
	1 Measure the voltage between the trailer socket: – Box van / Bus / Combi: connector CAT18 (1506), pin 2, circuit A_CLS23E (GY/OG), wiring harness side and ground. – Platform truck: connector CAT18, pin 2, circuit A_CLS23F (GY/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY the short to battery voltage in the corresponding circuit between the generic electronic module (GEM) and the trailer control unit using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the trailer control unit. TEST the system for normal operation.

DIAGNOSIS AND TESTING

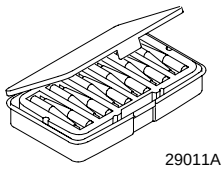
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F5: EXCLUDE THE TRAILER CONTROL UNIT AS THE CAUSE OF THE CONCERN	
	1 Measure the voltage between the trailer socket: – Box van / Bus / Combi: connector CAT18 (1506), pin 3, circuit A_CLS27E (GN/OG), wiring harness side and ground. – Platform truck: connector CAT18, pin 3, circuit A_CLS27F (GN/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY the short to battery voltage in the corresponding circuit between the generic electronic module (GEM) and the trailer control unit using the Wiring Diagrams. CHECK the operation of the system. → **No** RENEW the trailer control unit. TEST the system for normal operation.

DIAGNOSIS AND TESTING

Parking, Rear and License Plate Lamps

Refer to Wiring Diagrams Section 417-01,for schematic and connector information.

Special Tool(s)

 29011A	Terminal probe kit 29-011A

Inspection and Testing

NOTE: The generic electronic module (GEM) forms part of the central junction box (CJB).

NOTE: If the generic electronic module (GEM) is changed, the new one must be configured. For this purpose, the vehicle-specific data is read out of the module to be replaced using WDS and is transferred to the new module. REFER to:

Module Configuration (418-01, General Procedures),
Generic Electronic Module (GEM) (419-10, Diagnosis and Testing).

NOTE: Before reading out the vehicle-specific data, remake all the electrical connections which were separated in the vehicle, so that communication between the module and WDS is ensured.

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical or mechanical damage.

Visual Inspection Chart

Electrical
– Fuse(s) – Bulb(s) – Electrical connector(s) – Wiring harness

3. Resolve any obvious causes or concerns found during the visual inspection before carrying out any further tests.
4. If the cause of the concern cannot be found by visual inspection, continue with the symptom chart.

Symptom Chart

Symptom Chart

Symptom	Possible Sources	Action
• Side lights (parking lights) front/rear, license plate lamps and/or all additional side lights are inoperative	• Fuse(s) • Circuit(s) • Light switch • Central junction box (CJB)	• GO to Pinpoint Test A.
• One or more side lights (parking lights) front/rear, license plate lamps or additional side lights inoperative	• Fuse(s) • Circuit(s) • License plate lamp • Clearance lamp • Additional side light • Side light/turn signal lamp • Headlamp • Left/right-hand rear lamp assembly • Central junction box (CJB)	• GO to Pinpoint Test B.
• Side lights (parking lights) front/rear, license plate lamps and/or all additional side lamps are inoperative	• Circuit(s) • Light switch • Central junction box (CJB) • Trailer socket	• GO to Pinpoint Test C.

DIAGNOSIS AND TESTING

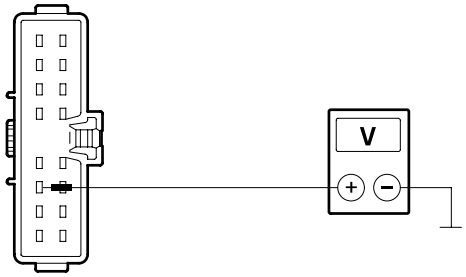
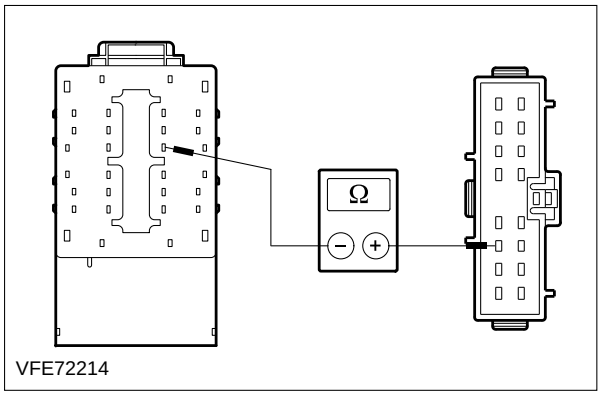
System Checks

NOTE: Use a digital multimeter for all electrical measurements.

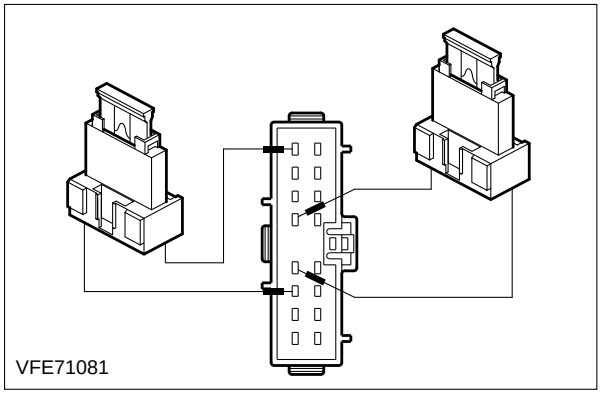
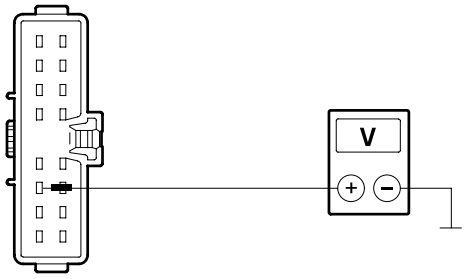
PINPOINT TEST Q : SIDE LIGHTS (PARKING LIGHTS) FRONT/REAR, LICENSE PLATE LAMPS AND/OR ALL ADDITIONAL SIDE LIGHTS ARE INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: DETERMINE THE FAULT CONDITION	
	1 SWITCH ON the parking lights and side lights one after the other.
	2 CHECK the side lights (parking lights). • Are the parking lamps and side lights inoperative? → **Yes** GO to A2. → **No** - The side lights are inoperative: GO to A7. - The parking lamps are inoperative: GO to A10.
A2: CHECK FUSE F71 (5 A) (CJB).	
	1 Disconnect Fuse F71 (5 A) (CJB).
	2 CHECK Fuse F71 (5 A) (CJB). • Is the fuse OK? → **Yes** GO to A3. → **No** INSTALL a new fuse F71 (5 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground with the aid of the Wiring Diagrams. CHECK the operation of the system.
A3: CHECK THE VOLTAGE SUPPLY TO FUSE F71 (5 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F71 (5 A) (CJB).
	2 Measure the voltage between fuse F71 (5 A) (CJB) and ground. • Is battery voltage measured? → **Yes** GO to A4. → **No** LOCATE and RECTIFY the break in the voltage supply of fuse F71 (5 A) (CJB) with the aid of the Wiring Diagrams. If necessary INSTALL a new central junction box (CJB). CHECK the operation of the system.

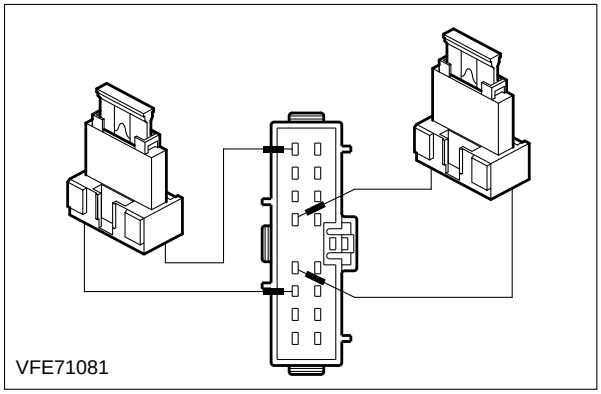
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A4: CHECK THE VOLTAGE SUPPLY TO THE LIGHT SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Light switch from connector CLF23.
 VFE0016145	3 Measure the voltage between the light switch, connector CLF23, pin 11, circuit SBP71A (RD/WH), wiring harness side and ground. • Is battery voltage measured? → **Yes** GO to A6. → **No** GO to A5.
A5: CHECK CIRCUIT SBP71C (RD/WH) BETWEEN CENTRAL JUNCTION BOX (CJB) AND LIGHT SWITCH FOR BREAKS	
	1 Disconnect Central junction box (CJB) from connector CBP02E.
 VFE72214	2 Measure the resistance between the central junction box (CJB), connector CBP02E, pin 19, circuit SBP71C (RD/WH), wiring harness side and light switch, connector CLF23, pin 11, circuit SBP71A (RD/WH), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new central junction box (CJB). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and soldered connection S2BP71 with the aid of the Wiring Diagrams. CHECK the operation of the system.

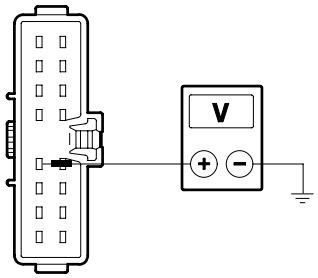
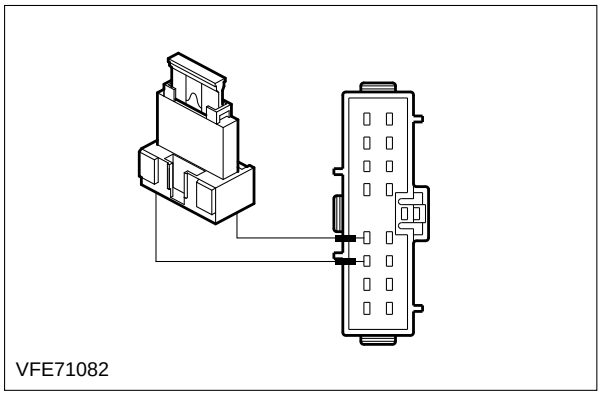
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A6: CHECK THE LIGHT SWITCH	
 VFE71081	1 Using two fused jumper wires (5 A) at the light switch, connector CLF23: – connect between pin 11, circuit SBP71A (RD/WH) and pin 16, circuit ZA104A (OG/GN), wiring harness side. – connect between pin 12, circuit SBP71B (RD/WH) and pin 13, circuit ZA105A (OG/GY), wiring harness side.
	2 CHECK the side lights (parking lights). • Are the side lights (parking lights) on? → **Yes** INSTALL a new light switch. CHECK the operation of the system. → **No** INSTALL a new central junction box (CJB). CHECK the operation of the system.
A7: CHECK THE VOLTAGE SUPPLY TO THE LIGHT SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Light switch from connector CLF23.
 VFE0016145	3 Measure the voltage between the light switch, connector CLF23, pin 11, circuit SBP71A (RD/WH), wiring harness side and ground. • Is battery voltage measured? → **Yes** GO to A8. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2BP71 and the light switch with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A8: CHECK THE LIGHT SWITCH	
	1 Using two fused jumper wires (5 A) at the light switch, connector CLF23: – connect between pin 11, circuit SBP71A (RD/WH) and pin 16, circuit ZA104A (OG/GN), wiring harness side. – connect between pin 12, circuit SBP71B (RD/WH) and pin 13, circuit ZA105A (OG/GY), wiring harness side.
	2 CHECK the side lights. • Are the side lights (parking lights) on? → **Yes** INSTALL a new light switch. CHECK the operation of the system. → **No** GO to A9.
A9: CHECK CIRCUIT ZA104A (OG/GN) BETWEEN THE LIGHT SWITCH AND THE CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Disconnect Central junction box (CJB) from connector CBP02F.
	2 Measure the resistance between the light switch, connector CLF23, pin 16, circuit ZA104A (OG/GN), wiring harness side and central junction box (CJB), connector CBP02F, pin 39, circuit ZA104A (OG/GN), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new central junction box (CJB). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the light switch and the central junction box (CJB) with the aid of the Wiring Diagrams. CHECK the operation of the system.
A10: CHECK THE VOLTAGE SUPPLY TO THE LIGHT SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Light switch from connector CLF23.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0003169	3 Measure the voltage between the light switch, connector CLF23, pin 12, circuit SBP71B (RD/WH), wiring harness side and ground. • Is battery voltage measured? → **Yes** GO to A11. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2BP71 and the light switch with the aid of the Wiring Diagrams. CHECK the operation of the system.
A11: CHECK THE LIGHT SWITCH	
 VFE71082	1 Using a fused bridging cable (5 A) at the light switch, connect between connector CLF23, pin 12, circuit SBP71B (RD/WH) and pin 13, circuit ZA105A (OG/GY), wiring harness side.
	2 CHECK the side lights. • Is the parking lamp on? → **Yes** INSTALL a new light switch. CHECK the operation of the system. → **No** GO to A12.
A12: CHECK CIRCUIT ZA105A (OG/GY) BETWEEN THE LIGHT SWITCH AND THE CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Disconnect Central junction box (CJB) from connector CBP02F.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the light switch, connector CLF23, pin 13, circuit ZA105A (OG/GY), wiring harness side and central junction box (CJB), connector CBP02F, pin 37, circuit ZA105A (OG/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new central junction box (CJB). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the light switch and the central junction box (CJB) with the aid of the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST R : ONE OR MORE SIDE LIGHTS (PARKING LIGHTS) FRONT/REAR, LICENSE PLATE LAMPS OR ADDITIONAL SIDE LIGHTS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: DETERMINE THE FAULT CONDITION	
	1 CHECK the side lights (parking lights).

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK the side lights (parking lights) front/rear, license plate lamps and/or all additional side lights. • Are the license plate lamps and, if fitted, the rear additional side lights or the side and rear additional side lights inoperative? → **Yes** - Vehicles without autolamps: Both rear side lights (parking lights) are inoperative (platform truck): LOCATE and RECTIFY the break in circuit B_GD129J/T/S (BK/YE) between soldered connection S4D129G and soldered connection S1D129E, with the aid of the Wiring Diagrams. CHECK the operation of the system. - Vehicles with autolamps: Both rear side lights (parking lights) are inoperative: GO to B2. - Left-hand rear side side light (parking light) is inoperative: GO to B3. - Right-hand rear side light (parking light) is inoperative: GO to B5. - Vehicles with tailgate and autolamps: Both license plate lamps are inoperative: GO to B7. - Vehicles with rear doors, autolamps and side lights/turn signal lamps: Both license plate lamps are inoperative: GO to B9. - One license plate lamp is inoperative (platform truck): GO to B11. - One license plate lamp is inoperative (box van, bus, combi): GO to B12. - One rear additional side light is inoperative: GO to B14. - One rear and center side light is inoperative (platform truck): GO to B16. - One rear and center side light is inoperative (box van, bus, combi): GO to B18. - Left and right-hand center side lights are inoperative (platform truck): GO to B20. - Left and right-hand rear side lights are inoperative (platform truck): GO to B21. - Both rear additional side lights and, if fitted, all left and right-hand side lights inoperative (platform truck): LOCATE and RECTIFY the break in circuit B_GD129AA(W)(K) (BK/YE), between soldered connection S4D129B and soldered connection S1D129E, with the aid of the Wiring Diagrams. CHECK the operation of the system. - Both license plate lamps and, if fitted, both rear additional side lights and all left and right-hand side lights inoperative (platform truck): GO to B22.

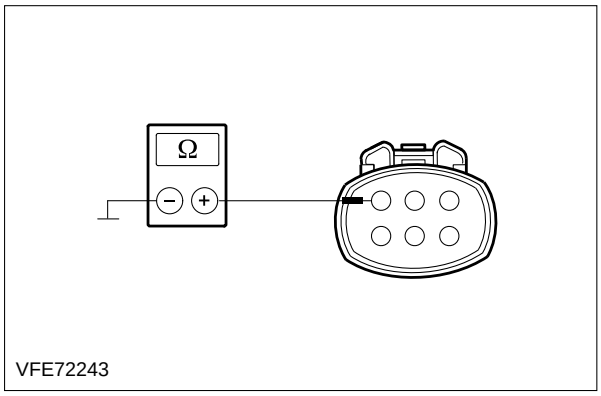
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	- Left-hand rear and center side lights and both license plate lamps are inoperative (box van, bus, combi): LOCATE and RECTIFY the break in circuit CBP79B(D) (VT/WH), between soldered connection S2BP79 and soldered connection S4BP79E, with the aid of the Wiring Diagrams. CHECK the operation of the system. - Right-hand rear and center side lights are inoperative (box van, bus, combi): LOCATE and RECTIFY the break in circuit CBP79C(M) (VT/WH), between soldered connection S2BP79 and soldered connection S4BP79F, with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** - Box van, bus, combi, without front side light/turn signal lamp: Left-hand front side light (parking light) inoperative: LOCATE and RECTIFY the break in circuit CBP76B (BU/BN), between soldered connection S2BP76 and the left-hand headlamp, with the aid of the Wiring Diagrams. CHECK the operation of the system. If necessary INSTALL a new headlamp. CHECK the operation of the system. - Left-hand front side light (parking light), left-hand front side light/turn signal lamp are inoperative: LOCATE and RECTIFY the break in circuit CBP76B(E)(F) (BU/BN), between soldered connection S2BP76 and soldered connection S1BP76, with the aid of the Wiring Diagrams. CHECK the operation of the system. - Vehicles with front side light/turn signal lamp: Left-hand front side light (parking light) inoperative (left-hand side light/turn signal lamp OK): LOCATE and RECTIFY the break in circuit CBP76E(F) (BU/BN), between soldered connection S1BP76 and the left-hand headlamp, with the aid of the Wiring Diagrams. CHECK the operation of the system. If necessary INSTALL a new headlamp. CHECK the operation of the system. - Left-hand front side light/turn signal lamp is inoperative: GO to B25. - Left-hand front clearance lamp is inoperative: GO to B27.

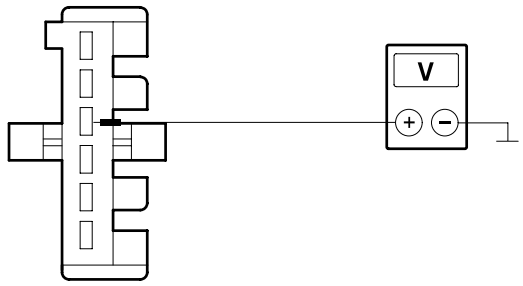
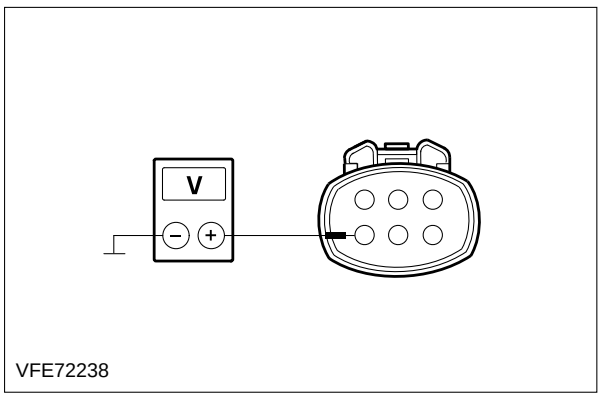
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	- Box van, bus, combi, without front side light/turn signal lamp: Right-hand front side light (parking lights) inoperative: LOCATE and RECTIFY the break in circuit CBP75 (YE/GY), between soldered connection S2BP75 and the right-hand headlamp, with the aid of the Wiring Diagrams. CHECK the operation of the system. If necessary INSTALL a new headlamp. CHECK the operation of the system. - Vehicles without front clearance lamps: Right-hand front side light (parking lights), right-hand front side light/turn signal lamp are inoperative: LOCATE and RECTIFY the break in circuit CBP75B(E)(F) (YE/GY), between soldered connection S2BP75 and soldered connection S1BP75, with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform truck with autolamps, side lights/turn signal lamps and front clearance lamps: Right-hand front side light (parking lights), right-hand front side light/turn signal lamp are inoperative: LOCATE and RECTIFY the break in circuit CBP75B(E) (YE/GY), between soldered connection S2BP75 and soldered connection S1BP75, with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform truck with autolamps, side lights/turn signal lamps and front clearance lamps: Right-hand front side light (parking lights), right-hand front side light/turn signal lamp and right-hand front clearance lamps are inoperative: GO to B33. - Vehicles with front side light/turn signal lamp and, if fitted, front clearance lamps: Right-hand front side light (parking lights) inoperative (right-hand side light/turn signal lamp and right-hand front clearance lamps OK): LOCATE and RECTIFY the break in circuit CBP75E(F) (YE/GY), between soldered connection S1BP75 and the right-hand headlamp, with the aid of the Wiring Diagrams. CHECK the operation of the system. If necessary INSTALL a new headlamp. CHECK the operation of the system. - Right-hand front side light/turn signal lamp is inoperative: GO to B29. - Right-hand front clearance lamp is inoperative: GO to B31.

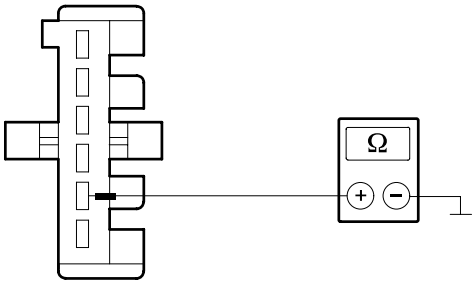
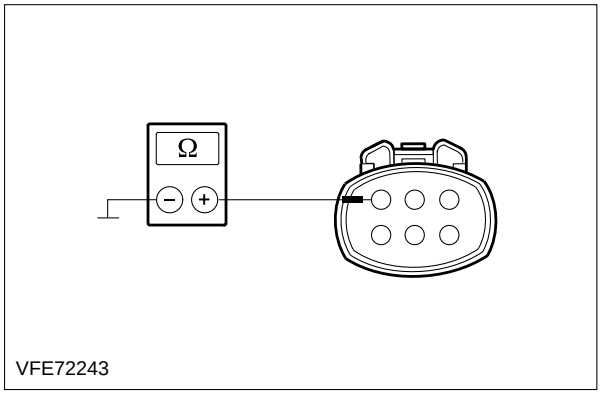
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	- Platform truck with autolamps, side lights/turn signal lamps and front clearance lamps: Left-hand front side light (parking lights), left/right-hand rear parking lamp, left-hand front side light/turn signal lamp and left-hand front clearance lamps are inoperative: GO to B36. - Vehicles with or without front side light/turn signal lamp: Left-hand front side light (parking lights), left-hand rear parking lamp and left-hand front side light/turn signal lamp are inoperative: GO to B36. - Vehicles with or without front side light/turn signal lamp: Right-hand front side light (parking lights), right-hand rear parking lamp and right-hand front side light/turn signal lamp are inoperative: GO to B39.
B2: CHECK GROUND CONNECTION TO REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 SWITCH OFF the side lights (parking lights).
	3 Disconnect Left-hand rear lamp assembly from connector CLS04.
	4 Measure the resistance between the left-hand rear lamp assembly, connector CLS04, pin 1, circuit B_GD129U (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** LOCATE and RECTIFY the break in circuit CBP76D(J)(K)(L) (BU/BN) between soldered connection S2BP76 and soldered connection S4BP76, with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in circuit B_GD129J(T)(S) (BK/YE) between soldered connection S4D129G and soldered connection S1D129E, with the aid of the Wiring Diagrams. CHECK the operation of the system.
B3: CHECK VOLTAGE SUPPLY TO LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 SWITCH OFF the side lights (parking lights).
	3 Disconnect Left-hand rear lamp assembly. – Box van, bus, combi: from connector CLS22 – Platform truck: from connector CLS04
	4 SWITCH ON the side lights (parking lights).

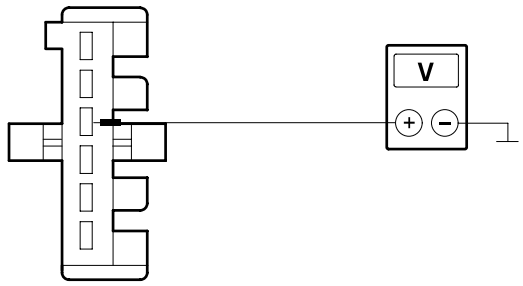
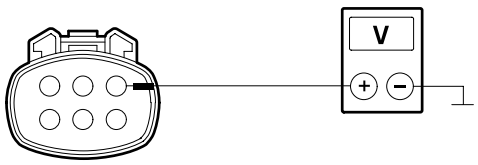
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	5 Box van, bus, combi:
 VFE0016213	6 Measure the voltage between the left-hand rear lamp assembly, connector CLS22, pin 3, circuit CBP76F(H) (BU/BN), wiring harness side and ground.
	7 Platform truck:
 VFE72238	8 Measure the voltage between the left-hand rear lamp assembly, connector CLS04, pin 3, circuit CBP76L(N) (BU/BN), wiring harness side and ground. • Is battery voltage measured? → **Yes** GO to B4. → **No** - Vehicles with autolamps: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP76 and the left-hand rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system. - All other models: LOCATE and RECTIFY the break in the circuit between soldered connection S2BP76 and the left-hand rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system.
B4: CHECK GROUND CONNECTION TO LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 SWITCH OFF the side lights (parking lights).
	2 Box van, bus, combi:

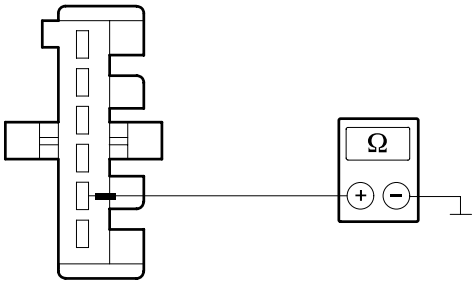
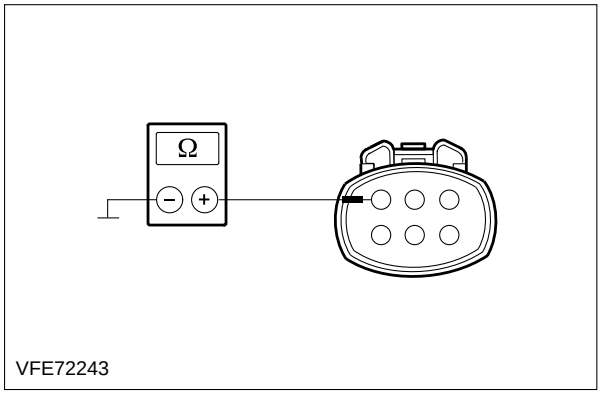
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0018115	3 Measure the resistance between the left-hand rear lamp assembly, connector CLS22, pin 5, circuit B-GD149B(R) (BK/GY), wiring harness side, and ground.
	4 Platform truck:
 VFE72243	5 Measure the resistance between the left-hand rear lamp assembly, connector CLS04, pin 1, circuit B-GD129U (BK/YE), wiring harness side, and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary INSTALL a new left-hand rear lamp assembly. CHECK the operation of the system. → **No** - Box van, bus, combi: LOCATE and RECTIFY the break in the circuit between the left-hand rear lamp assembly and ground connection GP49 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform truck: LOCATE and RECTIFY the break in the circuit between the left-hand rear lamp assembly and soldered connection S4D129G with the aid of the Wiring Diagrams. CHECK the operation of the system.
B5: CHECK VOLTAGE SUPPLY TO RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 SWITCH OFF the side lights (parking lights).
	3 Disconnect Right-hand rear lamp assembly from connector CLS26.
	4 SWITCH ON the side lights (parking lights).
	5 Box van, bus, combi:

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0016213	6 Measure the voltage between the right-hand rear lamp assembly, connector CLS26, pin 3, circuit CBP75(D) (YE/GY), wiring harness side, and ground.
	7 Platform truck:
 VFE0016217	8 Measure the voltage between the right-hand rear lamp assembly: – Platform truck without autolamps: connector CLS26, pin 3, circuit CBP75L (YE/GY), wiring harness side, and ground. – Platform truck with autolamps: connector CLS26, pin 3, circuit CBP76M (BU/BN), wiring harness side, and ground. • Is battery voltage measured? → **Yes** GO to B6. → **No** - Vehicles with autolamps: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP76 and the right-hand rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system. - All other models: LOCATE and RECTIFY the break in the circuit between soldered connection S2BP75 and the right-hand rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system.
B6: CHECK GROUND CONNECTION TO RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 SWITCH OFF the side lights (parking lights).
	2 Box van, bus, combi:

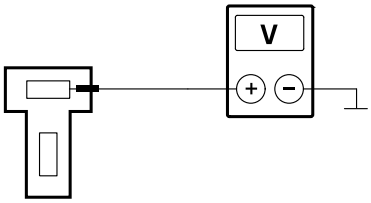
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0018115	3 Measure the resistance between the right-hand rear lamp assembly, connector CLS26, pin 5, circuit A-GD151AA(K) (BK/GN), wiring harness side, and ground.
	4 Platform truck:
 VFE72243	5 Measure the resistance between the right-hand rear lamp assembly, connector CLS26, pin 1, circuit B-GD129V (BK/YE), wiring harness side, and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary INSTALL a new right-hand rear lamp assembly. CHECK the operation of the system. → **No** - Box van, bus, combi: LOCATE and RECTIFY the break in the circuit between the right-hand rear lamp assembly and ground connection GP51 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform truck: LOCATE and RECTIFY the break in the circuit between the right-hand rear lamp assembly and soldered connection S4D129G with the aid of the Wiring Diagrams. CHECK the operation of the system.
B7: CHECK FUSE F79 (7.5 A) (CJB).	
	1 Disconnect Fuse F79 (7.5 A) (CJB).

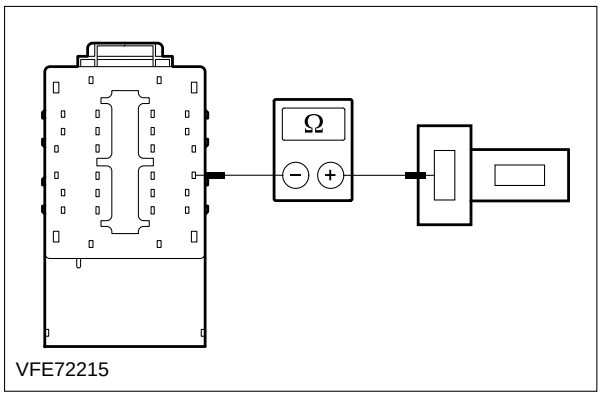
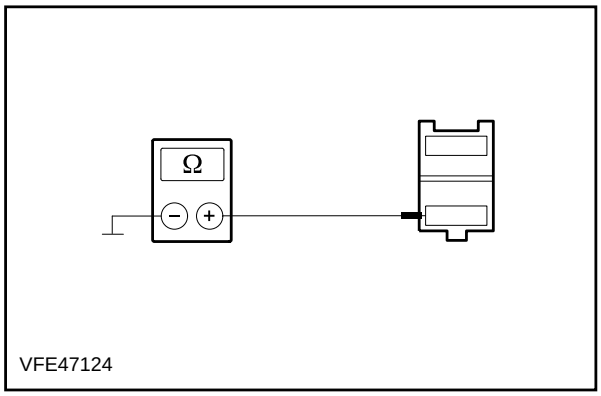
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK Fuse F79 (7.5 A) (CJB). • Is the fuse OK? → **Yes** GO to B8. → **No** INSTALL a new fuse F79 (7.5 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground with the aid of the Wiring Diagrams. CHECK the operation of the system.
B8: CHECK THE VOLTAGE SUPPLY TO FUSE F79 (7.5 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F79 (7.5 A) (CJB).
	2 Measure the voltage between fuse F79 (7.5 A) (CJB) and ground. • Is battery voltage measured? → **Yes** GO to B9. → **No** LOCATE and RECTIFY the break in the voltage supply of fuse F79 (7.5 A) (CJB) with the aid of the Wiring Diagrams. If necessary INSTALL a new central junction box (CJB). CHECK the operation of the system.
B9: CHECK THE POWER SUPPLY TO THE LICENSE PLATE LAMPS FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 SWITCH OFF the side lights (parking lights).
	3 Disconnect License plate lamp on left-hand side. – Vehicles with rear doors: from connector CLS04 – Vehicles with tailgate: from connector CLS04L
	4 SWITCH ON the side lights (parking lights).
	5 Vehicles with rear doors:

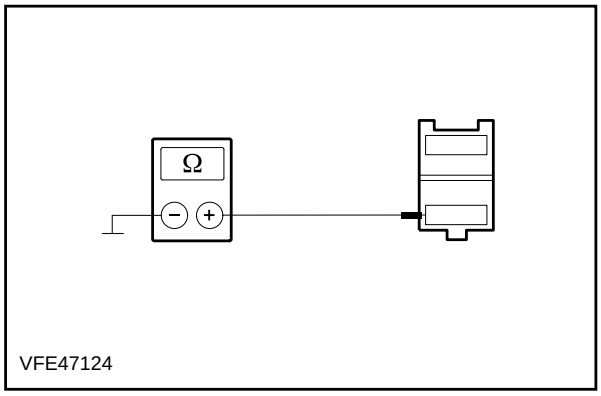
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0016149	6 Measure the voltage between the left-hand license plate lamp, connector CLS04, pin 1, circuit CBP79H (VT/WH)/CBP79J (VT/WH), wiring harness side and ground.
	7 Vehicles with tailgate:
 E49722	8 Measure the voltage between the left-hand license plate lamp, connector CLS04L, pin 1, circuit CBP79G (VT/WH) wiring harness side, and ground. • Is battery voltage measured? → **Yes** - Vehicles with tailgate: LOCATE and RECTIFY the break in the circuit between soldered connection S9D149B and ground connection GP49 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Vehicles with rear doors and side lights/turn signal lamps: LOCATE and RECTIFY the break in the circuit between soldered connection S4D149J and ground connection GP49 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** - Vehicles with tailgate:GO to B10. - All other vehicles: LOCATE and RECTIFY the break in circuit CBP79F(H) (VT/WH) between soldered connection S4BP79E and the left-hand license plate lamp with the aid of the Wiring Diagrams. CHECK the operation of the system.
B10: CHECK CIRCUIT CBP79A(D)(E)(F) (VT/WH) BETWEEN CENTRAL JUNCTION BOX (CJB) AND SOLDERED CONNECTION S4BP79 FOR BREAKS	
	1 Disconnect Central junction box (CJB) from connector CBP02B.

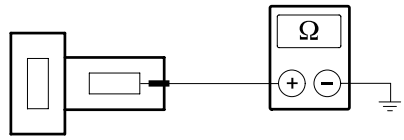
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72215	2 Measure the resistance between the central junction box (CJB), connector CBP02B, pin 16, circuit CBP79A (VT/WH), wiring harness side and left-hand license plate lamp, connector CLS04L, pin 1, circuit CBP79G (VT/WH), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new central junction box (CJB). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and soldered connection S4BP79 with the aid of the Wiring Diagrams. CHECK the operation of the system.
B11: CHECK GROUND CONNECTION TO INOPERATIVE LICENSE PLATE LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 SWITCH OFF the side lights (parking lights).
	3 Disconnect Inoperative license plate lamp. – left: from connector CLS22B – right: from connector CLS22A
 VFE47124	4 Measure the resistance at the inoperative license plate lamp: – left: connector CLS22B, pin 2, circuit B_GD129AB (BK/YE), wiring harness side, and ground. – right: connector CLS22A, pin 2, circuit B_GD129Y (BK/YE), wiring harness side, and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** - Vehicles with additional side lights: CHECK the inoperative license plate lamp and if necessary INSTALL a new one. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the inoperative license plate lamp and soldered connection S4D129B with the aid of the Wiring Diagrams. CHECK the operation of the system.

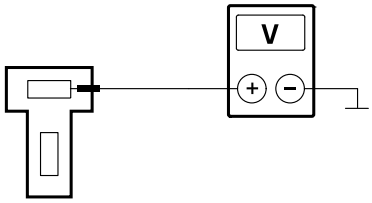
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B12: CHECK GROUND CONNECTION TO INOPERATIVE LICENSE PLATE LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 SWITCH OFF the side lights (parking lights).
	3 Disconnect Inoperative license plate lamp. – left, vehicles with rear doors: from connector CLS04 – left, vehicles with tailgate: from connector CLS04L – right, vehicles with rear doors: from connector CLS05 – right, vehicles with tailgate: from connector CLS05L
	4 Vehicles with rear doors:
	5 Measure the resistance between the inoperative license plate lamp: – left: connector CLS04, pin 2, circuit B_GD149F (BK/GY), wiring harness side, and ground. – right: connector CLS05, pin 2, circuit B_GD149E (BK/GY), wiring harness side, and ground.
	6 Vehicles with tailgate:

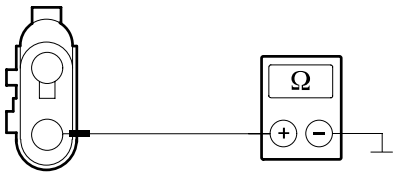
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0013703	7 Measure the resistance between the inoperative license plate lamp: – left: connector CLS04L, pin 2, circuit B_GD149V (BK/GY), wiring harness side, and ground. – right: connector CLS05L, pin 2, circuit B_GD149U (BK/GY), wiring harness side, and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** - Vehicles with rear doors, left-hand license plate lamp inoperative: CHECK the left-hand license plate lamp and INSTALL a new one if necessary. CHECK the operation of the system. - Vehicles with rear doors, right-hand license plate lamp inoperative: GO to B13. - Vehicles with tailgate: GO to B13. → **No** - Vehicles with rear doors: LOCATE and RECTIFY the break in the circuit between the inoperative license plate lamp and soldered connection S4D149J with the aid of the Wiring Diagrams. CHECK the operation of the system. - Vehicles with tailgate: LOCATE and RECTIFY the break in the circuit between the inoperative license plate lamp and soldered connection S2D149B with the aid of the Wiring Diagrams. CHECK the operation of the system.
B13: CHECK VOLTAGE SUPPLY TO INOPERATIVE LICENSE PLATE LAMP FOR OPEN CIRCUIT	
	1 SWITCH ON the side lights (parking lights).
	2 Vehicles with rear doors:
 VFE0016149	3 Measure the voltage between the right-hand license plate lamp, connector CLS05, pin 1, circuit CBP79J (VT/WH) wiring harness side, and ground.
	4 Vehicles with tailgate:

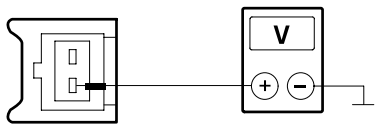
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E49722	5 Measure the voltage between the inoperative license plate lamp: – left: connector CLS04L, pin 1, circuit CBP79G (VT/WH), wiring harness side, and ground. – right: connector CLS05L, pin 1, circuit CBP79H (VT/WH), wiring harness side, and ground. • Is battery voltage measured? → **Yes** CHECK the inoperative license plate lamp and if necessary INSTALL a new one. CHECK the operation of the system. → **No** - Vehicles with rear doors: LOCATE and RECTIFY the break in the circuit between the left-hand license plate lamp and the right-hand license plate lamp with the aid of the Wiring Diagrams. CHECK the operation of the system. - Vehicles with tailgate: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP79 and the inoperative license plate lamp with the aid of the Wiring Diagrams. CHECK the operation of the system.
B14: CHECK VOLTAGE SUPPLY TO INOPERATIVE REAR ADDITIONAL SIDE LIGHT FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Inoperative rear additional side light. – left: from connector CLS40 – right: from connector CLS49
	3 SWITCH ON the side lights (parking lights).

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0016017	4 Measure the voltage between the inoperative rear additional side light: – left: connector CLS40, pin 1, circuit CBP79W (VT/WH), wiring harness side, and ground. – right: connector CLS49, pin 1, circuit CBP79X (VT/WH), wiring harness side, and ground. • Is battery voltage measured? → **Yes** GO to B15. → **No** - Left-hand side: LOCATE and RECTIFY the break in the circuit between the left-hand license plate lamp and the left-hand rear additional side light with the aid of the Wiring Diagrams. CHECK the operation of the system. - Right-hand side: LOCATE and RECTIFY the break in the circuit between the right-hand license plate lamp and the right-hand rear additional side light with the aid of the Wiring Diagrams. CHECK the operation of the system.
B15: CHECK GROUND CONNECTION TO INOPERATIVE REAR ADDITIONAL SIDE LIGHT FOR OPEN CIRCUIT	
	1 SWITCH OFF the side lights (parking lights).
 VFE0022794	2 Measure the resistance between the inoperative rear additional side light: – left: connector CLS40, pin 2, circuit B_GD129AD (BK/YE), wiring harness side, and ground. – right: connector CLS49, pin 2, circuit B_GD129AC (BK/YE), wiring harness side, and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the inoperative rear additional side light and INSTALL a new one if necessary. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the inoperative rear additional side light and soldered connection S4D129B with the aid of the Wiring Diagrams. CHECK the operation of the system.
B16: CHECK VOLTAGE SUPPLY TO INOPERATIVE SIDE LIGHT FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Inoperative side light. – left center: from connector CLS12 – left rear: from connector CLS15 – right center: from connector CLS17 – right, rear: from connector CLS16
	3 SWITCH ON the side lights (parking lights).
 VFE0022789	4 Measure the voltage at the inoperative side light between: – left center: connector CLS12, pin 1, circuit CBP79AB (VT/WH), wiring harness side, and ground. – left rear: connector CLS15, pin 1, circuit CBP79AE (VT/WH), wiring harness side, and ground. – right center: connector CLS17, pin 1, circuit CBP79AC (VT/WH), wiring harness side, and ground. – right rear: connector CLS16, pin 1, circuit CBP79AF (VT/WH), wiring harness side, and ground. • Is battery voltage measured? → **Yes** GO to B17. → **No** - Left-hand center side light inoperative: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP79B and the left-hand center side light with the aid of the Wiring Diagrams. CHECK the operation of the system. - Left-hand rear side light inoperative: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP79C and the left-hand rear side light with the aid of the Wiring Diagrams. CHECK the operation of the system. - Right-hand center side light inoperative: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP79B and the right-hand center side light with the aid of the Wiring Diagrams. CHECK the operation of the system. - Right-hand rear side light inoperative: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP79C and the right-hand rear side light with the aid of the Wiring Diagrams. CHECK the operation of the system.

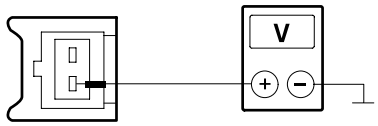
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B17: CHECK GROUND CONNECTION TO INOPERATIVE SIDE LIGHT FOR OPEN CIRCUIT	
	1 SWITCH OFF the side lights (parking lights).
 VFE0022920	2 Measure the resistance at the inoperative side light between: – left center: connector CLS12, pin 2, circuit B_GD129AK (BK/YE), wiring harness side, and ground. – left rear: connector CLS15, pin 2, circuit B_GD129AH (BK/YE), wiring harness side, and ground. – right center: connector CLS17, pin 2, circuit B_GD129AL (BK/YE), wiring harness side, and ground. – right, rear: connector CLS16, pin 2, circuit B_GD129AG (BK/YE), wiring harness side, and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the inoperative side light and if necessary INSTALL a new one. CHECK the operation of the system. → **No** - Left-hand center side light inoperative: LOCATE and RECTIFY the break in the circuit between the left-hand center side light and soldered connection S4D129D with the aid of the Wiring Diagrams. CHECK the operation of the system. - Left-hand rear side light inoperative: LOCATE and RECTIFY the break in the circuit between the left-hand rear side light and soldered connection S4D129C with the aid of the Wiring Diagrams. CHECK the operation of the system. - Right-hand center side light inoperative: LOCATE and RECTIFY the break in the circuit between the right-hand center side light and soldered connection S4D129D with the aid of the Wiring Diagrams. CHECK the operation of the system. - Right-hand rear side light inoperative: LOCATE and RECTIFY the break in the circuit between the right-hand rear side light and soldered connection S4D129C with the aid of the Wiring Diagrams. CHECK the operation of the system.
B18: CHECK VOLTAGE SUPPLY TO INOPERATIVE SIDE LIGHT FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

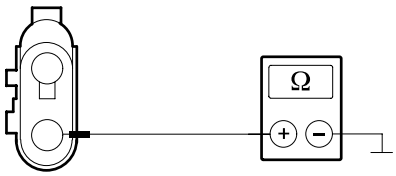
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Inoperative side light. – left center: from connector CLS14 – left rear: from connector CLS15 – right center: from connector CLS13 – right, rear: from connector CLS16
	3 SWITCH ON the side lights (parking lights).
	4 Left/right-hand center side light:
 VFE0016017	5 Measure the voltage at the inoperative side light between: – left center: connector CLS14, pin 1, circuit CBP79E (VT/WH), wiring harness side, and ground. – right center: connector CLS13, pin 1, circuit CBP79N (VT/WH), wiring harness side, and ground.
	6 Left/right-hand rear side light:

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0022789	7 Measure the voltage at the inoperative side light between: – left rear: connector CLS15, pin 1, circuit CBP79G (VT/WH), wiring harness side, and ground. – right rear: connector CLS16, pin 1, circuit CBP79P (VT/WH), wiring harness side, and ground. • Is battery voltage measured? → **Yes** GO to B19. → **No** - Left-hand center side light inoperative: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP79E and the left-hand center side light with the aid of the Wiring Diagrams. CHECK the operation of the system. - Left-hand rear side light inoperative: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP79E and the left-hand rear side light with the aid of the Wiring Diagrams. CHECK the operation of the system. - Right-hand center side light inoperative: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP79F and the right-hand center side light with the aid of the Wiring Diagrams. CHECK the operation of the system. - Right-hand rear side light inoperative: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP79F and the right-hand rear side light with the aid of the Wiring Diagrams. CHECK the operation of the system.
B19: CHECK GROUND CONNECTION TO INOPERATIVE SIDE LIGHT FOR OPEN CIRCUIT	
	1 SWITCH OFF the side lights (parking lights).
	2 Left/right-hand center side light:

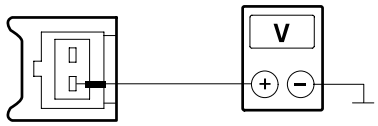
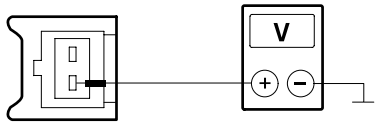
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0022794	3 Measure the resistance at the inoperative side light between: – left center: connector CLS14, pin 2, circuit B_GD149R (BK/YE), wiring harness side, and ground. – right center: connector CLS13, pin 2, circuit A_GD151J (BK/YE), wiring harness side, and ground.
	4 Left/right-hand rear side light:

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0022920	5 Measure the resistance at the inoperative side light between: – left rear: connector CLS15, pin 2, circuit B_GD149Q (BK/YE), wiring harness side, and ground. – right, rear: connector CLS16, pin 2, circuit A_GD151H (BK/YE), wiring harness side, and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the inoperative side light and if necessary INSTALL a new one. CHECK the operation of the system. → **No** - Left-hand center side light inoperative: LOCATE and RECTIFY the break in the circuit between the left-hand center side light and soldered connection S4D149H with the aid of the Wiring Diagrams. CHECK the operation of the system. - Left-hand rear side light inoperative: LOCATE and RECTIFY the break in the circuit between the left-hand rear side light and soldered connection S4D149H with the aid of the Wiring Diagrams. CHECK the operation of the system. - Right-hand center side light inoperative: LOCATE and RECTIFY the break in the circuit between the right-hand center side light and soldered connection S4D151A with the aid of the Wiring Diagrams. CHECK the operation of the system. - Right-hand rear side light inoperative: LOCATE and RECTIFY the break in the circuit between the right-hand rear side light and soldered connection S4D151A with the aid of the Wiring Diagrams. CHECK the operation of the system.
B20: CHECK VOLTAGE SUPPLY TO LEFT AND RIGHT-HAND CENTER SIDE LIGHTS FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand center side light from connector CLS12.
	3 SWITCH ON the side lights (parking lights).

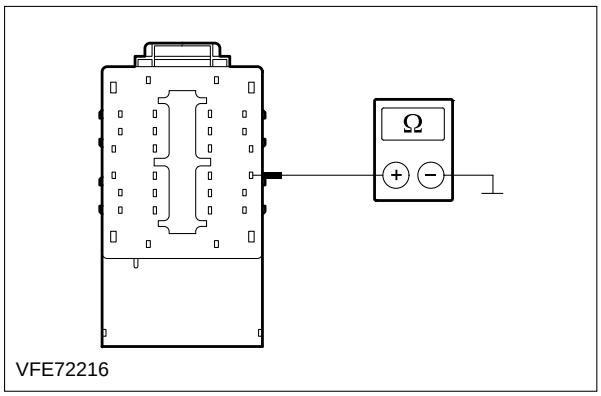
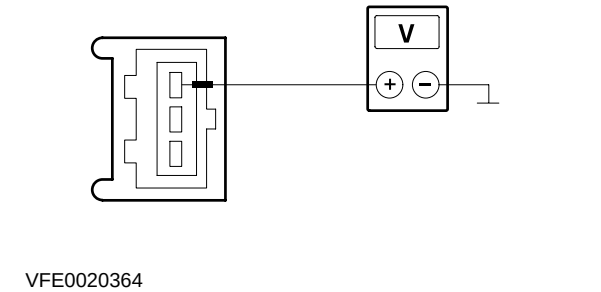
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0022789	4 Measure the voltage between the left-hand center side light, connector CLS12, pin 1, circuit CBP79AB (VT/WH) wiring harness side, and ground. • Is battery voltage measured? → **Yes** LOCATE and RECTIFY the break in circuit CBP79Q(AA) (VT/WH), between soldered connection S4BP79A and soldered connection S4BP79B, with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in circuit B_GD129AM(AE) (BK/YE) between soldered connection S4D129D and soldered connection S4D129B, with the aid of the Wiring Diagrams. CHECK the operation of the system.
B21: CHECK VOLTAGE SUPPLY TO LEFT AND RIGHT-HAND REAR SIDE LIGHTS FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand rear side light from connector CLS15.
	3 SWITCH ON the side lights (parking lights).
 VFE0022789	4 Measure the voltage between the left-hand center side light, connector CLS15, pin 1, circuit CBP79AE (VT/WH) wiring harness side, and ground. • Is battery voltage measured? → **Yes** LOCATE and RECTIFY the break in circuit CBP79R(AD) (VT/WH), between soldered connection S4BP79A and soldered connection S4BP79C, with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in circuit B_GD129AJ(AF) (BK/YE) between soldered connection S4D129C and soldered connection S4D129B, with the aid of the Wiring Diagrams. CHECK the operation of the system.
B22: CHECK FUSE F79 (7.5 A) (CJB).	
	1 Disconnect Fuse F79 (7.5 A) (CJB).

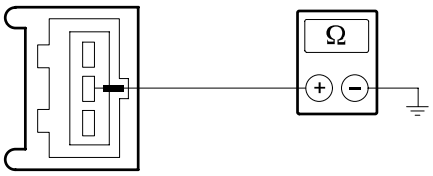
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK Fuse F79 (7.5 A) (CJB). • Is the fuse OK? → **Yes** GO to B23. → **No** INSTALL a new fuse F79 (7.5 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground with the aid of the Wiring Diagrams. CHECK the operation of the system.
B23: CHECK THE VOLTAGE SUPPLY TO FUSE F79 (7.5 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F79 (7.5 A) (CJB).
	2 Measure the voltage between fuse F79 (7.5 A) (CJB) and ground. • Is battery voltage measured? → **Yes** GO to B24. → **No** LOCATE and RECTIFY the break in the voltage supply of fuse F79 (7.5 A) (CJB) with the aid of the Wiring Diagrams. If necessary INSTALL a new central junction box (CJB). CHECK the operation of the system.
B24: CHECK THE CENTRAL JUNCTION BOX (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02B.

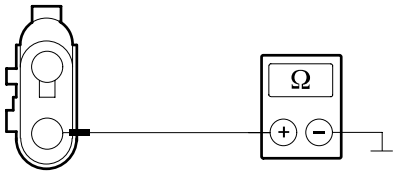
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72216	3 Measure the resistance between the central junction box (CJB), connector CBP02B, pin 16, circuit CBP79D (VT/WH), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new central junction box (CJB). CHECK the operation of the system. → **No** - Platform truck: LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and soldered connection S4BP79A with the aid of the Wiring Diagrams. CHECK the operation of the system. - Box van, bus, combi with autolamps and side lights/turn signal lamps: LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and soldered connection S2BP79, with the aid of the Wiring Diagrams. CHECK the operation of the system.
B25: CHECK VOLTAGE SUPPLY OF LEFT-HAND FRONT SIDE LIGHT/TURN SIGNAL LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand front side light/turn signal lamp. – Box van, bus, combi: from connector CLS15A – Platform truck: from connector CLS25
	3 SWITCH ON the side lights (parking lights).
 VFE0020364	4 Measure the voltage between the left-hand front side light/turn signal lamp: – Box van, bus, combi: connector CLS15A, pin 3, circuit CBP76G (BU/BN), wiring harness side, and ground. – Platform truck: connector CLS25, pin 3, circuit CBP76G (BU/BN), wiring harness side, and ground. • Is battery voltage measured? → **Yes** GO to B26. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S1BP76 and the left-hand front side light/turn signal lamp with the aid of the Wiring Diagrams. CHECK the operation of the system.

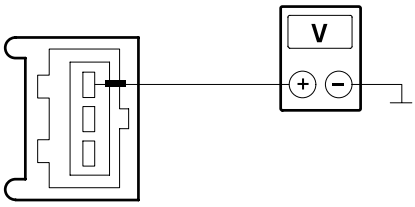
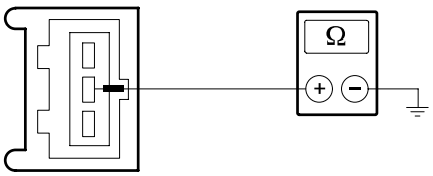
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B26: CHECK GROUND CONNECTION TO LEFT-HAND FRONT SIDE LIGHT/TURN SIGNAL LAMP FOR OPEN CIRCUIT	
	1 SWITCH OFF the side lights (parking lights).
 VFE0010896	2 Measure the resistance between the left-hand front side light/turn signal lamp: – Box van, bus, combi: connector CLS15A, pin 2, circuit A_GD129S (BK/YE), wiring harness side, and ground. – Platform truck: connector CLS25, pin 2, circuit A_GD129S (BK/YE), wiring harness side, and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary INSTALL a new left-hand front side light/turn signal lamp. CHECK the operation of the system. → **No** - Box van, bus, combi: LOCATE and RECTIFY the break in the circuit between the left-hand front side light/turn signal lamp and soldered connection S1D129A with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform truck: LOCATE and RECTIFY the break in the circuit between the left-hand front side light/turn signal lamp and soldered connection S2D129A with the aid of the Wiring Diagrams. CHECK the operation of the system.
B27: CHECK VOLTAGE SUPPLY TO LEFT-HAND FRONT CLEARANCE LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand front clearance lamp from connector CLS13.
	3 SWITCH ON the side lights (parking lights).

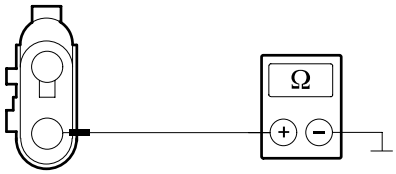
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0016017	4 Measure the voltage between the left-hand front clearance lamp, connector CLS13, pin 1, circuit CBP76H (BU/BN), wiring harness side, and ground. • Is battery voltage measured? → **Yes** GO to B28. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2BP76 and the left-hand front clearance lamp with the aid of the Wiring Diagrams. CHECK the operation of the system.
B28: CHECK GROUND CONNECTION TO LEFT-HAND FRONT CLEARANCE LAMP FOR OPEN CIRCUIT	
	1 SWITCH OFF the side lights (parking lights).
 VFE0022794	2 Measure the resistance between the left-hand front clearance lamp, connector CLS23, pin 2, circuit A_GD133H (BK), wiring harness side, and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary INSTALL a new left-hand front clearance lamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the left-hand front clearance lamp and soldered connection S2D113C with the aid of the Wiring Diagrams. CHECK the operation of the system.
B29: CHECK VOLTAGE SUPPLY OF RIGHT-HAND FRONT SIDE LIGHT/TURN SIGNAL LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Right-hand front side light/turn signal lamp. – Box van, bus, combi: from connector CLS14B – Platform truck: from connector CLS21
	3 SWITCH ON the side lights (parking lights).

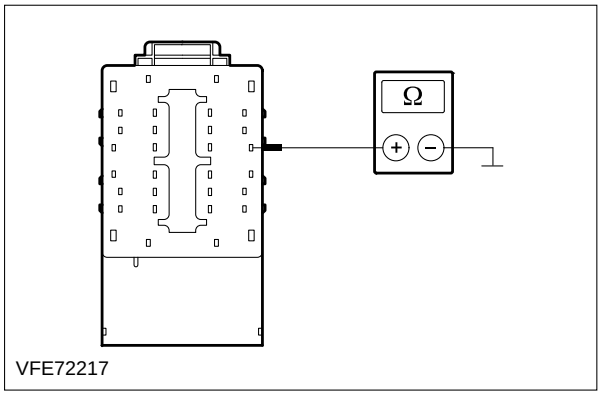
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0020364	4 Measure the voltage between the left-hand front side light/turn signal lamp: – Box van, bus, combi: connector CLS14B, pin 3, circuit CBP75G (YE/GY), wiring harness side, and ground. – Platform truck: connector CLS21, pin 3, circuit CBP75G (YE/GY), wiring harness side, and ground. • Is battery voltage measured? → **Yes** GO to B30. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S1BP75 and the right-hand front side light/turn signal lamp with the aid of the Wiring Diagrams. CHECK the operation of the system.
B30: CHECK GROUND CONNECTION TO RIGHT-HAND FRONT SIDE LIGHT/TURN SIGNAL LAMP FOR OPEN CIRCUIT	
	1 SWITCH OFF the side lights (parking lights).
 VFE0010896	2 Measure the resistance between the right-hand front side light/turn signal lamp: – Box van, bus, combi: connector CLS14B, pin 2, circuit A_GD131S (BK/GY), wiring harness side, and ground. – Platform truck: connector CLS21, pin 2, circuit A_GD131S (BK/RD), wiring harness side, and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary INSTALL a new right-hand front side light/turn signal lamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the right-hand front side light/turn signal lamp and soldered connection S1D131B with the aid of the Wiring Diagrams. CHECK the operation of the system.
B31: CHECK VOLTAGE SUPPLY TO RIGHT-HAND FRONT CLEARANCE LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Right-hand front clearance lamp from connector CLS14.
	3 SWITCH ON the side lights (parking lights).

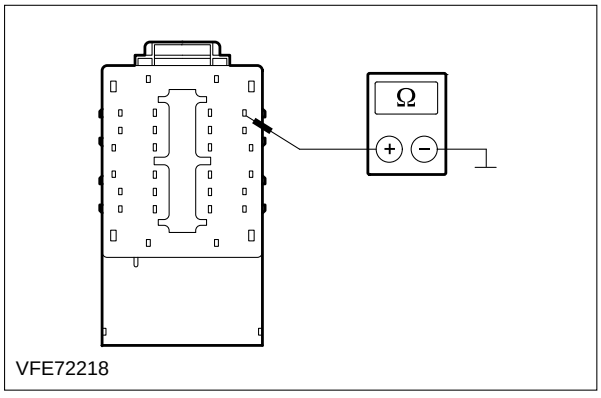
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0016017	4 Measure the voltage between the right-hand front clearance lamp, connector CLS14, pin 1, circuit CBP75L (YE/GY), wiring harness side, and ground. • Is battery voltage measured? → **Yes** GO to B32. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2BP75 and the right-hand front clearance lamp with the aid of the Wiring Diagrams. CHECK the operation of the system.
B32: CHECK GROUND CONNECTION TO RIGHT-HAND FRONT CLEARANCE LAMP FOR OPEN CIRCUIT	
	1 SWITCH OFF the side lights (parking lights).
 VFE0022794	2 Measure the resistance between the right-hand front clearance lamp, connector CLS14, pin 2, circuit A_GD138H (BK/WH), wiring harness side, and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary INSTALL a new right-hand front clearance lamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the right-hand front clearance lamp and soldered connection S9D138A with the aid of the Wiring Diagrams. CHECK the operation of the system.
B33: CHECK FUSE F75 (7.5 A) (CJB).	
	1 Disconnect Fuse F75 (7.5 A) (CJB).
	2 CHECK Fuse F75 (7.5 A) (CJB). • Is the fuse OK? → **Yes** GO to B34. → **No** INSTALL a new fuse F75 (7.5 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B34: CHECK THE VOLTAGE SUPPLY TO FUSE F75 (7.5 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F75 (7.5 A) (CJB).
	2 Measure the voltage between fuse F75 (7.5 A) (CJB) and ground. • Is battery voltage measured? → **Yes** GO to B35. → **No** LOCATE and RECTIFY the break in the voltage supply of fuse F75 (7.5 A) (CJB) with the aid of the Wiring Diagrams. If necessary INSTALL a new central junction box (CJB). CHECK the operation of the system.
B35: CHECK THE CENTRAL JUNCTION BOX (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02B.
 VFE72217	3 Measure the resistance between the central junction box (CJB), connector CBP02B, pin 20, circuit CBP75A (YE/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new central junction box (CJB). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and soldered connection S2BP75 with the aid of the Wiring Diagrams. CHECK the operation of the system.
B36: CHECK FUSE F76 (7.5 A) (CJB).	
	1 Disconnect Fuse F76 (7.5 A) (CJB).

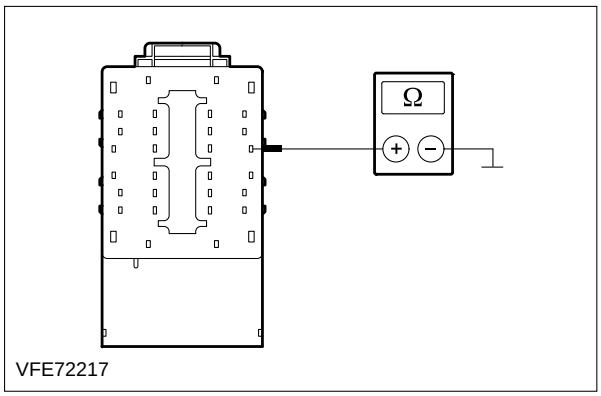
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK Fuse F76 (7.5 A) (CJB). • Is the fuse OK? → **Yes** GO to B37. → **No** INSTALL a new fuse F76 (7.5 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground with the aid of the Wiring Diagrams. CHECK the operation of the system.
B37: CHECK THE VOLTAGE SUPPLY TO FUSE F76 (7.5 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F76 (7.5 A) (CJB).
	2 Measure the voltage between fuse F76 (7.5 A) (CJB) and ground. • Is battery voltage measured? → **Yes** GO to B38. → **No** LOCATE and RECTIFY the break in the voltage supply of fuse F76 (7.5 A) (CJB) with the aid of the Wiring Diagrams. If necessary INSTALL a new central junction box (CJB). CHECK the operation of the system.
B38: CHECK THE CENTRAL JUNCTION BOX (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02B.
 VFE72218	3 Measure the resistance between the central junction box (CJB), connector CBP02B, pin 28, circuit CBP76A (BU/BN), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new central junction box (CJB). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and soldered connection S2BP76 with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B39: CHECK FUSE F75 (7.5 A) (CJB).	
	1 Disconnect Fuse F75 (7.5 A) (CJB).
	2 CHECK Fuse F75 (7.5 A) (CJB). • Is the fuse OK? → **Yes** GO to B40. → **No** INSTALL a new fuse F75 (7.5 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground with the aid of the Wiring Diagrams. CHECK the operation of the system.
B40: CHECK THE VOLTAGE SUPPLY TO FUSE F75 (7.5 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F75 (7.5 A) (CJB).
	2 Measure the voltage between fuse F75 (7.5 A) (CJB) and ground. • Is battery voltage measured? → **Yes** GO to B41. → **No** LOCATE and RECTIFY the break in the voltage supply of fuse F75 (7.5 A) (CJB) with the aid of the Wiring Diagrams. If necessary INSTALL a new central junction box (CJB). CHECK the operation of the system.
B41: CHECK THE CENTRAL JUNCTION BOX (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02B.

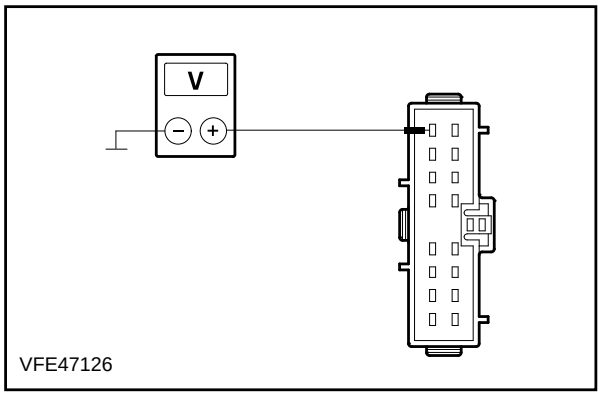
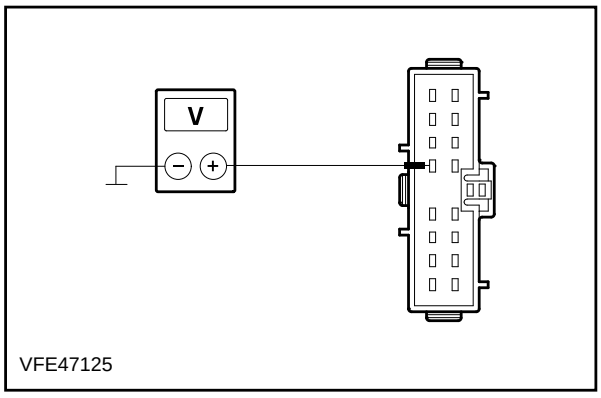
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72217	3 Measure the resistance between the central junction box (CJB), connector CBP02B, pin 20, circuit CBP75(A) (YE/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new central junction box (CJB). CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and soldered connection S2BP75 with the aid of the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST S : SIDE LIGHTS (PARKING LIGHTS) FRONT/REAR, LICENSE PLATE LAMPS AND/OR ALL ADDITIONAL SIDE LIGHTS STAY ON ALL THE TIME

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position 0.
	2 Disconnect Light switch from connector CLF23.
	3 Ignition switch in position II.
	4 CHECK the side lights (parking lights) front/rear, license plate lamps and, if fitted, all additional side lights. • Are all the side lights (parking lights) front/rear, license plate lamps and, if fitted, all additional side lights on all the time? → **Yes** GO to C2. → **No** - No lamp illuminates: INSTALL a new light switch. CHECK the operation of the system. - License plate lamps and, if fitted, side and rear additional side lights are on all the time: GO to C4. - Left or right-hand front side lights (parking lights) and, if fitted, left or right-hand side light/turn signal lamp and left or right-hand front clearance lamp are on all the time: GO to C5.
C2: NARROW DOWN THE CAUSE OF THE SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Central junction box (CJB) from connector CBP02F.
	3 Ignition switch in position II.
	4 Measure the voltage between the light switch, connector CLF23, pin 16, circuit ZA104A (OG/GN), wiring harness side, and ground. • Is battery voltage measured? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit between the light switch and the central junction box (CJB) with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to C3.
C3: ELIMINATE THE CENTRAL JUNCTION BOX (CJB) AS POSSIBLE CAUSE FOR THE SHORT TO BATTERY VOLTAGE	
	1 Measure the voltage between the light switch, connector CLF23, pin 13, circuit ZA105A (OG/GY), wiring harness side, and ground. • Is battery voltage measured? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit between the light switch and the central junction box (CJB) with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** INSTALL a new central junction box (CJB). CHECK the operation of the system.
C4: NARROW DOWN THE FAULT CONDITION	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02B.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 CHECK license plate lamps and, if fitted, side and rear additional side lights. • Are the license plate lamps and, if fitted, side and rear additional side lights on all the time? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuits connected to the central junction box (CJB), connector CBP02B, pin 16 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** INSTALL a new central junction box (CJB). CHECK the operation of the system.
C5: NARROW DOWN THE FAULT CONDITION	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02B.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

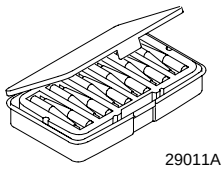
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 CHECK left and right-hand front side lights (parking lights) and, if fitted, left and right-hand side light/turn signal lamp and left and right-hand front clearance lamp. • Are the left or right-hand front side lights (parking lights) and, if fitted, left or right-hand side light/turn signal lamp and left or right-hand front clearance lamp on all the time? → **Yes** - Left-hand front side lights (parking lights) and, if fitted, left-hand side light/turn signal lamp and left-hand front clearance lamp are on all the time: LOCATE and RECTIFY the short to battery voltage in the circuits connected to the central junction box (CJB), connector CBP02B, pin 28 with the aid of the Wiring Diagrams. CHECK the operation of the system. Vehicles with trailer coupling, check trailer socket and RENEW if necessary. CHECK the operation of the system. - Right-hand front side lights (parking lights) and, if fitted, right-hand side light/turn signal lamp and right-hand front clearance lamp are on all the time: LOCATE and RECTIFY the short to battery voltage in the circuits connected to the central junction box (CJB), connector CBP02B, pin 20 with the aid of the Wiring Diagrams. CHECK the operation of the system. Vehicles with trailer coupling, check trailer socket and RENEW if necessary. CHECK the operation of the system. → **No** INSTALL a new central junction box (CJB). CHECK the operation of the system.

DIAGNOSIS AND TESTING

Fog Lamps

Refer to Wiring Diagrams Section 417-01,for schematic and connector information.

Special Tool(s)

 29011A	Terminal Probe Kit 29-011A

Inspection and Testing

NOTE: Before reading out the vehicle-specific data, remake all the separated electrical connections in the vehicle, so that communication between the module and WDS is ensured.

NOTE: The generic electronic module (GEM) forms part of the central junction box (CJB).

NOTE: If the generic electronic module (GEM) is changed, the new one must be reinitialized. For this purpose, the vehicle-specific data is read out of the module to be replaced using WDS and is transferred to the new module. REFER to:

Communications Network (418-00, Diagnosis and Testing),
Generic Electronic Module (GEM) (419-10, Diagnosis and Testing).

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical or mechanical damage.

Visual Inspection Chart

Electrical
– Fuse(s) – Bulb(s) – Electrical connector(s) – Wiring loom

3. Resolve any obvious causes or concerns found during the visual inspection before carrying out any further tests.
4. If the cause of the concern cannot be found by visual inspection, continue with the symptom chart.

Symptom Chart

Symptom Chart

Symptom	Possible Sources	Action
• Fog lamps not functioning	• Fuse(s) • Circuit(s) • Light switch • Central junction box (CJB) • Trailer control unit	• GO to Pinpoint Test A.
• Individual fog lamps not working	• Circuit(s) • Front fog lamps • Rear lamp assembly	• GO to Pinpoint Test B.
• Rear fog lamps and front fog lamps are permanently lit	• Light switch • Central junction box (CJB)	• RENEW the light switch. CHECK the operation of the system. If the concern is not rectified, RENEW the central junction box (CJB). CHECK the operation of the system.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Rear fog lamps or front fog lamps are permanently lit	• Circuit(s) • Light switch • Central junction box (CJB) • Trailer control unit	• GO to Pinpoint Test C.

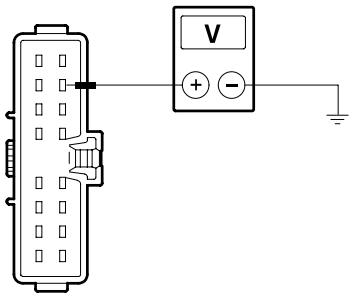
System Checks

NOTE: Use a digital multimeter for all electrical measurements.

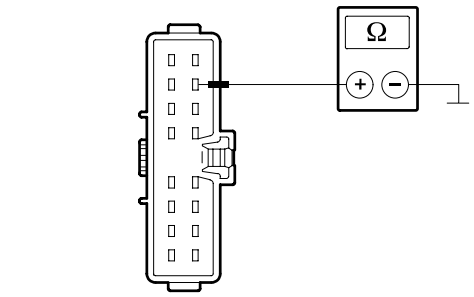
PINPOINT TEST T : FOG LAMPS NOT FUNCTIONING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 Only on vehicles without an auxiliary relay (front fog lamps) (Scandinavia): TURN ON the dipped beam headlamps.
	3 Switch on the front fog lamps.
	4 TURN ON the rear fog lamps.
	5 CHECK fog lamps. • Are the front and the rear fog lamps inoperative? → **Yes** - Vehicles without an auxiliary relay (front fog lamps) (Scandinavia):GO to A2. - Vehicles with an auxiliary relay (front fog lamps) (Scandinavia):GO to A6. → **No** - Front fog lamps are inoperative: GO to A10. - Rear fog lamps are inoperative: GO to A21.
A2: CHECK FUSE F67 (15 A) (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F67 (15 A) (CJB).
	3 CHECK Fuse F67 (15 A) (CJB). • Is the fuse OK? → **Yes** GO toA3. → **No** RENEW fuse F67 (15 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short using the Wiring Diagrams. CHECK the operation of the system.

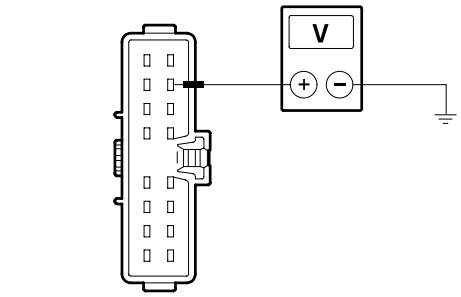
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A3: CHECK THE VOLTAGE SUPPLY TO FUSE F67 (15 A) (CJB)	
	1 Connect Fuse F67 (15 A) (CJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F67 (15 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** GO to A4. → **No** LOCATE AND RECTIFY the break in the voltage supply to fuse F67 (15 A) (CJB) with the aid of the Wiring Diagrams. CHECK the operation of the system.
A4: CHECK THE VOLTAGE SUPPLY TO THE LIGHT SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Light switch from connector CLF23.
	3 Ignition switch in position II.
 VFE0003184	4 Measure the voltage between the light switch, connector CLF23, pin 7: – Box van / Bus / Combi: Circuit SBP67G (RD/BU), wiring harness side and ground. – Platform truck: Circuit SBP67B (RD/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the light switch. CHECK the operation of the system. → **No** GO to A5.
A5: CHECK THE VOLTAGE SUPPLY TO THE LIGHT SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02E.

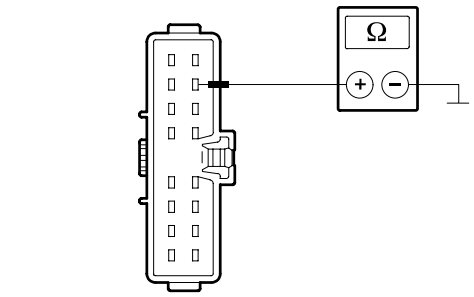
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0016294	3 Measure the resistance between the light switch, connector CLF23, pin 7: – Box van / Bus / Combi: Circuit SBP67G (RD/BU), wiring harness side and the central junction box (CJB), connector CBP02E, pin 17, circuit SBP67F (RD/BU), wiring harness side. – Platform truck: Circuit SBP67B (RD/BU), wiring harness side and the central junction box (CJB), connector CBP02E, pin 17, circuit SBP67A (RD/BU), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** RENEW THE CJB. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the CJB and the light switch with the aid of the Wiring Diagrams. CHECK the operation of the system.
A6: CHECK FUSE F69 (20 A) (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F69 (20 A) (CJB).
	3 CHECK Fuse F69 (20 A) (CJB). • Is the fuse in order? → **Yes** GO to A7. → **No** RENEW fuse F69 (20 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short using the Wiring Diagrams. CHECK the operation of the system.
A7: CHECK THE VOLTAGE SUPPLY TO FUSE F69 (20 A) (CJB)	
	1 Connect Fuse F69 (20 A) (CJB).
	2 Ignition switch in position II.

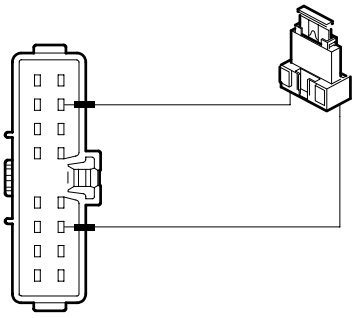
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between fuse F69 (20 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** GO to A8. → **No** LOCATE AND RECTIFY the break in the voltage supply to fuse F69 (20 A) (CJB) with the aid of the Wiring Diagrams. CHECK the operation of the system.
A8: CHECK THE VOLTAGE SUPPLY TO THE LIGHT SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Light switch from connector CLF23.
	3 Ignition switch in position II.
 VFE0003184	4 Measure the voltage between the light switch, connector CLF23, pin 7: – Box van / Bus / Combi: Circuit SBP69A (GY/RD), wiring harness side and ground. – Platform truck: Circuit SBP69A (RD/GY), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the light switch. CHECK the operation of the system. → **No** GO to A9.
A9: CHECK THE VOLTAGE SUPPLY TO THE LIGHT SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02E.

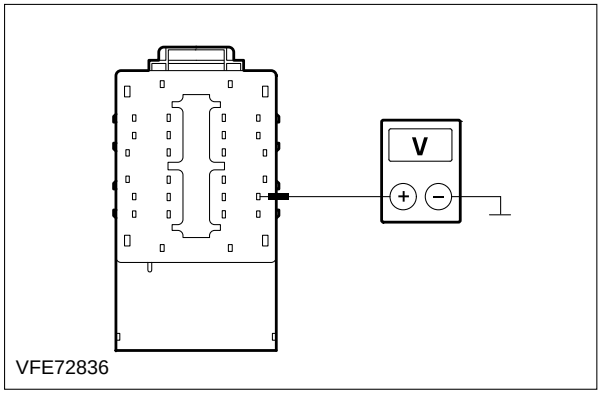
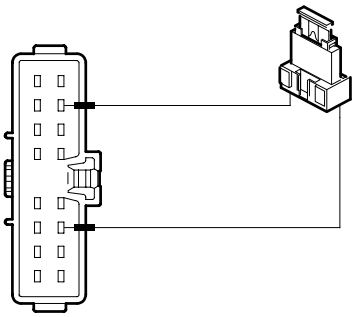
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0016294	3 Measure the resistance between the light switch, connector CLF23, pin 7: – Box van / Bus / Combi: Circuit SBP69A (GY/RD), wiring harness side and the central junction box (CJB), connector CBP02E, pin 29, circuit SBP69A (GY/RD), wiring harness side. – Platform truck: Circuit SBP69A (RD/GY), wiring harness side and the central junction box (CJB), connector CBP02E, pin 29, circuit SBP69A (RD/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** RENEW THE CJB. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the CJB and the light switch with the aid of the Wiring Diagrams. CHECK the operation of the system.
A10: CHECK FUSE F80 (15 A) (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F80 (15 A) (CJB).
	3 CHECK Fuse F80 (15 A) (CJB). • Is the fuse in order? → **Yes** GO to A11. → **No** RENEW fuse F80 (15 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short using the Wiring Diagrams. CHECK the operation of the system.
A11: CHECK THE VOLTAGE SUPPLY TO FUSE F80 (15 A) (CJB)	
	1 Connect Fuse F80 (15 A) (CJB).
	2 Ignition switch in position II.
	3 Only on vehicles without an auxiliary relay (front fog lamps) (Scandinavia): TURN ON the dipped beam headlamps.
	4 Switch on the front fog lamps.

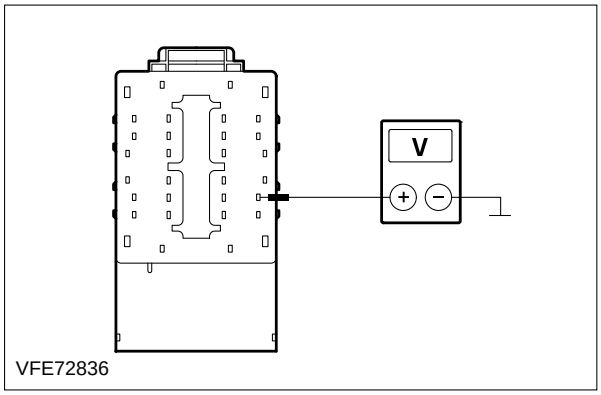
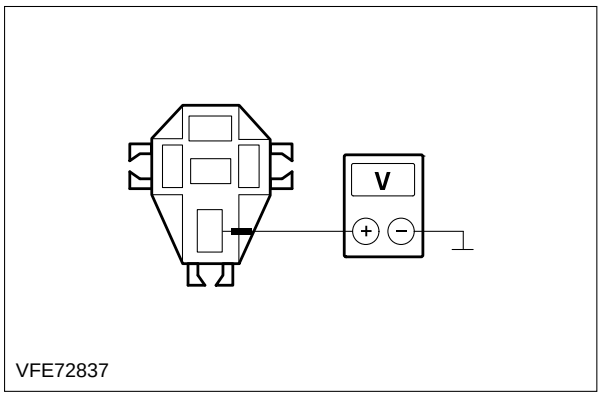
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	5 Measure the voltage between fuse F80 (15 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** GO to A20. → **No** - Vehicles without an auxiliary relay (front fog lamps) (Scandinavia):GO to A12. - Vehicles with an auxiliary relay (front fog lamps) (Scandinavia): GO to A14.
A12: CHECK LIGHT SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Light switch from connector CLF23.
 E0024111	3 Connect a fused jumper wire (15 A) at the light switch, connector CLF23, between pin 3, circuit CLF21A (GY/VT), wiring harness side and pin 7: – Box van / Bus / Combi: circuit SBP67G (RD/BU), wiring harness side. – Platform truck: circuit SBP67B (RD/BU), wiring harness side.
	4 Ignition switch in position II.
	5 Measure the voltage between fuse F80 (15 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** RENEW the light switch. CHECK the operation of the system. → **No** GO to A13.
A13: CHECK THE VOLTAGE SUPPLY TO FUSE F80 (15 A) (CJB) FOR OPEN CIRCUIT	
NOTE: The fused jumper lead used in the previous test step is still connected to the light switch.	
	1 Ignition switch in position 0.
	2 Disconnect CJB from connector CBP02E.
	3 Ignition switch in position II.

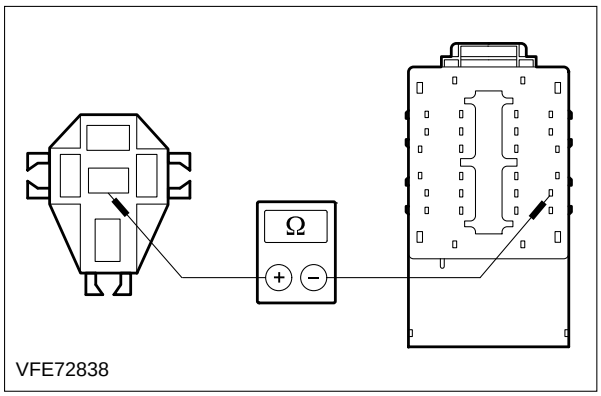
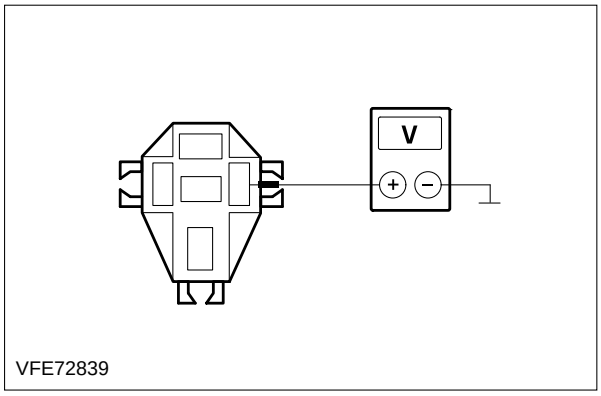
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72836	4 Measure the voltage between the CJB, connector CBP02E, pin 12, circuit CLF21A (GY/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW THE CJB. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the light switch and CJB using the wiring diagrams. CHECK the operation of the system.
A14: CHECK LIGHT SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Light switch from connector CLF23.
 E0024111	3 Connect a fused jumper wire (15 A) to the light switch, connector CLF23, between pin 7: – Box van / Bus / Combi without a trailer socket: circuit SBP69A (GY/RD), wiring harness side and pin 3, circuit CLF21A (GY/VT), wiring harness side. – Box van / Bus / Combi with a trailer socket: circuit SBP69A (GY/RD), wiring harness side and pin 3, circuit CLF21B (GY/VT), wiring harness side. – Platform truck: circuit SBP69A (RD/GY), wiring harness side and pin 3, circuit CLF21 (GY/VT), wiring harness side.
	4 Ignition switch in position II.
	5 Measure the voltage between fuse F80 (15 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** RENEW the light switch. CHECK the operation of the system. → **No** GO to A15.
A15: CHECK THE VOLTAGE SUPPLY TO FUSE F80 (15 A) (CJB) FOR OPEN CIRCUIT	
NOTE: The fused jumper lead used in the previous test step is still connected to the light switch.	
	1 Ignition switch in position 0.
	2 Disconnect CJB from connector CBP02E.

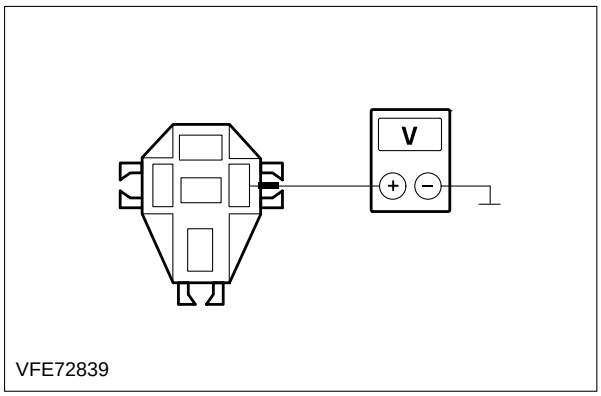
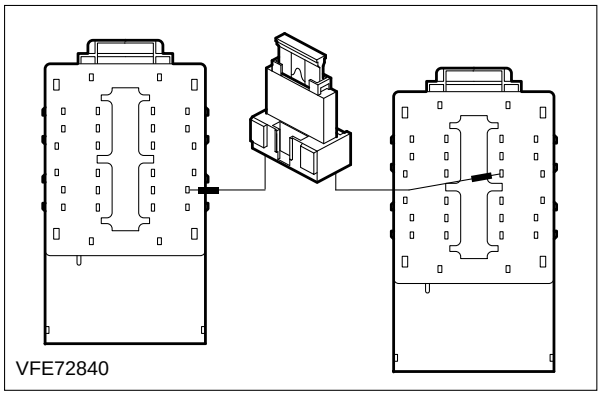
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Ignition switch in position II.
 VFE72836	4 Measure the voltage between the CJB, connector CBP02E, pin 12, circuit A_CLF21A (GY/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW THE CJB. CHECK the operation of the system. → **No** GO to A16.
A16: CHECK THE VOLTAGE SUPPLY TO THE AUXILIARY RELAY (FRONT FOG LAMPS) FOR OPEN CIRCUIT	
NOTE: The fused jumper lead used in the previous test step is still connected to the light switch.	
	1 Ignition switch in position 0.
	2 Disconnect Auxiliary relay (front fog lamps) from socket CLF12.
	3 Ignition switch in position II.
 VFE72837	4 Measure the voltage between the auxiliary relay (front fog lamps), connector CLF12, pin 3: – Box van / Bus / Combi without a trailer socket: circuit CLF21A (GY/VT), socket side and ground. – Box van / Bus / Combi with a trailer socket: circuit CLF21B (GY/VT), socket side and ground. – Platform truck: circuit CLF21 (GY/VT), socket side and ground. • Does the meter display battery voltage? → **Yes** GO to A17. → **No** LOCATE and RECTIFY the break in the circuit between the light switch and the auxiliary relay (front fog lamps) with the aid of the wiring diagrams. CHECK the operation of the system.
A17: CHECK THE VOLTAGE SUPPLY TO FUSE F80 (15 A) (CJB) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72838	2 Measure the resistance between the auxiliary relay (front fog lamps), connector CLF12, pin 4, circuit A_CLF21A (GY/VT), socket side and the CJB, connector CBP02E, pin 12, circuit A_CLF21A (GY/VT), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to A18. → **No** LOCATE and RECTIFY the break in the circuit between the auxiliary relay (front fog lamps) and the CJB with the aid of the wiring diagrams. CHECK the operation of the system.
A18: CHECK THE CONTROL CIRCUIT OF THE AUXILIARY RELAY (FRONT FOG LAMPS) FOR SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position II.
 VFE72839	2 Measure the voltage between the auxiliary relay (front fog lamps), socket CLF12, pin 1, circuit CLF18C (BU/WH), socket side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuits connected to soldered connection S2LF18 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to A19.
A19: RULE OUT THE LIGHT SWITCH AS A POSSIBLE CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Connect Light switch to connector CLF23.
	3 Ignition switch in position II.

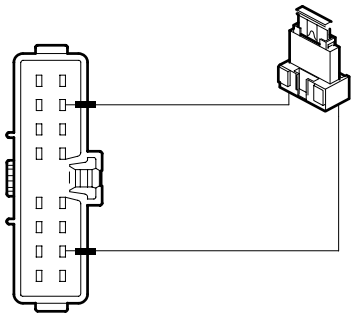
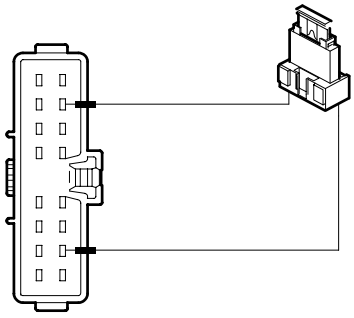
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72839	4 Measure the voltage between the auxiliary relay (front fog lamps), connector CLF12, pin 1, circuit CLF18C (BU/WH), socket side and ground. • Does the meter display battery voltage? → **Yes** RENEW the light switch. CHECK the operation of the system. → **No** RENEW the auxiliary relay (front fog lamps). CHECK the operation of the system.
A20: CHECK THE SHARED POWER SUPPLY OF THE FRONT FOG LAMPS FOR OPEN CIRCUIT	
NOTE: The front fog lamps are still switched on.	
	1 Ignition switch in position 0.
	2 Disconnect CJB from connector CBP02B.
	3 Disconnect CJB from connector CBP02E.
 VFE72840	4 Connect a fused jumper wire (15 A) to the CJB, connector CBP02E, between pin 12, circuit A_CLF21A (GY/VT), wiring harness side and the CJB, connector CBP02B, pin 19: – Box van / Bus / Combi: circuit SBP80A (VT/RD), wiring harness side. – Platform truck: circuit SBP80A (RD/VT), wiring harness side.
	5 Ignition switch in position II.
	6 CHECK the front fog lamps. • Do the front fog lamps illuminate? → **Yes** RENEW THE CJB. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the CJB and soldered connection S2BP80 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A21: CHECK FUSE F81 (10 A) (CJB)	
	1 Ignition switch in position 0.

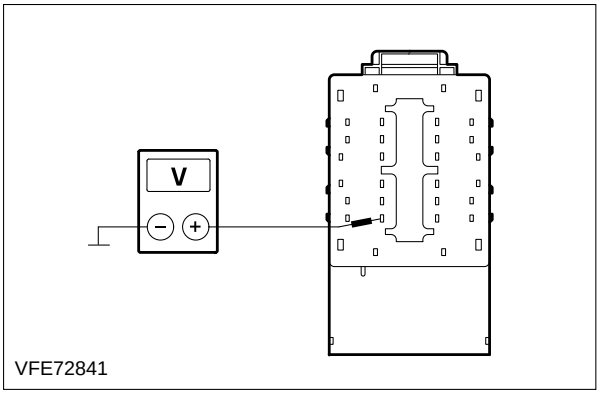
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Fuse F81 (10 A) (CJB).
	3 CHECK Fuse F81 (10 A) (CJB). • Is the fuse OK? → **Yes** GO to A22. → **No** RENEW fuse F81 (10 A) (CJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short using the Wiring Diagrams. CHECK the operation of the system.
A22: CHECK THE VOLTAGE SUPPLY TO FUSE F81 (10 A) (CJB)	
	1 Connect Fuse F81 (10 A) (CJB).
	2 Ignition switch in position II.
	3 TURN ON the dipped beam headlamps.
	4 TURN ON the rear fog lamps.
	5 Measure the voltage between fuse F81 (10 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** - Vehicles without an auxiliary relay (front fog lamps) (Scandinavia):GO to A26. - Vehicles with an auxiliary relay (front fog lamps) (Scandinavia):GO to A27. → **No** - Vehicles without an auxiliary relay (front fog lamps) (Scandinavia):GO to A23. - Vehicles with an auxiliary relay (front fog lamps) (Scandinavia):GO to A24.
A23: RULE OUT THE LIGHT SWITCH AS A POSSIBLE CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Light switch from connector CLF23.

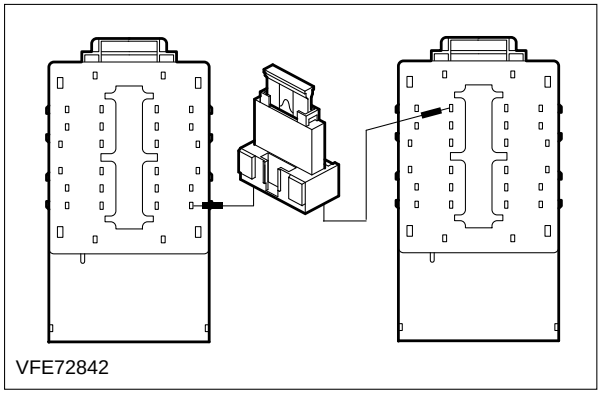
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0024110	3 Connect a fused jumper wire (10 A) at the light switch, connector CLF23, between pin 2, circuit CLS48A (BU), wiring harness side and pin 7: – Box van / Bus / Combi: circuit SBP67G (RD/BU), wiring harness side. – Platform truck: circuit SBP67B (RD/BU), wiring harness side.
	4 Ignition switch in position II.
	5 Measure the voltage between fuse F81 (10 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** RENEW the light switch. CHECK the operation of the system. → **No** GO to A25.
A24: RULE OUT THE LIGHT SWITCH AS A POSSIBLE CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Light switch from connector CLF23.
 E0024110	3 Connect a fused jumper wire (10 A) to the light switch, connector CLF23, between pin 7: – Box van / Bus / Combi: circuit SBP69A (GY/RD), wiring harness side and pin 2, circuit CLS48A (BU), wiring harness side. – Platform truck: circuit SBP69A (RD/GY), wiring harness side and pin 2, circuit CLS48 (BU), wiring harness side.
	4 Ignition switch in position II.

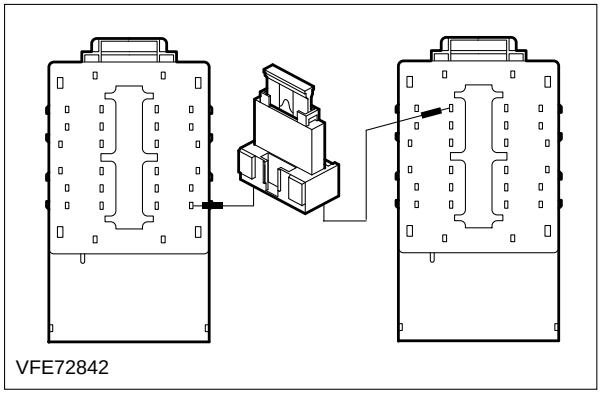
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	5 Measure the voltage between fuse F81 (10 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** RENEW the light switch. CHECK the operation of the system. → **No** GO to A25.
A25: CHECK THE VOLTAGE SUPPLY TO FUSE F81 (10 A) (CJB) FOR OPEN CIRCUIT	
NOTE: The fused jumper lead used in the previous test step is still connected to the light switch.	
	1 Ignition switch in position 0.
	2 Disconnect CJB from connector CBP02E.
	3 Ignition switch in position II.
	4 Measure the voltage between the CJB, connector CBP02E, pin 6: – Platform trucks, vehicles with an auxiliary relay (front fog lamps) (Scandinavia): circuit CLS48 (BU), wiring harness side and ground. – All other models: circuit CLS48A (BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW THE CJB. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the light switch and CJB using the wiring diagrams. CHECK the operation of the system.
A26: CHECK THE CJB	
NOTE: The rear fog lamps are still switched on.	
	1 Ignition switch in position 0.
	2 Disconnect CJB from connector CBP02B.
	3 Disconnect CJB from connector CBP02E.

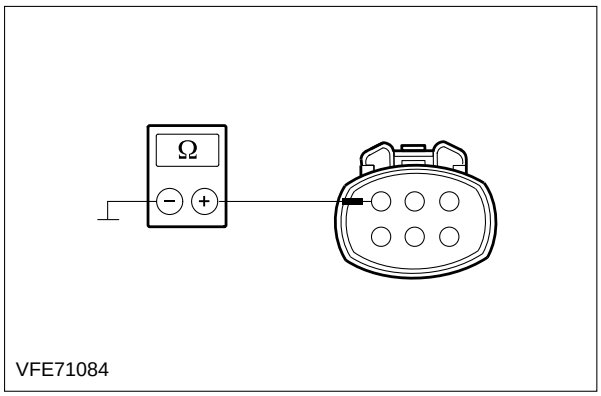
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72842	4 Connect a fused jumper wire (10 A) between the CJB, connector CBP02E, pin 8, circuit CLS48A (BU), wiring harness side and the CJB, connector CBP02B, pin 26: – Box van / Bus / Combi: circuit SBP81D (RD), wiring harness side. – Platform truck: circuit A_SBP81A (RD), wiring harness side.
	5 Ignition switch in position II.
	6 CHECK the rear fog lamps. • Do the rear fog lamps illuminate? → **Yes** RENEW THE CJB. CHECK the operation of the system. → **No** - Box van / Bus / Combi without a trailer socket: LOCATE and RECTIFY the break in the circuit between the CJB and soldered connection SPFR1 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Box van / Bus / Combi with a trailer socket: GO to A29. - Platform truck: GO to A28.
A27: CHECK THE CJB	
NOTE: The rear fog lamps are still switched on.	
	1 Ignition switch in position 0.
	2 Disconnect CJB from connector CBP02B.
	3 Disconnect CJB from connector CBP02E.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72842	4 Connect a fused jumper wire (10 A) between the CJB, connector CBP02E, pin 8: – Box van / Bus / Combi without a trailer socket: circuit CLS48A (BU), wiring harness side and the CJB, connector CBP02B, pin 26, circuit SBP81A (RD), wiring harness side. – Box van / Bus / Combi with a trailer socket: circuit CLS48A (BU), wiring harness side and the CJB, connector CBP02B, pin 26, circuit A_SBP81A (RD), wiring harness side. – Platform truck: circuit CLS48 (BU), wiring harness side and the CJB, connector CBP02B, pin 26, circuit SBP81D (RD), wiring harness side.
	5 Ignition switch in position II.
	6 CHECK the rear fog lamps. • Do the rear fog lamps illuminate? → **Yes** RENEW THE CJB. CHECK the operation of the system. → **No** - Box van / Bus / Combi without a trailer socket: LOCATE and RECTIFY the break in the circuit between the CJB and soldered connection S2BP81 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Box van / Bus / Combi with a trailer socket: GO to A29. - Platform truck: GO to A28.
A28: CHECK THE SHARED GROUND CONNECTION OF THE REAR FOG LAMPS FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand rear lamp assembly from connector CLS04.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the resistance between the left-hand rear lamp assembly, connector CLS04, pin 1: – Vehicles without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: circuit A_GD129M (BK/YE), wiring harness side and ground. – All other vehicles: circuit B_GD129U (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm measured? → **Yes** - Vehicles without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between the CJB and soldered connection SPFR1 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Vehicles with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between the CJB and soldered connection S4BP81 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Vehicles with a trailer socket: GO to A29. → **No** - Vehicles without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between soldered connection SGP_29_8 and ground connection GP29 with the aid of the wiring diagrams. CHECK the operation of the system. - All other vehicles: LOCATE and RECTIFY the break in the circuit between soldered connection S4D129G and ground connection GP29 with the aid of the wiring diagrams. CHECK the operation of the system.
A29: CHECK INLINE FUSE F83 (15 A).	
	1 Ignition switch in position 0.
	2 Disconnect Inline fuse F83 (15 A)..

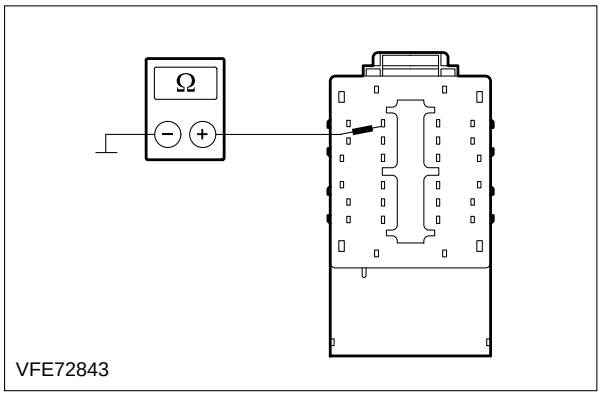
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK Inline fuse F83 (15 A).. • Is the fuse in order? → **Yes** GO to A30. → **No** RENEW the inline fuse F83 (15 A) and TEST the system for normal operation. If the fuse blows again, LOCATE and RECTIFY the short using the Wiring Diagrams. CHECK the operation of the system.
A30: CHECK THE VOLTAGE SUPPLY TO INLINE FUSE F83 (15 A) FOR OPEN CIRCUIT	
	1 Connect Inline fuse F83 (15 A)..
	2 Ignition switch in position II.
	3 Measure the voltage between inline fuse F83 (15 A) and ground. • Does meter display battery voltage? → **Yes** GO to A31. → **No** LOCATE AND RECTIFY the break in the voltage supply of inline fuse F83 (15 A) with the aid of the Wiring Diagrams. CHECK the operation of the system.
A31: CHECK THE VOLTAGE SUPPLY TO THE TRAILER CONTROL UNIT FOR OPEN CIRCUIT.	
	1 Ignition switch in position 0.
	2 Disconnect Trailer control unit from connector CAT18.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between the trailer control unit, connector CAT18, pin 1: – Box van / Bus / Combi: circuit SDF02A (BU/GN), wiring harness side and ground. – Platform truck: circuit SDF02A (RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A32. → **No** LOCATE and RECTIFY the break in the circuit between inline fuse F83 (15 A) and the trailer control unit with the aid of the Wiring Diagrams. CHECK the operation of the system.
A32: CHECK THE GROUND CONNECTION OF THE TRAILER CONTROL UNIT FOR OPEN CIRCUIT.	
	1 Ignition switch in position 0.
	2 Measure the resistance between the trailer control unit, connector CAT18, pin 5, circuit GD180F (BK), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to A33. → **No** LOCATE and RECTIFY the break in the circuit between the trailer control unit and soldered connection S4D180 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A33: CHECK THE CIRCUIT BETWEEN THE CJB AND THE TRAILER CONTROL UNIT FOR OPEN CIRCUIT	
	1 Ignition switch in position II.
	2 TURN ON the dipped beam headlamps.
	3 SWITCH ON the rear fog lamp.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between the trailer control unit, connector CAT18, pin 4: – Box van / Bus / Combi: circuit A_SBP81E (RD), wiring harness side and ground. – Platform truck: circuit A_SBP81F ((RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A35. → **No** GO to A34.
A34: CHECK THE CIRCUIT BETWEEN THE CJB AND THE TRAILER CONTROL UNIT FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect CJB from connector CBP02B.
	3 Measure the resistance between the CJB, connector CBP02B, pin 26: – Box van / Bus / Combi: circuit A_SBP81A (RD), wiring harness side and the trailer control unit, connector CAT18, pin 4 circuit A_SBP81E (RD), wiring harness side. – Platform truck: circuit A_SBP81D (RD), wiring harness side and the trailer control unit, connector CAT18, pin 4 circuit A_SBP81F (RD), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** RENEW THE CJB. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between CJB and the trailer control unit using the Wiring Diagrams. CHECK the operation of the system.
A35: EXCLUDE THE TRAILER CONTROL UNIT AS A POSSIBLE CAUSE OF THE FAULT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the trailer control unit, connector CAT18, pin 12, circuit B_SBP81A (RD), wiring harness side and ground. • Is a resistance of less than 10,000 Ohm registered? → **Yes** RENEW the trailer control unit. CHECK the operation of the system. → **No** - Box van / Bus / Combi: LOCATE and RECTIFY the break in the circuit between the trailer control unit and soldered connection S4BP81 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform truck: LOCATE and RECTIFY the break in the circuit between the trailer control unit and soldered connection S9BP81 with the aid of the Wiring Diagrams. CHECK the operation of the system.

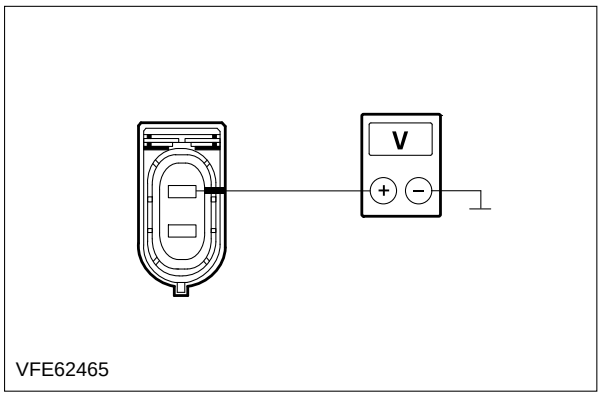
PINPOINT TEST U : INDIVIDUAL FOG LAMPS NOT WORKING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 Only on vehicles without an auxiliary relay (front fog lamps) (Scandinavia): TURN ON the dipped beam headlamps.
	3 Switch on the front fog lamps.
	4 TURN ON the rear fog lamps.

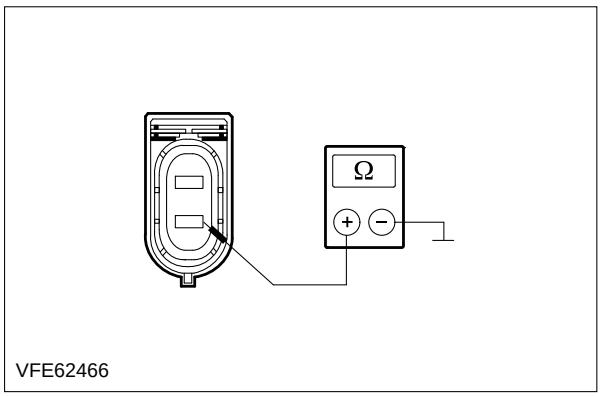
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	5 CHECK fog lamps. • Is one front fog lamp inoperative? → **Yes** - Left-hand front fog lamp inoperative, vehicles without auxiliary relay (front fog lamps) (Scandinavia):GO to B2. - Left-hand front fog lamp inoperative, vehicles with auxiliary relay (front fog lamps) (Scandinavia):GO to B4. - Right-hand front fog lamp inoperative, vehicles without auxiliary relay (front fog lamps) (Scandinavia): GO to B6. - Right-hand front fog lamp inoperative, vehicles with auxiliary relay (front fog lamps) (Scandinavia): GO to B8. → **No** - Left-hand rear fog lamp inoperative: GO to B10. - Right-hand rear fog lamp inoperative: GO to B12.
B2: CHECK THE VOLTAGE SUPPLY OF THE LEFT-HAND FRONT FOG LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand front fog lamp from connector CLF29.
	3 Ignition switch in position II.
	4 Switch on the front fog lamps.
	5 Measure the voltage between the left-hand front fog lamp, connector CLF29, pin 1, circuit SBP80D (RD/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B3. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection SE_1 and the front fog lamp with the aid of the wiring diagrams. CHECK the operation of the system.
B3: CHECK THE GROUND CONNECTION OF THE LEFT-HAND FRONT FOG LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

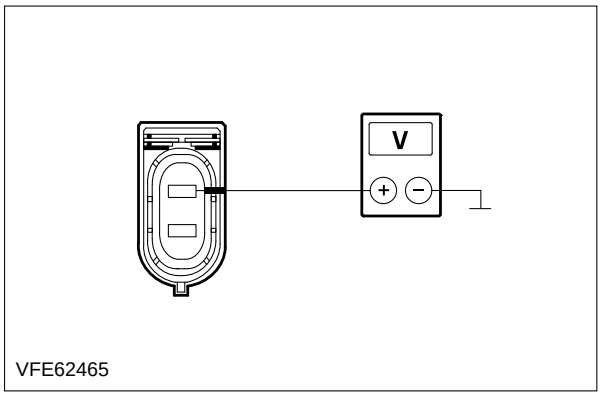
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the left-hand front fog lamp, connector CLF29, pin 2, circuit A_GD129V (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new fog lamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the front fog lamp and soldered connection SGP_29_1 with the aid of the Wiring Diagrams. CHECK the operation of the system.
B4: CHECK THE VOLTAGE SUPPLY OF THE LEFT-HAND FRONT FOG LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand front fog lamp from connector CLF29L.
	3 Ignition switch in position II.
	4 Switch on the front fog lamps.
	5 Box van / Bus / Combi: Measure the voltage between the left-hand front fog lamp, connector CLF29, pin 1, circuit SBP80B (VT/RD), wiring harness side and ground.
 VFE62465	6 Platform truck: Measure the voltage between the left-hand front fog lamp, connector CLF29L, pin 1, circuit SBP80B (RD/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B5. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2BP80 and the front fog lamp with the aid of the Wiring Diagrams. CHECK the operation of the system.
B5: CHECK THE GROUND CONNECTION OF THE LEFT-HAND FRONT FOG LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

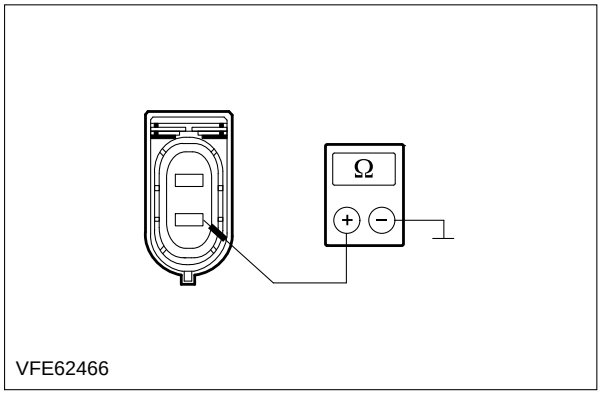
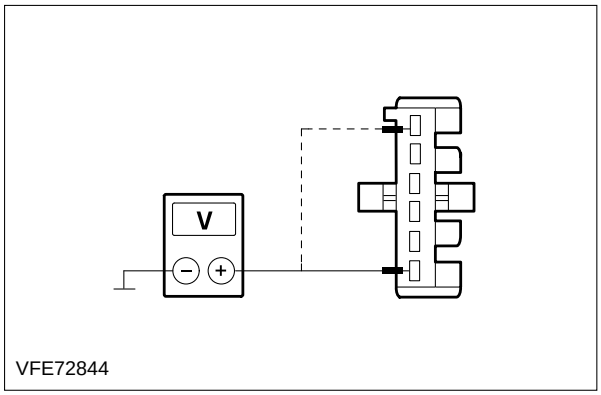
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Box van / Bus / Combi: Measure the resistance between the left-hand front fog lamp, connector CLF29, pin 2, circuit A_GD129F (BK/YE), wiring harness side and ground.
 VFE62466	3 Platform truck: Measure the resistance between the left-hand front fog lamp, connector CLF29L, pin 2, circuit A_GD129F (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new fog lamp. CHECK the operation of the system. → **No** - Box van / Bus / Combi: LOCATE and RECTIFY the break in the circuit between the front fog lamp and soldered connection S1D129A with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform truck: LOCATE and RECTIFY the break in the circuit between the front fog lamp and soldered connection S2D129A with the aid of the Wiring Diagrams. CHECK the operation of the system.
B6: CHECK THE VOLTAGE SUPPLY OF THE RIGHT-HAND FRONT FOG LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Front fog lamp from connector CLF28.
	3 Ignition switch in position II.
	4 Switch on the front fog lamps.
	5 Measure the voltage between the right-hand front fog lamp, connector CLF28, pin 1, circuit SBP80F (RD/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B7. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection SE_1 and the front fog lamp with the aid of the wiring diagrams. CHECK the operation of the system.

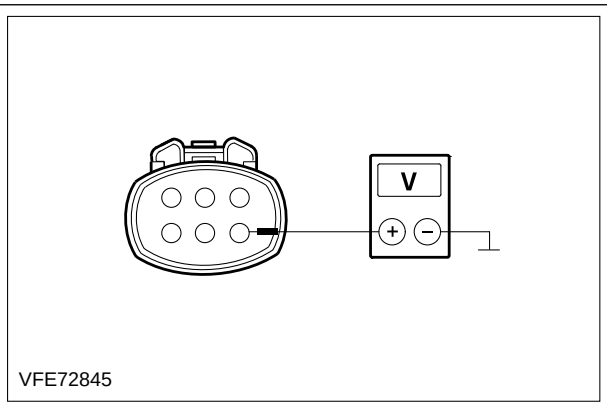
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B7: CHECK THE GROUND CONNECTION OF THE RIGHT-HAND FRONT FOG LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Measure the resistance between the right-hand front fog lamp, connector CLF28, pin 2, circuit A_GD131X (BK/RD), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new fog lamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the front fog lamp and soldered connection SGP_31_1 with the aid of the Wiring Diagrams. CHECK the operation of the system.
B8: CHECK THE VOLTAGE SUPPLY OF THE RIGHT-HAND FRONT FOG LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Front fog lamp from. – Box van / Bus / Combi: Connector CLF28 – Platform truck: Connector CLF29R
	3 Ignition switch in position II.
	4 Switch on the front fog lamps.
	5 Box van / Bus / Combi: Measure the voltage between the right-hand front fog lamp, connector CLF28, pin 1, circuit SBP80C (VT/RD), wiring harness side and ground.
 VFE62465	6 Platform truck: Measure the voltage between the right-hand front fog lamp, connector CLF29R, pin 1, circuit SBP80C (RD/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B9. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2BP80 and the front fog lamp with the aid of the Wiring Diagrams. CHECK the operation of the system.

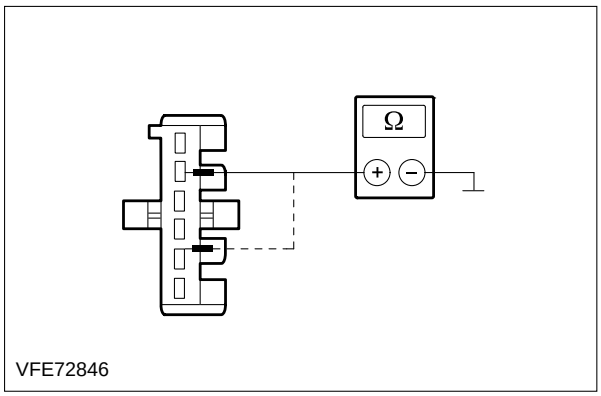
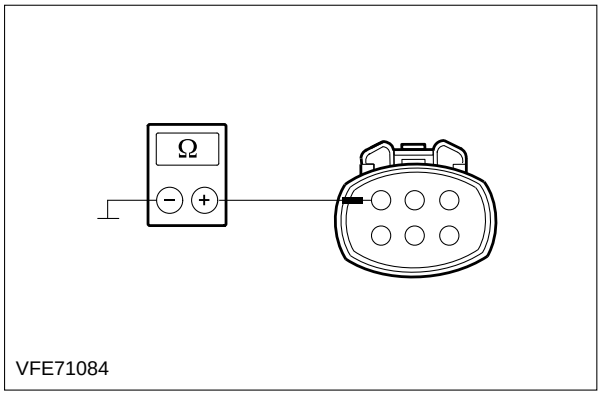
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B9: CHECK THE GROUND CONNECTION OF THE RIGHT-HAND FRONT FOG LAMP FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Box van / Bus / Combi: Measure the resistance between the right-hand front fog lamp, connector CLF28, pin 2, circuit A_GD131J (BK/RD), wiring harness side and ground.
 VFE62466	3 Platform truck: Measure the resistance between the right-hand front fog lamp, connector CLF29R, pin 2, circuit A_GD131J (BK/RD), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** INSTALL a new fog lamp. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the front fog lamp and soldered connection S1D131B with the aid of the Wiring Diagrams. CHECK the operation of the system.
B10: CHECK THE VOLTAGE SUPPLY TO THE LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect left-hand rear lamp assembly from. – Box van / Bus / Combi: Connector CLS22 – Platform truck: Connector CLS04
	3 Ignition switch in position II.
	4 TURN ON the rear fog lamps.
 VFE72844	5 Box van / Bus / Combi: Measure the voltage between the left-hand rear lamp assembly, connector CLS22: – Vehicles without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: pin 1, circuit SBP81A (RD), wiring harness side and ground. – Vehicles with trailer socket: pin 6, circuit B_SBP81E (RD), wiring harness side and ground. – Vehicles with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: pin 6, circuit SBP81D (RD), wiring harness side and ground.

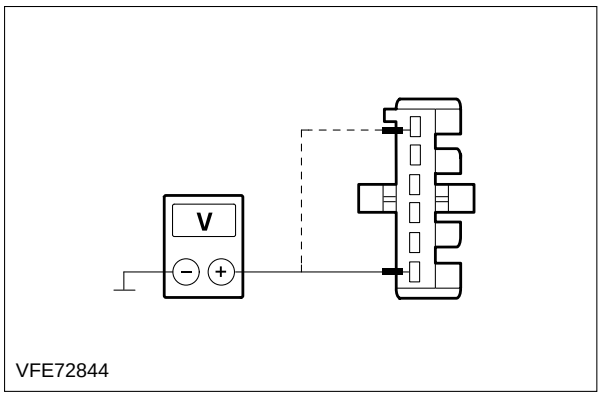
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72845	6 Platform truck: Measure the voltage between the left-hand rear lamp assembly, connector CLS04, pin 6: – Vehicles without an auxiliary relay (front fog lamps) (Scandinavia), with a trailer socket: circuit B_SBP81D (RD), wiring harness side and ground. – Vehicles with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: circuit SBP81L (RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B11. → **No** - Box van / Bus / Combi without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between soldered connection SPFR1 and the rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system. - Box van / Bus / Combi with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between soldered connection S2BP81 and the rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform trucks without an auxiliary relay (front fog lamps) (Scandinavia), with a trailer socket: LOCATE and RECTIFY the break in the circuit between soldered connection S9BP81 and the rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system. - All other vehicles: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP81 and the rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system.
B11: CHECK THE GROUND CONNECTION AT THE LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

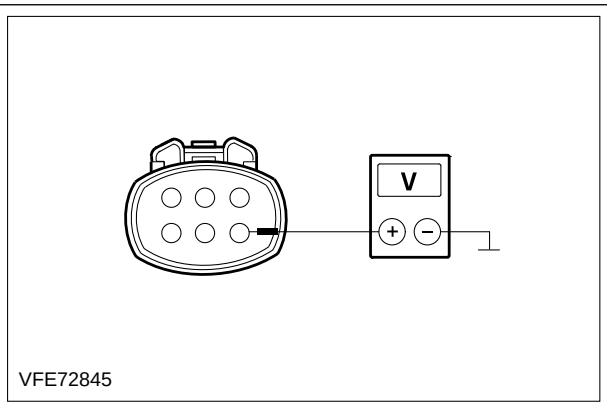
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72846	2 Box van / Bus / Combi: Measure the resistance between the left-hand rear lamp assembly, connector CLS22: – Vehicles without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: pin 2, circuit B_GD149F (BK/RD), wiring harness side and ground. – Vehicles with trailer socket: pin 5, circuit A_GD149R (BK/GY), wiring harness side and ground. – Vehicles with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: pin 5, circuit B_GD149B (BK/GY), wiring harness side and ground.
 VFE71084	3 Platform truck: Measure the resistance between the left-hand rear lamp assembly, connector CLS04, pin 1, circuit B_GD129U (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** RENEW the rear lamp assembly. CHECK the operation of the system. → **No** - Box van / Bus / Combi without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and soldered connection SGP_49_4 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Box van / Bus / Combi with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and soldered connection S4D149H with the aid of the Wiring Diagrams. CHECK the operation of the system. - Box van / Bus / Combi with a trailer socket: LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and soldered connection S4D149A with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform truck: LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and soldered connection S4D129G with the aid of the Wiring Diagrams. CHECK the operation of the system.

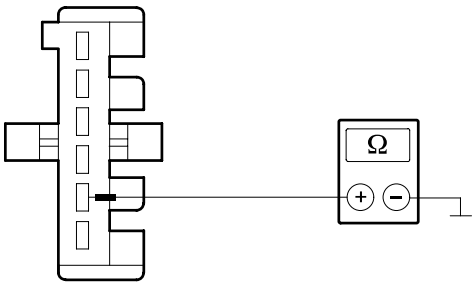
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B12: THE VARIABLE SPEED INPUT GEAR IS ADJUSTED TO THE LARGEST POSSIBLE LOAD-BEARING DIAMETER.	
	1 Ignition switch in position 0.
	2 Disconnect Right-hand rear lamp cluster from connector CLS26.
	3 Ignition switch in position II.
	4 TURN ON the rear fog lamps.
	5 Box van / Bus / Combi: Measure the voltage between the right-hand rear lamp assembly, connector CLS26: – Vehicles without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: pin 1, circuit SBP81C (RD), wiring harness side and ground. – Vehicles with trailer socket: pin 6, circuit B_SBP81F (RD), wiring harness side and ground. – Vehicles with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: pin 6, circuit SBP81E (RD), wiring harness side and ground.

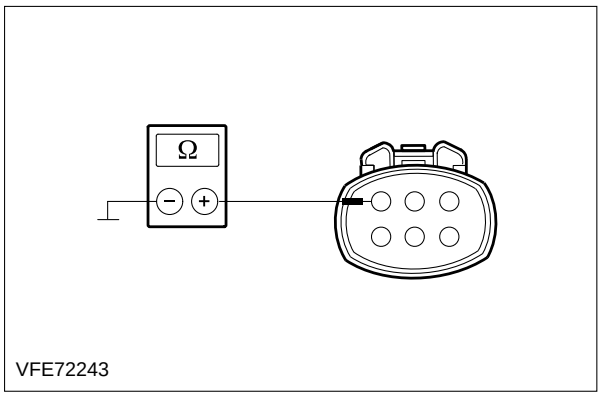
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72845	6 Platform truck: Measure the voltage between the right-hand rear lamp assembly, connector CLS26: – Vehicles with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: pin 6, circuit SBP81K (RD), wiring harness side and ground. – Vehicles without an auxiliary relay (front fog lamps) (Scandinavia), with a trailer socket: pin 6, circuit B_SBP81E (RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B13. → **No** - Box van / Bus / Combi without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between soldered connection SPFR1 and the rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system. - Box van / Bus / Combi with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between soldered connection S2BP81 and the rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform trucks without an auxiliary relay (front fog lamps) (Scandinavia), with a trailer socket: LOCATE and RECTIFY the break in the circuit between soldered connection S9BP81 and the rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system. - All other vehicles: LOCATE and RECTIFY the break in the circuit between soldered connection S4BP81 and the rear lamp assembly with the aid of the Wiring Diagrams. CHECK the operation of the system.
B13: CHECK THE GROUND CONNECTION OF THE RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Box van / Bus / Combi: Measure the resistance between the right-hand rear lamp assembly, connector CLS26: – Vehicles without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: pin 1, circuit B_GD151R (BK/GN), wiring harness side and ground.
 E0018115	3 Box van / Bus / Combi: Measure the resistance between the right-hand rear lamp assembly, connector CLS26: – Vehicles without an auxiliary relay (front fog lamps) (Scandinavia), with a trailer socket: pin 5, circuit A_GD151AA (BK/GN), wiring harness side and ground. – Vehicles with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: pin 5, circuit A_GD151K ((BK/GN), wiring harness side and ground.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Platform truck: Measure the resistance between the right-hand rear lamp assembly, connector CLS26, pin 1, circuit B_GD129V (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** RENEW the rear lamp assembly. CHECK the operation of the system. → **No** - Box van / Bus / Combi without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and soldered connection SGP_51_2 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Box van / Bus / Combi with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and ground connection GP51 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Box van / Bus / Combi with a trailer socket: LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and soldered connection S4D151A with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform truck: LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and soldered connection S4D129G with the aid of the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST V : REAR FOG LAMPS OR FRONT FOG LAMPS ARE PERMANENTLY LIT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F80 (10 A) (CJB).
	3 Disconnect Fuse F81 (10 A) (CJB).
	4 Ignition switch in position II.
	5 CHECK the front fog lamps.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	6 CHECK the rear fog lamps. • Are the front fog lamps lit up continuously? → **Yes** - Box van / Bus / Combi without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the break in the circuit between the rear lamp assembly and soldered connection SE_1 with the aid of the Wiring Diagrams. CHECK the operation of the system. - All other vehicles: LOCATE and RECTIFY the short to battery voltage in the circuits connected to soldered connection S2BP80 using the Wiring Diagrams. CHECK the operation of the system. If the concern persists RENEW the CJB. CHECK the operation of the system. → **No** - Rear fog lamps permanently lit: Box van / Bus / Combi without an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the short to battery voltage in the circuits connected to soldered connection SPFR_1 with the aid of the Wiring Diagrams. CHECK the operation of the system. If the concern persists, RENEW the CJB. CHECK the operation of the system. - Rear fog lamps permanently lit: Box van / Bus / Combi with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the short to battery voltage in the circuits connected to soldered connection S2BP81 with the aid of the Wiring Diagrams. CHECK the operation of the system. If the concern persists, RENEW the CJB. CHECK the operation of the system. - Rear fog lamps permanently lit: Platform trucks with an auxiliary relay (front fog lamps) (Scandinavia), without a trailer socket: LOCATE and RECTIFY the short to battery voltage in the circuits connected to soldered connection S4BP81 with the aid of the Wiring Diagrams. CHECK the operation of the system. If the concern persists, RENEW the CJB. CHECK the operation of the system. - Rear fog lamps permanently lit, vehicles with trailer socket: GO to C2. - No malfunction detected: GO to C4.
C2: NARROW DOWN THE CONDITIONS UNDER WHICH THE FAULT OCCURS	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Trailer control unit from connector CAT18.
	3 Ignition switch in position II. • Are the rear fog lamps permanently lit? → **Yes** - Box van / Bus / Combi: LOCATE and RECTIFY the short to battery voltage in the circuits connected to soldered connection S4BP81 with the aid of the Wiring Diagrams. CHECK the operation of the system. - Platform truck: LOCATE and RECTIFY the short to battery voltage in the circuits connected to soldered connection S9BP81 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to C3.
C3: RULE OUT TRAILER CONTROL UNIT AS CAUSE FOR A SHORT TO BATTERY VOLTAGE	
	1 Measure the voltage between the trailer control unit, connector CAT18, pin 4: – Box van / Bus / Combi: circuit A_SBP81E (RD), wiring harness side and ground. – Platform truck: circuit A_SBP81F ((RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit between the CJB and the trailer control unit with the aid of the Wiring Diagrams. CHECK the operation of the system. If the concern persists RENEW the CJB. CHECK the operation of the system. → **No** RENEW the trailer control unit. CHECK the operation of the system.
C4: ELIMINATE THE LIGHT SWITCH AS A POSSIBLE CAUSE FOR THE SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Connect Fuse F80 (10 A) (CJB).
	3 Connect Fuse F81 (10 A) (CJB).
	4 Disconnect Light switch from connector CLF23.
	5 Ignition switch in position II.
	6 CHECK the front fog lamps.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	7 CHECK the rear fog lamps. • Are the front or rear fog lamps lit up continuously? → **Yes** - Front fog lamps permanently lit: GO to C5. - Rear fog lamps permanently lit: GO to C6. → **No** RENEW the light switch. CHECK the operation of the system.
C5: ELIMINATE THE CENTRAL JUNCTION BOX (CJB) AS CAUSE FOR THE SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02E.
	3 Ignition switch in position II.
	4 CHECK the front fog lamps. • Are the front fog lamps lit up continuously? → **Yes** INSTALL a new CJB. CHECK the operation of the system. → **No** LOCATE and RECTIFY the short to battery voltage in the circuits between the light switch and the central junction box (CJB) with the aid of the Wiring Diagrams. CHECK the operation of the system.
C6: ELIMINATE THE CENTRAL JUNCTION BOX (CJB) AS CAUSE FOR THE SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02E.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

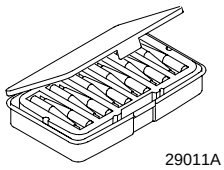
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 CHECK the rear fog lamps. • Are the rear fog lamps permanently lit? → **Yes** RENEW THE CJB. CHECK the operation of the system. → **No** LOCATE and RECTIFY the short to battery voltage in the circuit between the light switch and the central junction box (CJB) with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

Reversing Lamps

Refer to Wiring Diagrams Section 417-01,for schematic and connector information.

Special Tool(s)

 29011A	Set of adapter plugs for test probes 29-011A

Inspection and Testing

NOTE: The generic electronic module (GEM) forms part of the central junction box (CJB).

NOTE: If the generic electronic module (GEM) is changed, the new one must be reinitialized. For this purpose, the vehicle-specific data is read out of the module to be replaced using WDS and is transferred to the new module. REFER to:

Communications Network (418-00, Diagnosis and Testing),
Generic Electronic Module (GEM) (419-10, Diagnosis and Testing).

NOTE: Before reading out the vehicle-specific data, remake all the electrical connections to the module to be removed, so that communication between the module and WDS is ensured.

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical or mechanical damage.

Visual Inspection Chart

Electrical
– Fuse(s) – Switch – Electrical connector(s) – Wiring loom

3. Resolve any obvious causes or concerns found during the visual inspection before carrying out any further tests.
4. If the cause of the concern cannot be found by visual inspection, continue with the symptom chart.

Symptom chart

Symptom chart

Symptom	Possible Sources	Action
• Reversing lamps do not operate	• Fuse(s) • Circuit(s) • Reversing lamp switch • Central junction box (CJB)	• GO to Pinpoint Test A.
• One reversing lamp is inoperative	• Fuse(s) • Circuit(s) • Rear lamp assembly	• GO to Pinpoint Test B.
• The reversing lamps are on continuously	• Circuit(s) • Reversing lamp switch • Parking aid module • Powertrain control module (PCM) • Rear lamp assembly • Trailer socket	• GO to Pinpoint Test C.

Pinpoint test

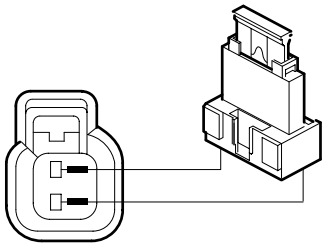
NOTE: Use a digital multimeter for all electrical measurements.

DIAGNOSIS AND TESTING

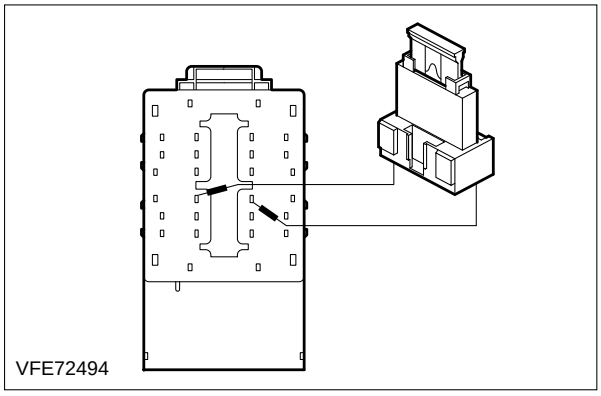
PINPOINT TEST W : REVERSING LAMPS DO NOT OPERATE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK FUSE F33 (10 A) (EJB)	
	1 Ignition switch in position 0.
	2 Disconnect fuse F33 (10 A) (EJB).
	3 CHECK fuse F33 (10 A) (EJB). • Is the fuse OK? → **Yes** GO to A2. → **No** RENEW fuse F33 (10 A) (EJB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK the operation of the system.
A2: CHECK THE VOLTAGE SUPPLY TO FUSE F33 (10A) (EJB) FOR OPEN CIRCUIT	
	1 Connect fuse F33 (10 A) (EJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F33 (10A) (EJB) and ground. • Does meter display battery voltage? → **Yes** GO to A3. → **No** RENEW THE EJB. CHECK the operation of the system.
A3: CHECK THE POWER SUPPLY OF THE REVERSING LAMP SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Reversing lamp switch from CET47.
	3 Ignition switch in position II.

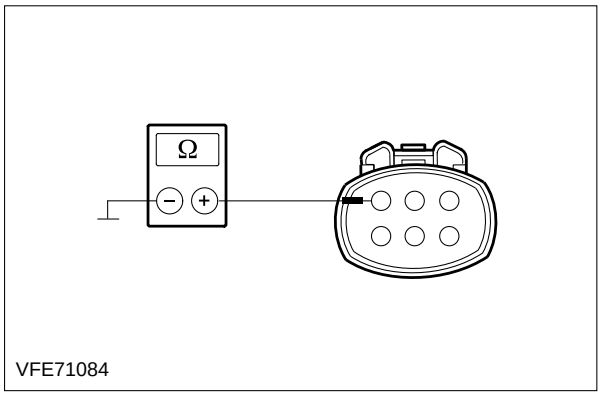
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0016137	4 Measure the voltage between reversing lamp switch, connector CET47, pin 2: – Box van, bus, combi: circuit CBB33B (WH/BN), wiring harness side and ground. – Chassis cab vehicle: circuit CBB33B (GY/BK), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A4. → **No** LOCATE and RECTIFY the break in the circuits between fuse F33 (10 A) (EJB) and the reversing lamp switch using the wiring diagrams. CHECK the operation of the system.
A4: RULE OUT THE REVERSING LAMP SWITCH AS CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
 VFE0022225	2 Connect a fused (10 A) jumper lead at reversing lamp switch, connector CET47, between pin 1, circuit ZA113A (OG/GY), wiring harness side and pin 2: – Box van, bus, combi: circuit CBB33B (WH/BN), wiring harness side. – Chassis cab vehicle: circuit CBB33B (GY/BK), wiring harness side.
	3 Ignition switch in position II.
	4 CHECK the reversing lamps. • Do the reversing lamps illuminate? → **Yes** RENEW the reversing lamp switch. CHECK the operation of the system. → **No** GO to A5.
A5: CHECK CIRCUIT BETWEEN REVERSING LAMP SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR OPEN CIRCUIT	
NOTE: The fused jumper lead used in the previous step is still connected at the reversing lamp switch.	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Central junction box (CJB) from connector CBP02B.
	3 Ignition switch in position II.
	4 Measure voltage between central junction box (CJB), connector CBP02B, pin 14, circuit ZA113C (OG/GY), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A6. → **No** LOCATE and RECTIFY break in circuits between reversing lamp switch and central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system.
A6: CHECK THE CENTRAL JUNCTION BOX (CJB)	
NOTE: The fused jumper wire is still connected at the reversing lamp switch.	
	1 Ignition switch in position 0.
 VFE72494	2 Connect a fused (10 A) jumper wire at the central junction box (CJB), connector CBP02B, between pin 14, circuit ZA113C (OG/GY) and pin 15, circuit CLS10A (GN/BN), wiring harness side.
	3 Ignition switch in position II.
	4 CHECK the reversing lamps. • Do the reversing lamps illuminate? → **Yes** INSTALL a new CJB. CHECK the operation of the system. → **No** - Box van, bus, combi: LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and soldered connection S2LS10 using the Wiring Diagrams. CHECK the operation of the system. - Chassis cab vehicle: GO to A7.

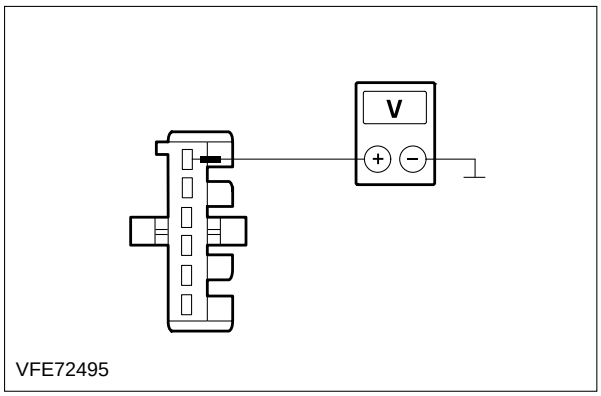
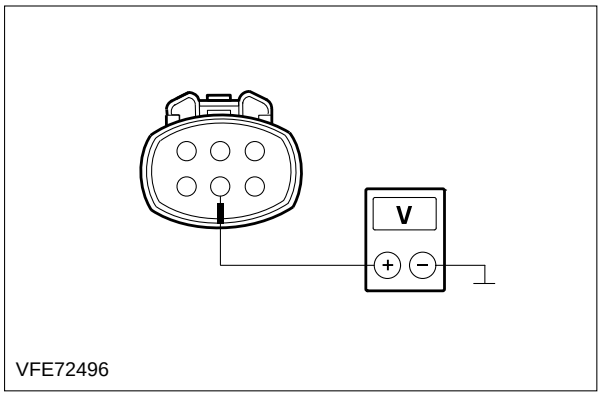
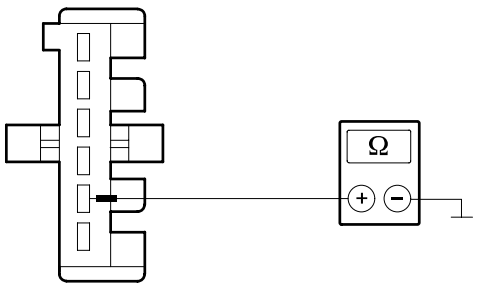
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A7: CHECK COMMON GROUND SUPPLY TO THE REAR LAMP ASSEMBLIES FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand rear lamp assembly from connector CLS04.
	3 Measure the resistance between the left-hand rear lamp assembly, connector CLS04, pin 1, circuit B_GD129U (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and soldered connection S4LS10 using the Wiring Diagrams. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S4D129G and ground connection GP29 with the aid of the Wiring Diagrams. CHECK the operation of the system.

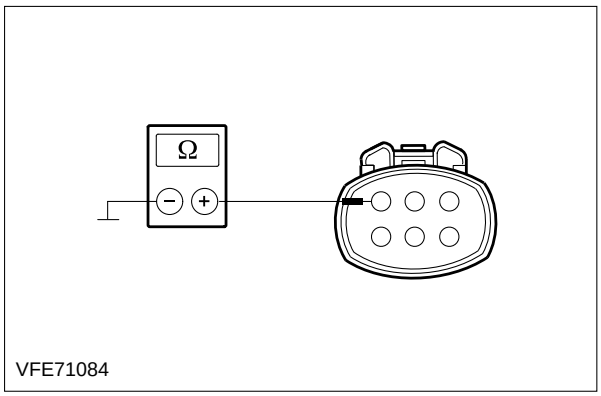
PINPOINT TEST X : ONE REVERSING LAMP IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 ENGAGE the reverse gear.
	3 CHECK the reversing lamps. • Is the left-hand reversing lamp inoperative? → **Yes** GO to B2. → **No** GO to B4.
B2: CHECK THE VOLTAGE SUPPLY TO THE LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand rear lamp assembly. – Box van, bus, combi: from connector CLS22 – Chassis cab vehicle: from connector CLS04
	3 Ignition switch in position II.
	4 ENGAGE the reverse gear.

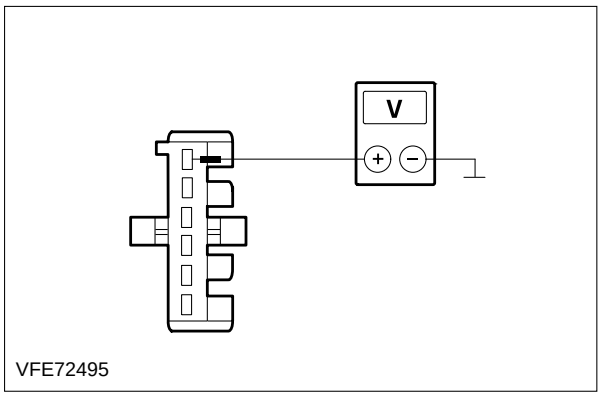
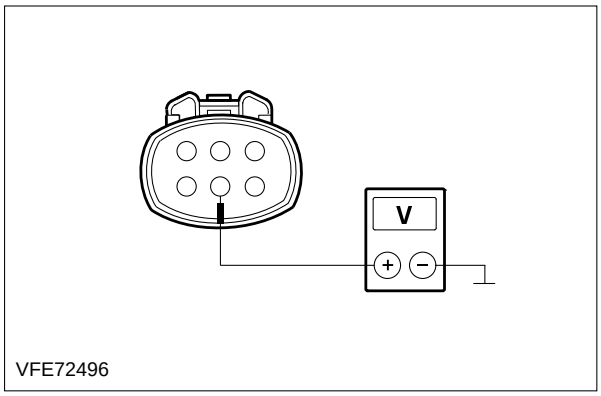
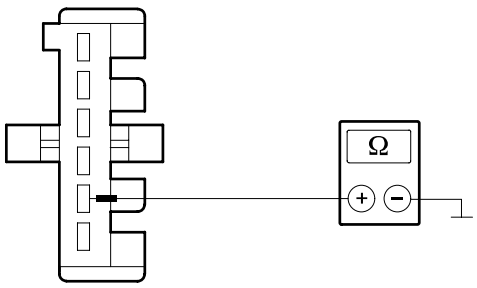
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72495	5 Box van, bus, combi: Measure voltage between left-hand rear lamp assembly, connector CLS22, between pin 1: – Vehicles without tailgate: circuit CLS10F (GN/BN), wiring harness side and ground. – Vehicles with tailgate or with tow bar socket: circuit CLS10G (GN/BN), wiring harness side and ground.
 VFE72496	6 Chassis cab vehicle: Measure the voltage between left-hand rear lamp assembly, connector CLS04, pin 5, circuit CLS10J (GN/BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B3. → **No** - Box van, bus, combi: LOCATE and RECTIFY the break in the circuit between soldered connection S2LS10 and the left-hand rear lamp assembly using the wiring diagrams. CHECK the operation of the system. - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between soldered connection S4LS10 and the left-hand rear lamp assembly using the wiring diagrams. CHECK the operation of the system.
B3: CHECK THE GROUND CONNECTION TO THE LEFT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 E0018115	2 Box van, bus, combi: Measure resistance between left-hand rear lamp assembly, connector CLS22, between pin 5: – Vehicles without tailgate: circuit B_GD149B (BK/GY), wiring harness side and ground. – Vehicles with tailgate or with tow bar socket: circuit A_GD149R (BK/GY), wiring harness side and ground.

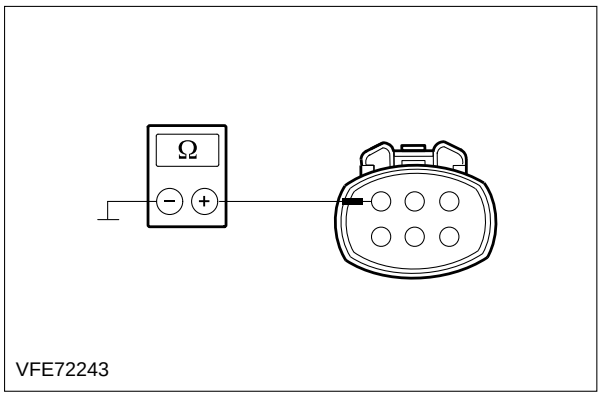
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Chassis cab vehicle: Measure the resistance between the left-hand rear lamp assembly, connector CLS04, between pin 1, circuit B_GD129U (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary RENEW the left-hand rear lamp assembly. CHECK the operation of the system. → **No** - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between left-hand rear lamp assembly and soldered connection S4D129G using the Wiring Diagrams. CHECK the operation of the system. - Box van, bus, combi vehicles with tailgate or with tow bar socket: LOCATE and RECTIFY the break in the circuit between left-hand rear lamp assembly and soldered connection S4D149A using the Wiring Diagrams. CHECK the operation of the system. - Box van, bus, combi, without tailgate or without tow bar socket: LOCATE and RECTIFY the break in the circuit between left-hand rear lamp assembly and soldered connection S4D149H using the Wiring Diagrams. CHECK the operation of the system.
B4: CHECK THE VOLTAGE SUPPLY TO THE RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Right-hand rear lamp assembly from connector CLS26.
	3 Ignition switch in position II.
	4 ENGAGE the reverse gear.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE72495	5 Box van, bus, combi: Measure voltage between right-hand rear lamp assembly, connector CLS26, between pin 1: – Vehicles without tailgate: circuit CLS10E (GN/BN), wiring harness side and ground. – Vehicles with tailgate or with tow bar socket: circuit CLS10J (GN/BN), wiring harness side and ground.
 VFE72496	6 Chassis cab vehicle: Measure the voltage between right-hand rear lamp assembly, connector CLS26, pin 5, circuit CLS10H (GN/BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B5. → **No** - Box van, bus, combi: LOCATE and RECTIFY the break in the circuit between soldered connection S2LS10 and the right-hand rear lamp assembly using the wiring diagrams. CHECK the operation of the system. - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between soldered connection S4LS10 and the right-hand rear lamp assembly using the wiring diagrams. CHECK the operation of the system.
B5: CHECK THE GROUND CONNECTION TO THE RIGHT-HAND REAR LAMP ASSEMBLY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 E0018115	2 Box van, bus, combi: Measure resistance between right-hand rear lamp assembly, connector CLS26, between pin 5: – Vehicles without tailgate: circuit A_GD151K (BK/GN), wiring harness side and ground. – Vehicles with tailgate or with tow bar socket: circuit A_GD151AA (BK/GN), wiring harness side and ground.

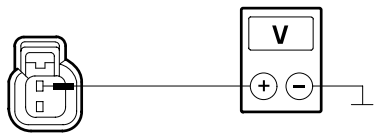
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Chassis cab vehicle: Measure the resistance between the right-hand rear lamp assembly, connector CLS26, between pin 1, circuit B_GD129V (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohms registered? → **Yes** CHECK and if necessary RENEW the right-hand rear lamp assembly. CHECK the operation of the system. → **No** - Box van, bus, combi, without tailgate or without tow bar socket: LOCATE and RECTIFY the break in the circuit between right-hand rear lamp assembly and soldered connection S4D149H using the Wiring Diagrams. CHECK the operation of the system. - Box van, bus, combi vehicles with tailgate or with tow bar socket: LOCATE and RECTIFY the break in the circuit between right-hand rear lamp assembly and soldered connection S4D149A using the Wiring Diagrams. CHECK the operation of the system. - Chassis cab vehicle: LOCATE and RECTIFY the break in the circuit between right-hand rear lamp assembly and soldered connection S4D129G using the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST Y : THE REVERSING LAMPS ARE ON CONTINUOUSLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: RULE OUT THE REVERSING LAMP SWITCH AS CAUSE OF THE FAULT	
	1 Ignition switch in position 0.
	2 Disconnect Reversing lamp switch from connector CET47.
	3 Ignition switch in position II.
	4 CHECK the reversing lamps. • Are the reversing lamps on continuously? → **Yes** GO to C2. → **No** RENEW the reversing lamp switch. CHECK the operation of the system.

DIAGNOSIS AND TESTING

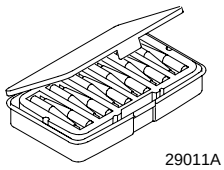
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C2: NARROW DOWN THE CONDITIONS UNDER WHICH THE FAULT OCCURS	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02B.
	3 Ignition switch in position II.
	4 CHECK the reversing lamps. • Are the reversing lamps on continuously? → **Yes** LOCATE and RECTIFY short to battery voltage in the circuits connected to the central junction box (CJB), connector CBP02B, pin 15 with the aid of the wiring diagrams. CHECK the operation of the system. - On vehicles with trailer socket: CHECK and if necessary RENEW the trailer socket. CHECK the operation of the system. → **No** GO to C3.
C3: ELIMINATE THE CENTRAL JUNCTION BOX (CJB) AS CAUSE FOR THE SHORT TO BATTERY VOLTAGE	
 VFE0016230	1 Measure voltage between reversing lamp switch, connector CET47, pin 1, circuit ZA113A (OG/GY), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY short to battery voltage in circuit between reversing lamp switch and central junction box (CJB) using the Wiring Diagrams. CHECK the operation of the system. → **No** INSTALL a new CJB. CHECK the operation of the system.

DIAGNOSIS AND TESTING

Trailer Lamps

Refer to Wiring Diagrams Section 417-01,for schematic and connector information.

Special Tool(s)

 29011A	Set of adapter plugs for test probes 29-011A

Inspection and Testing

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical damage.

Visual Inspection Chart

Electrical
– Fuse(s) – Trailer socket – Electrical connector(s) – Wiring loom

3. Resolve any obvious causes or concerns found during the visual inspection before carrying out any further tests.
4. If the cause of the concern cannot be found by visual inspection, continue with the symptom chart.

Symptom chart

Symptom chart

Symptom	Possible Sources	Action
• The trailer lamps are inoperative	• Fuse(s) • Engine Junction Box (EJB) • Circuit(s) in the vehicle. • Circuit(s) in the trailer. • Trailer socket	• GO to Pinpoint Test A.
• The individual trailer lamp is inoperative	• Circuit(s) in the vehicle. • Circuit(s) in the trailer. • Trailer control unit • Trailer socket	• GO to Pinpoint Test B.
• Trailer lamps illuminate continuously	• Circuit(s) in the vehicle. • Circuit(s) in the trailer. • Trailer control unit • Trailer socket	• GO to Pinpoint Test C.

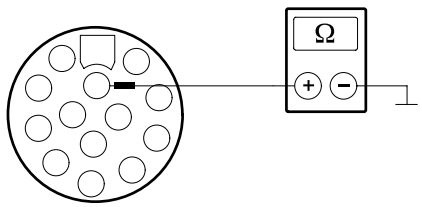
Pinpoint Test

NOTE: Use a digital multimeter for all electrical measurements.

PINPOINT TEST Z : THE TRAILER LAMPS ARE INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: DETERMINE THE FAULTY LAMPS ON THE TRAILER	
	1 Ignition switch in position II.
	2 SWITCH ON in turn the side lights, stop lamps, rear fog lamps and left- and right-hand turn signal lamps. Engage REVERSE GEAR.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Engage REVERSE GEAR.
	4 CHECK the trailer lamps. • Are all trailer lamps inoperative? → **Yes** GO to A2. → **No** - Only fog lamp and turn signal lamps on trailer are inoperative: GO to A3. - The trailer stop lamps are inoperative: GO to A9. - Trailer backup lamps inoperative: GO to A11. - The trailer fog lamp is inoperative: GO to A13. - The trailer side lamp is inoperative (on one side): GO to Pinpoint Test B. - The trailer turn signal is inoperative (on one side): GO to Pinpoint Test B.
A2: CHECK GROUND CONNECTION OF TRAILER SOCKET FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 VFE0037220	2 Measure the resistance between the trailer socket, connector CAT23, pin 3: – Box van / Bus / Combi: circuit C_GD149D (BK/GY) and ground. – Platform truck: circuit B_GD119C (BK/BU) and ground. • Is the resistance less than 2 ohms? → **Yes** Continue troubleshooting on the trailer. CHECK system operates correctly → **No** - Box van / Bus / Combi: LOCATE and RECTIFY the break in the circuit between the trailer socket and ground connection G49 using the Wiring Diagrams. CHECK system operates correctly - Platform truck: LOCATE and RECTIFY the break in the circuit between the trailer socket and ground connection G19 using the Wiring Diagrams. CHECK system operates correctly
A3: CHECK FUSE F12 (30 A) (EJB).	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F12 (30 A) (EJB)..

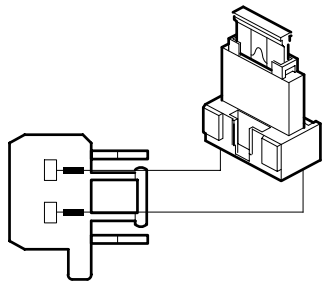
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK Fuse F12 (30 A) (EJB).. • Is the fuse OK? → **Yes** GO to A4. → **No** RENEW fuse F12 (30 A) (EJB). CHECK system operates correctly If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK system operates correctly
A4: CHECK THE VOLTAGE SUPPLY TO FUSE F12 (30 A) (EJB)	
	1 Connect Fuse F12 (30 A) (EJB)..
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F12 (30 A) (EJB) and ground. • Does the meter display battery voltage? → **Yes** GO to A5. → **No** CHECK the Engine Junction Box (EJB) and RENEW it if required. CHECK system operates correctly
A5: CHECK INLINE FUSE F83 (15 A)	
	1 Ignition switch in position 0.
	2 Disconnect Inline fuse F83 (15 A).
	3 CHECK Inline fuse F83 (15 A). • Is the inline fuse OK.? → **Yes** GO to A6. → **No** RENEW inline fuse F83 (15 A). CHECK system operates correctly If the fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK system operates correctly
A6: CHECK POWER SUPPLY TO INLINE FUSE F83 (15 A)	
	1 Connect Inline fuse F83 (15 A).
	2 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between inline fuse F83 (15A) and ground. • Does the meter display battery voltage? → **Yes** GO to A7. → **No** LOCATE and RECTIFY the break in the circuit between fuse F12 (30 A) (EJB) and inline fuse F83 (15 A) using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW Engine Junction Box (EJB). CHECK system operates correctly
A7: CHECK THE VOLTAGE SUPPLY TO THE TRAILER CONTROL UNIT FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Trailer control unit from connector CAT18.
	3 Ignition switch in position II.
	4 Measure the voltage between the trailer control unit, connector CAT18, pin 1: – Box van / Bus / Combi: circuit SDF02A (RD), wiring harness side and ground. – Platform truck: circuit SDF02A (BU/GN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A8. → **No** LOCATE and RECTIFY the break in the circuit between inline fuse F83 (15 A) and the trailer control unit using the Wiring Diagrams. CHECK system operates correctly
A8: CHECK THE GROUND CONNECTION OF THE TRAILER CONTROL UNIT FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the trailer control unit, connector CAT18, pin 5: – Box van / Bus / Combi: circuit C_GD149F (BK/GY), wiring harness side and ground. – Platform truck: connector CAT18, pin 1, circuit B_GD119F (BK/BU), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the trailer control unit. CHECK system operates correctly → **No** - Box van / Bus / Combi: LOCATE and RECTIFY the break in the circuit between the trailer control unit and soldered connection S9D149 using the Wiring Diagrams. CHECK system operates correctly - Platform truck: LOCATE and RECTIFY the break in the circuit between the trailer control unit and soldered connection S2D119 using the Wiring Diagrams. CHECK system operates correctly
A9: CHECK THE VEHICLE STOP LAMPS	
	1 Ignition switch in position 0.
	2 Disconnect Stop lamp switch from connector CCB08.
 VFE0038423	3 Connect a fused jumper wire (15 A) to the stop lamp switch, connector CCB08, pin 1, circuit SBP65A (RD) and pin 2, circuit CCB08A (VT/WH), wiring harness side.
	4 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	5 CHECK the stop lamps at the vehicle. • Do the stop lamps at the vehicle illuminate? → **Yes** GO to A10. → **No** REFER to:Stoplamps (417-01 Exterior Lighting, Diagnosis and Testing).
A10: CHECK VOLTAGE AT THE TRAILER SOCKET (STOP LAMPS)	
NOTE: The fused jumper lead used in the previous step is still connected to the stop lamp switch.	
	1 Ignition switch in position 0.
	2 Connect Trailer socket tester to connector CAT23.
	3 Ignition switch in position II.
	4 CHECK trailer socket tester. • Is voltage supply measured at the trailer socket, pin 6 (stop lamps)? → **Yes** Continue troubleshooting on the trailer. CHECK system operates correctly → **No** - Box van / Bus / Combi: LOCATE and RECTIFY the break in the circuit(s) between soldered connection S4CB08 and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly - Platform truck: LOCATE and RECTIFY the break in the circuit between soldered connection S1CB08T and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly
A11: CHECK VEHICLE REVERSING LAMPS	
	1 Ignition switch in position II.
	2 Engage REVERSE GEAR.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK the reversing lamps at the vehicle. • Are the reversing lamps at the vehicle illuminated? → **Yes** GO to A12. → **No** REFER to:Reversing Lamps (417-01 Exterior Lighting, Diagnosis and Testing).
A12: CHECK THE VOLTAGE AT THE TRAILER SOCKET (BACKUP LAMPS)	
	1 Ignition switch in position 0.
	2 Connect Trailer socket tester to connector CAT23.
	3 Ignition switch in position II.
	4 Engage REVERSE GEAR.
	5 CHECK trailer socket tester. • Is voltage supply displayed at the trailer socket, pin 8 (backup lamps)? → **Yes** Continue troubleshooting on the trailer. CHECK system operates correctly → **No** - Box van / Bus / Combi: LOCATE and RECTIFY the break in the circuit(s) between soldered connection S4LS10 and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly - Platform truck: LOCATE and RECTIFY the break in the circuit(s) between soldered connection S1LS10T and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly
A13: CHECK THE FOG LAMPS ON THE VEHICLE	
NOTE: Ensure that no adapters are connected to the trailer socket.	
	1 Ignition switch in position II.
	2 SWITCH ON the rear fog lamp.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK the rear fog lamp on the vehicle. • Does the rear foglamp on the vehicle illuminate? → **Yes** GO to A14. → **No** REFER to:Fog Lamps (417-01 Exterior Lighting, Diagnosis and Testing).
A14: CHECK THE VOLTAGE AT THE TRAILER SOCKET (REAR FOG LAMP)	
	1 SWITCH OFF the rear fog lamp.
	2 Ignition switch in position 0.
	3 Connect Trailer socket tester to connector CAT23.
	4 Ignition switch in position II.
	5 SWITCH ON the rear fog lamp.
	6 CHECK trailer socket tester. • Is voltage supply measured at the trailer socket, pin 2 (rear fog lamp)? → **Yes** Continue troubleshooting on the trailer. CHECK system operates correctly → **No** GO to A15.
A15: CHECK THE TRAILER CONTROL UNIT	
NOTE: The trailer socket tester used in the previous step is still connected to the trailer socket, connector CAT23.	
	1 Ignition switch in position 0.
	2 Disconnect Trailer control unit from connector CAT18.
	3 Connect a fused bridging cable (10 A) to the trailer control unit, connector CAT18, pin 11, circuit CAT07A (GY/OG), wiring harness side and pin 4: – Box van / Bus / Combi: circuit A_SBP81E (RD), wiring harness side. – Platform truck: circuit A_SBP81F (RD), wiring harness side.
	4 Ignition switch in position II.
	5 SWITCH ON the rear fog lamp.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	6 CHECK trailer socket tester. • Is voltage supply measured at the trailer socket, pin 2 (rear fog lamp)? → **Yes** RENEW the trailer control unit. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit(s) between the trailer control unit and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly

PINPOINT TEST AA : THE INDIVIDUAL TRAILER LAMP IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: DETERMINE WHICH LAMP IS INOPERATIVE	
	1 Ignition switch in position II.
	2 SWITCH ON in turn the side lights, stop lamps, and left- and right-hand turn signal lamps.
	3 CHECK the trailer lamps. • Is one of the side lamps at the back of the trailer inoperative? → **Yes** GO to B2. → **No** - One of the trailer stop lamps is inoperative: Continue fault finding on the trailer. CHECK system operates correctly - The trailer turn signal lamp, left-hand side is inoperative: GO to B5. - The trailer turn signal lamp, right-hand side is inoperative: GO to B8.
B2: CHECK REAR SIDE LAMPS ON VEHICLE	
	1 SWITCH ON side lamp.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK rear side lamps on vehicle. • Do the rear side lamps on the vehicle illuminate? → **Yes** - Left-hand rear side lamp on trailer is inoperative: GO to B3. - Right-hand rear side lamp on trailer is inoperative: GO to B4. → **No** REFER to:Parking, Rear and License Plate Lamps (417-01 Exterior Lighting, Diagnosis and Testing).
B3: CHECK VOLTAGE AT THE TRAILER SOCKET (LEFT-HAND SIDE LAMP)	
	1 SWITCH OFF side lamp.
	2 Ignition switch in position 0.
	3 Connect Trailer socket tester to connector CAT23.
	4 Ignition switch in position II.
	5 SWITCH ON side lamp.
	6 CHECK trailer socket tester. • Is voltage supply measured at the trailer socket, pin 7 (left-hand side lamp)? → **Yes** Continue troubleshooting on the trailer. CHECK system operates correctly → **No** - Box van / Bus / Combi: LOCATE and RECTIFY the break in the circuit(s) between soldered connection S4BP76 and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly - Platform truck: LOCATE and RECTIFY the break in the circuit(s) between soldered connection S1BP76B and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly
B4: CHECK VOLTAGE AT THE TRAILER SOCKET (RIGHT-HAND SIDE LAMP)	
	1 SWITCH OFF side lamp.
	2 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Connect Trailer socket tester to connector CAT23.
	4 Ignition switch in position II.
	5 SWITCH ON side lamp.
	6 CHECK trailer socket tester. • Is voltage supply measured at the trailer socket, pin 5 (right-hand side lamp)? → **Yes** Continue troubleshooting on the trailer. CHECK system operates correctly → **No** - Box van / Bus / Combi: LOCATE and RECTIFY the break in the circuit(s) between soldered connection S4BP75 and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly - Platform truck: LOCATE and RECTIFY the break in the circuit(s) between soldered connection S1BP75B and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly
B5: CHECK THE LH TURN SIGNAL LAMPS AT THE VEHICLE	
	1 Ignition switch in position II.
	2 SWITCH ON the left-hand turn signals.
	3 CHECK the turn signal lamps, left-hand side at the vehicle. • Are the turn signal lamps at the vehicle flashing? → **Yes** GO to B6. → **No** REFER to:Turn Signal and Hazard Lamps (417-01 Exterior Lighting, Diagnosis and Testing).
B6: CHECK VOLTAGE AT THE TRAILER SOCKET (LEFT-HAND TURN SIGNAL LAMP)	
	1 SWITCH OFF the turn signal lamps left-hand side.
	2 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Connect Trailer socket tester to connector CAT23.
	4 Ignition switch in position II.
	5 SWITCH ON the left-hand turn signals.
	6 CHECK trailer socket tester. • Is changing voltage supply measured at the trailer socket, pin 1 (left-hand turn signal lamp)? → **Yes** Continue troubleshooting on the trailer. CHECK system operates correctly → **No** GO to B7.
B7: CHECK THE CIRCUIT BETWEEN THE TRAILER CONTROL UNIT AND THE TRAILER SOCKET	
	1 Ignition switch in position 0.
	2 Disconnect Trailer socket tester from connector CAT23.
	3 Disconnect Trailer control unit from connector CAT18.
	4 Measure the resistance between the trailer control unit, connector CAT18, pin 6, circuit CAT06A (YE), wiring harness side and trailer socket, connector CAT23, pin 1, circuit CAT06B (YE). • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the trailer control unit. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit(s) between the trailer control unit and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly
B8: CHECK THE RH TURN SIGNAL LAMPS AT THE VEHICLE	
	1 Ignition switch in position II.
	2 SWITCH ON the right-hand turn signal lamps.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK the turn signal lamps, right-hand side at the vehicle. • Are the turn signal lamps at the vehicle flashing? → **Yes** GO to B9. → **No** REFER to:Turn Signal and Hazard Lamps (417-01 Exterior Lighting, Diagnosis and Testing).
B9: CHECK VOLTAGE AT THE TRAILER SOCKET (RIGHT-HAND TURN SIGNAL LAMP)	
	1 SWITCH OFF the right-hand turn signal lamps.
	2 Ignition switch in position 0.
	3 Connect Trailer socket tester to connector CAT23.
	4 Ignition switch in position II.
	5 SWITCH ON the right-hand turn signal lamps.
	6 CHECK trailer socket tester. • Is changing voltage supply measured at the trailer socket, pin 4 (right-hand turn signal lamp)? → **Yes** Continue troubleshooting on the trailer. CHECK system operates correctly → **No** GO to B10.
B10: CHECK THE CIRCUIT BETWEEN THE TRAILER CONTROL UNIT AND THE TRAILER SOCKET	
	1 Ignition switch in position 0.
	2 Disconnect Trailer socket tester from connector CAT23.
	3 Disconnect Trailer control unit from connector CAT18.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the resistance between the trailer control unit, connector CAT18, pin 7, circuit CAT09A (GN), wiring harness side and trailer socket, connector CAT23, pin 4, circuit CAT09B (GN). • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the trailer control unit. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit(s) between the trailer control unit and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly

PINPOINT TEST AB : TRAILER LAMPS ILLUMINATE CONTINUOUSLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 Check the trailer lamps. • Is/are the side lamp(s) on the trailer permanently on? → **Yes** GO to C2. → **No** - Trailer rear fog lamp(s) permanently on: GO to C3. - Trailer stop lamps illuminate continuously: GO to C6. - Trailer reversing lamp(s) is/are permanently on: GO to C7. - Trailer left-hand turn signal lamp illuminates continuously: GO to C8. - Trailer right-hand turn signal lamp illuminates continuously: GO to C11. - Trailer rear fog lamp(s) and turn signal lamps permanently on: RENEW the trailer control unit. CHECK system operates correctly
C2: CHECK REAR SIDE LAMPS ON VEHICLE	
	1 Ignition switch in position 0.
	2 Disconnect Trailer from connector CAT23.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 CHECK rear side lamps on vehicle. • Does the left or right-hand rear side lamp on vehicle illuminate continuously? → **Yes** REFER to:Parking, Rear and License Plate Lamps (417-01 Exterior Lighting, Diagnosis and Testing). → **No** Continue troubleshooting on the trailer. CHECK system operates correctly
C3: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position 0.
	2 Disconnect Trailer from connector CAT23.
	3 Ignition switch in position II.
	4 CHECK the rear fog lamp on the vehicle. • Does the rear fog lamp on the vehicle come on? → **Yes** REFER to:Fog Lamps (417-01 Exterior Lighting, Diagnosis and Testing). → **No** GO to C4.
C4: NARROW DOWN THE LOCATION OF THE SHORT TO BATTERY VOLTAGE ON THE VEHICLE (REAR FOG LAMP)	
	1 Ignition switch in position 0.
	2 Connect Trailer socket tester to connector CAT23.
	3 Ignition switch in position II.
	4 CHECK trailer socket tester. • Is voltage supply measured at the trailer socket, pin 2 (rear fog lamp)? → **Yes** GO to C5. → **No** Continue troubleshooting on the trailer.
C5: RULE OUT THE TRAILER CONTROL UNIT AS CAUSE FOR SHORT CIRCUIT TO BATTERY VOLTAGE ON THE VEHICLE (REAR FOG LAMP)	
	1 Ignition switch in position 0.
	2 Disconnect Inline fuse F83 (15 A).

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Ignition switch in position II.
	4 CHECK trailer socket tester. • Is voltage supply measured at the trailer socket, pin 2 (rear fog lamp)? → **Yes** LOCATE and RECTIFY the short to battery voltage in the corresponding circuit(s) between the trailer control unit and the trailer socket using the Wiring Diagrams. CHECK system operates correctly If necessary RENEW the trailer socket. CHECK system operates correctly → **No** RENEW the trailer control unit. CHECK system operates correctly
C6: CHECK THE VEHICLE STOP LAMPS	
	1 Ignition switch in position 0.
	2 Disconnect Trailer from connector CAT23.
	3 Ignition switch in position II.
	4 CHECK the stop lamps at the vehicle. • Are the stoplamps on the vehicle permanently lit? → **Yes** REFER to:Stoplamps (417-01 Exterior Lighting, Diagnosis and Testing). → **No** Continue troubleshooting on the trailer. CHECK system operates correctly
C7: CHECK VEHICLE REVERSING LAMPS	
	1 Ignition switch in position 0.
	2 Disconnect Trailer from connector CAT23.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 CHECK the reversing lamps at the vehicle. • Are the backup lamps on the vehicle continuously lit? → **Yes** REFER to:Reversing Lamps (417-01 Exterior Lighting, Diagnosis and Testing). → **No** Continue troubleshooting on the trailer. CHECK system operates correctly
C8: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position 0.
	2 Disconnect Trailer from connector CAT23.
	3 Ignition switch in position II.
	4 CHECK left-hand turn signal lamp on vehicle. • Does the left-hand turn signal lamp on the vehicle flash continuously? → **Yes** REFER to:Turn Signal and Hazard Lamps (417-01 Exterior Lighting, Diagnosis and Testing). → **No** GO to C9.
C9: NARROW DOWN THE LOCATION OF THE SHORT TO BATTERY VOLTAGE ON THE VEHICLE (LEFT-HAND TURN SIGNAL LAMP)	
	1 Ignition switch in position 0.
	2 Connect Trailer socket tester to connector CAT23.
	3 Ignition switch in position II.
	4 CHECK trailer socket tester. • Is voltage supply measured at the trailer socket, pin 1 (left-hand turn signal lamp)? → **Yes** GO to C10. → **No** Continue troubleshooting on the trailer.
C10: RULE OUT THE TRAILER CONTROL UNIT AS CAUSE FOR SHORT CIRCUIT TO BATTERY VOLTAGE ON THE VEHICLE (LEFT-HAND TURN SIGNAL LAMP)	
	1 Ignition switch in position 0.
	2 Disconnect Inline fuse F83 (15 A).

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Ignition switch in position II.
	4 CHECK trailer socket tester. • Is voltage supply measured at the trailer socket, pin 1 (left-hand turn signal lamp)? → **Yes** LOCATE and RECTIFY the short to battery voltage in the corresponding circuit(s) between the trailer control unit and the trailer socket using the Wiring Diagrams. If necessary RENEW the trailer socket. CHECK system operates correctly → **No** RENEW the trailer control unit. CHECK system operates correctly
C11: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position 0.
	2 Disconnect Trailer from connector CAT23.
	3 Ignition switch in position II.
	4 CHECK right-hand turn signal lamp on vehicle. • Does the left-hand turn signal lamp on the vehicle flash continuously? → **Yes** REFER to:Turn Signal and Hazard Lamps (417-01 Exterior Lighting, Diagnosis and Testing). → **No** GO to C12.
C12: NARROW DOWN THE LOCATION OF THE SHORT TO BATTERY VOLTAGE ON THE VEHICLE (RIGHT-HAND TURN SIGNAL LAMP)	
	1 Ignition switch in position 0.
	2 Connect Trailer socket tester to connector CAT23.
	3 Ignition switch in position II.
	4 CHECK trailer socket tester. • Is voltage supply measured at the trailer socket, pin 4 (right-hand turn signal lamp)? → **Yes** GO to C13. → **No** Continue troubleshooting on the trailer.

DIAGNOSIS AND TESTING

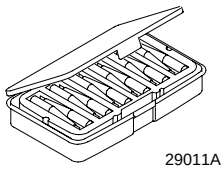
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C13: RULE OUT THE TRAILER CONTROL UNIT AS CAUSE FOR SHORT CIRCUIT TO BATTERY VOLTAGE ON THE VEHICLE (RIGHT-HAND TURN SIGNAL LAMP)	
	1 Ignition switch in position 0.
	2 Disconnect Inline fuse F83 (15 A).
	3 Ignition switch in position II.
	4 CHECK trailer socket tester. • Is voltage supply measured at the trailer socket, pin 4 (right-hand turn signal lamp)? → **Yes** LOCATE and RECTIFY the short to battery voltage in the corresponding circuit(s) between the trailer control unit and the trailer socket using the Wiring Diagrams. If necessary RENEW the trailer socket. CHECK system operates correctly → **No** RENEW the trailer control unit. CHECK system operates correctly

DIAGNOSIS AND TESTING

Headlamp Leveling

Refer to Wiring Diagrams Section 417-01,for schematic and connector information.

Special Tool(s)

 29011A	Set of adapter plugs for test probes 29-011A

Inspection and Testing

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical or mechanical damage.

Visual Inspection Chart

Electrical
– Fuse(s) – Wiring loom – Electrical connector(s) – Switch

3. Resolve any obvious causes or concerns found during the visual inspection before carrying out any further tests.
4. If the cause of the concern cannot be found by visual inspection, continue with the symptom chart.

Symptom chart

Symptom chart

Symptom	Possible Sources	Action
• Headlamp levelling system inoperative on both sides	• Circuit(s) • Headlight switch • Headlamp • Headlamp leveling motor	• GO to Pinpoint Test A.
• Headlamp levelling system inoperative on one side	• Circuit(s) • Headlamp • Headlamp levelling motor.	• GO to Pinpoint Test B.

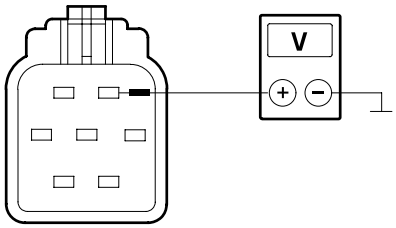
Pinpoint Test

NOTE: Use a digital multimeter for all electrical measurements.

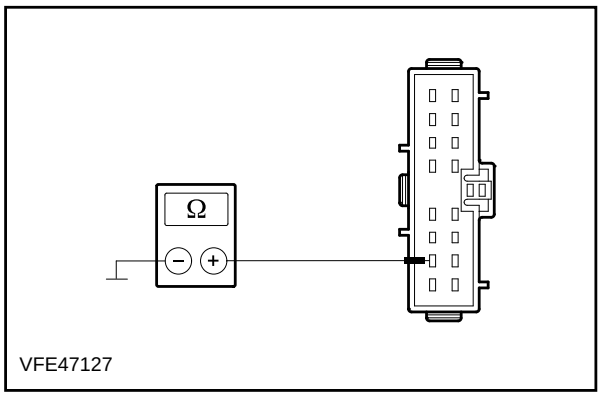
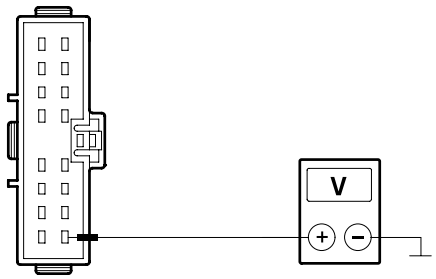
PINPOINT TEST AC : HEADLAMP LEVELLING SYSTEM INOPERATIVE ON BOTH SIDES

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: NARROW DOWN THE CONDITIONS UNDER WHICH THE FAULT OCCURS	
	1 Ignition switch in position 0.
	2 Disconnect left-hand headlamp. – Box van / Bus / Combi: from connector C1LF08 – Platform truck: from connector CLF08

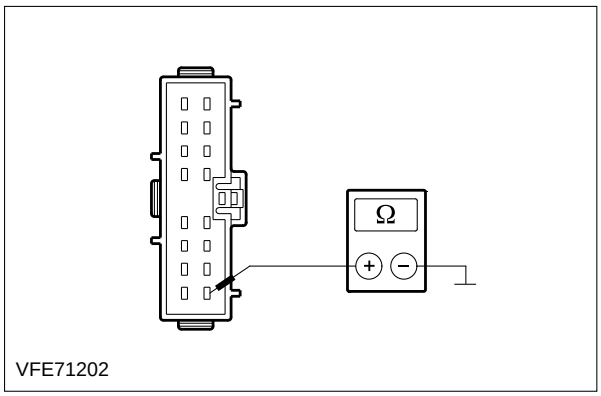
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Disconnect Right-hand headlamp. – Box van / Bus / Combi: from connector C1LF09 – Platform truck, with side light/side turn signal lamp: from connector C1LF09 – Platform truck, without side light/side turn signal lamp: from connector CLF09
	4 Ignition switch in position II.
	5 SWITCH ON the low beam.
 VFE0016224	6 Measure voltage between the left-hand head-lamps: – Box van / Bus / Combi: from connector C1LF08, pin 2, circuit VLF15E (GN), wiring harness side and ground. – Platform truck, with side light/side turn signal lamp: from connector CLF08, pin 2, circuit VLF15E (GN), wiring harness side and ground. – Platform truck, without side light/side turn signal lamp: from connector CLF08, pin 2, circuit VLF15C (GN), wiring harness side and ground.
	7 ADJUST the headlamp levelling switch up/down.
	8 CHECK test results. • When the headlamp levelling system switch is being adjusted, does the voltage level remain constant at battery voltage? → **Yes** GO to A2. → **No** - The voltage changes when the headlamp levelling system switch is adjusted: GO to A5. - No voltage is displayed: GO to A4.
A2: CHECK THE GROUND CONNECTION OF THE HEADLIGHT SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Headlight switch from connector CLF23.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE47127	3 Measure the resistance between the headlight switch, connector CLF23, pin 10, circuit B_GD116A (BK/VT), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** GO to A3. → **No** LOCATE and RECTIFY the break in the circuit between the headlamp switch and ground connection G16 using the Wiring Diagrams. CHECK system operates correctly
A3: RULE OUT THE HEADLAMP SWITCH AS THE CAUSE OF THE CONCERN	
	1 Ignition switch in position II.
 VFE0024363	2 Measure the voltage between headlamp switch, connector CLF23, pin 1, circuit VLF15A (GN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY short to battery voltage in the circuits connected to soldered connection S2LF15 using the Wiring Diagrams. CHECK system operates correctly → **No** RENEW headlight switch. CHECK system operates correctly
A4: CHECK THE CONTROL CIRCUITS OF THE HEADLAMP LEVELLING SYSTEM FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Headlight switch from connector CLF23.

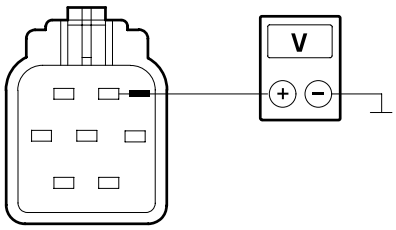
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE71202	3 Measure the resistance between headlamp switch, connector CLF23, pin 1, circuit VLF15A (GN), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** LOCATE and RECTIFY break in circuit between headlamp switch and soldered connection S2LF15 using the Wiring Diagrams. CHECK system operates correctly → **No** LOCATE and RECTIFY short to ground in the circuits connected to soldered connection S2LF15 using the Wiring Diagrams. CHECK system operates correctly
A5: EXCLUDE THE HEADLAMP AS THE CAUSE OF THE CONCERN	
	1 Ignition switch in position 0.
	2 Connect Left-hand headlamp:. – Box van / Bus / Combi: to connector C1LF08 – Platform truck: to connector CLF08
	3 Ignition switch in position II.
	4 SWITCH ON the low beam.
	5 ADJUST the headlamp levelling switch up/down.
	6 CHECK left-hand headlamp adjustment. • Has the headlamp concerned been adjusted in accordance with the actuation of the headlamp levelling switch? → **Yes** CHECK and if necessary RENEW the right-hand headlamp levelling motor. CHECK system operates correctly → **No** CHECK and if necessary RENEW the left-hand headlamp levelling motor. CHECK system operates correctly

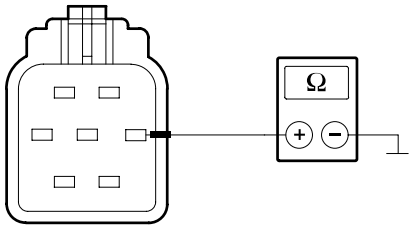
PINPOINT TEST AD : HEADLAMP LEVELLING SYSTEM INOPERATIVE ON ONE SIDE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK SIDE LIGHTS ON THE SIDE AFFECTED	
	1 Ignition switch in position II.
	2 SWITCH ON side lights.

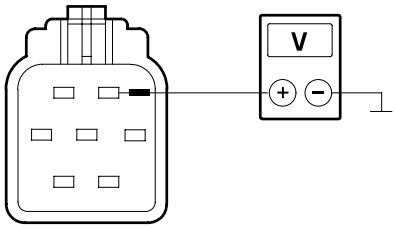
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK front side lamps. • Are the front side lamps illuminated? → **Yes** - Left-hand headlamp levelling system inoperative: GO to B2. - Right-hand headlamp levelling system inoperative: GO to B4. → **No** REFER to:Parking, Rear and License Plate Lamps (417-01 Exterior Lighting, Diagnosis and Testing).
B2: CHECK THE CONTROL CIRCUIT OF THE HEADLAMP LEVELLING SYSTEM ON THE LEFT-HAND SIDE FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect left-hand headlamp. – Box van / Bus / Combi: from connector C1LF08 – Platform truck: from connector CLF08
	3 Ignition switch in position II.
	4 SWITCH ON the dipped beam.
 VFE0016224	5 Measure voltage between the left-hand headlamps: – Box van / Bus / Combi: from connector C1LF08, pin 2, circuit VLF15E (GN), wiring harness side and ground. – Platform truck, with side light/side turn signal lamp: from connector CLF08, pin 2, circuit VLF15E (GN), wiring harness side and ground. – Platform truck, without side light/side turn signal lamp: from connector CLF08, pin 2, circuit VLF15C (GN), wiring harness side and ground.
	6 CHECK test results.

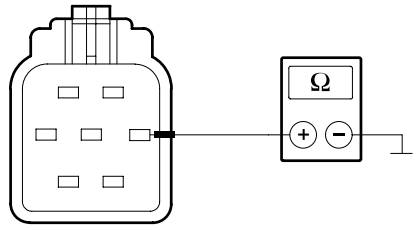
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	7 ADJUST the headlamp levelling switch up/down. • Does the voltage display change in accordance with the actuation of the headlamp levelling switch? → **Yes** GO to B3. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2LF15 and the headlamp using the wiring diagrams. CHECK system operates correctly
B3: CHECK THE GROUND SUPPLY OF THE HEADLAMP (LEVELLING SYSTEM MOTOR) ON THE LEFT-HAND SIDE FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 VFE0032899	2 Measure the resistance between the left-hand headlamp: – Box van / Bus / Combi: from connector C1LF08, pin 5, circuit A_GD129U (BK/YE), wiring harness side and ground. – Platform truck, with side light/side turn signal lamp: from connector CLF08, pin 5, circuit A_GD129U (BK/YE), wiring harness side and ground. – Platform truck, without side light/side turn signal lamp: from connector CLF08, pin 5, circuit A_GD129D (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** CHECK wiring harness in headlamp for break. If necessary RENEW headlamp levelling motor. CHECK system operates correctly → **No** - Box van / Bus / Combi: LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S1D129A using the Wiring Diagrams. CHECK system operates correctly - Platform truck: LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S2D129A using the Wiring Diagrams. CHECK system operates correctly
B4: CHECK THE CONTROL CIRCUIT OF THE HEADLAMP LEVELLING SYSTEM ON THE RIGHT-HAND SIDE FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Right-hand headlamp. – Box van / Bus / Combi: from connector C1LF09 – Platform truck, with side light/side turn signal lamp: from connector C1LF09 – Platform truck, without side light/side turn signal lamp: from connector CLF09
	3 Ignition switch in position II.
	4 SWITCH ON the dipped beam.
 VFE0016224	5 Measure the voltage at the right-hand headlamp: – Box van / Bus / Combi: Connector C1LF09, pin 2, circuit VLF15F (GN), wiring harness side and ground. – Platform truck, with side light/side turn signal lamp: Connector C1LF09, pin 2, circuit VLF15F (GN), wiring harness side and ground. – Platform truck, without side light/side turn signal lamp: from connector CLF09, pin 2, circuit VLF15D (GN), wiring harness side and ground.
	6 CHECK test results.
	7 ADJUST the headlamp levelling switch up/down. • Does the voltage display change in accordance with the actuation of the headlamp levelling switch? → **Yes** GO to B3. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2LF15 and the headlamp using the wiring diagrams. CHECK system operates correctly
B5: CHECK GROUND CONNECTION OF HEADLAMP (LEVELLING SYSTEM MOTOR) ON THE SIDE AFFECTED FOR BREAKS	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0032899	2 Measure the resistance between the right-hand headlamp: – Box van / Bus / Combi: Connector C1LF09, pin 5, circuit A_GD131W (BK/GY), wiring harness side and ground. – Platform truck, with side light/side turn signal lamp: Connector C1LF09, pin 5, circuit A_GD131U (BK/GY), wiring harness side and ground. – Platform truck, without side light/side turn signal lamp: from connector CLF09, pin 5, circuit A_GD131G (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** CHECK wiring harness in headlamp for break. If necessary RENEW headlamp levelling motor. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between the headlamp and soldered connection S1D131B using the Wiring Diagrams. CHECK system operates correctly

GENERAL PROCEDURES

Headlamp Adjustment (32 113 0)

General Equipment

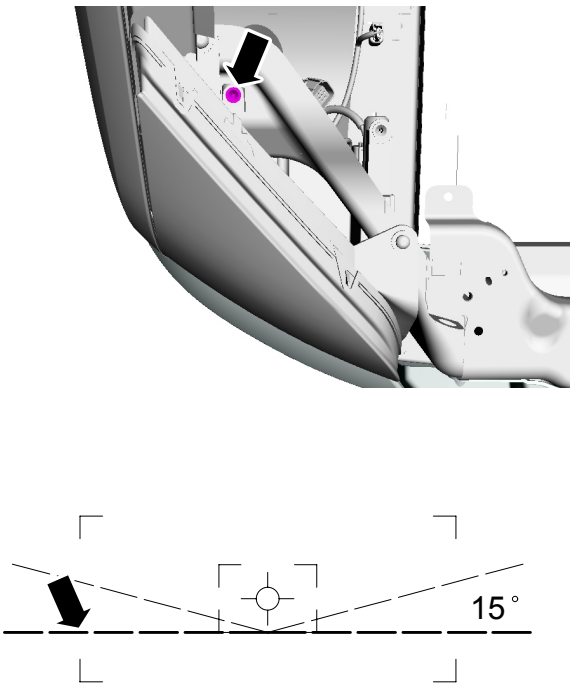
Beam setting equipment

Vehicles with height-adjusting shock absorbers

1. **Set the suspension at normal ride height. Refer to the Owner's Literature.**

All vehicles

2. **Stand the vehicle on level ground.**
3. **Make sure that the tire pressures are to specification and that the vehicle is not abnormally laden.**
4. **Repeatedly operate the headlamp leveling switch and then set it to "0".**
5. **Switch on dipped beam.**
6. **Set the measuring screen of the beam setting equipment to the correct headlamp adjustment setting.**
7. **Adjust the dipped beams so that the light/dark boundary touches the horizontal line.**

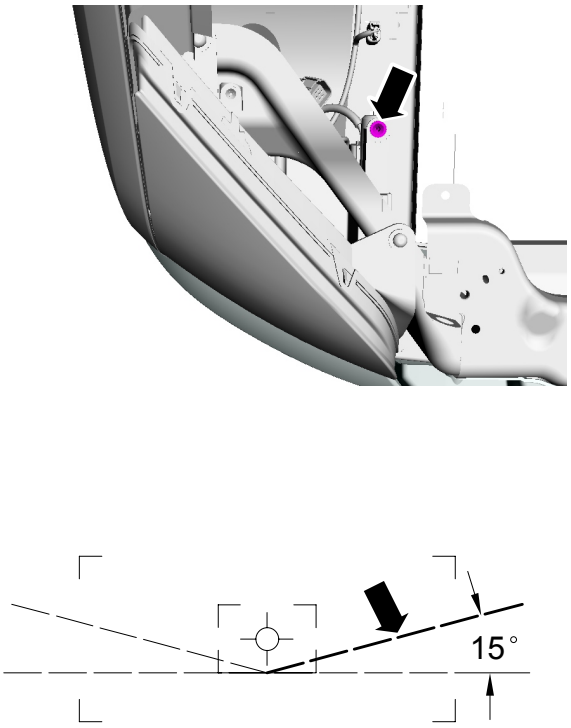


E67755

8. **NOTE:Some scattered light from the low beam may lie above the 15 degrees line.**

NOTE: After horizontal adjustment readjustment of the vertical axis might be necessary.

Adjust the headlamps so that the rising line of the boundary line lies at the intersection of horizontal line and the 15 degree line (left-hand drive vehicle shown).



E67756

GENERAL PROCEDURES

Front Fog Lamp Adjustment

General Equipment

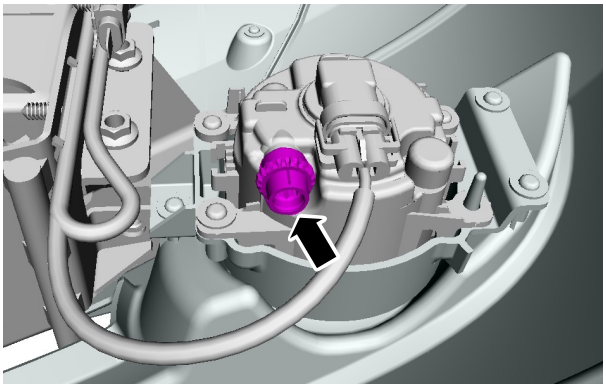
Beam setting equipment

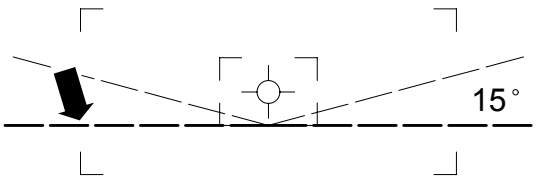
Vehicles with height-adjusting shock absorbers

1. **Set the suspension at normal ride height. Refer to the Owner's Literature.**

All vehicles

2. **Stand the vehicle on level ground.**
3. **Make sure that the tire pressures are to specification and that the vehicle is not abnormally laden.**
4. **Switch on the front fog lamps.**
5. **Set the measuring screen of the beam setting equipment to the correct front fog lamp adjustment setting.**
6. **Adjust the fog lamp so that the light/dark boundary touches the horizontal line.**





E67757

GENERAL PROCEDURES

Headlamp Masking

All vehicles

NOTE: The templates for right-hand drive and left-hand drive vehicles are not interchangeable. The templates for the right-hand headlamp and left-hand headlamp are not interchangeable.

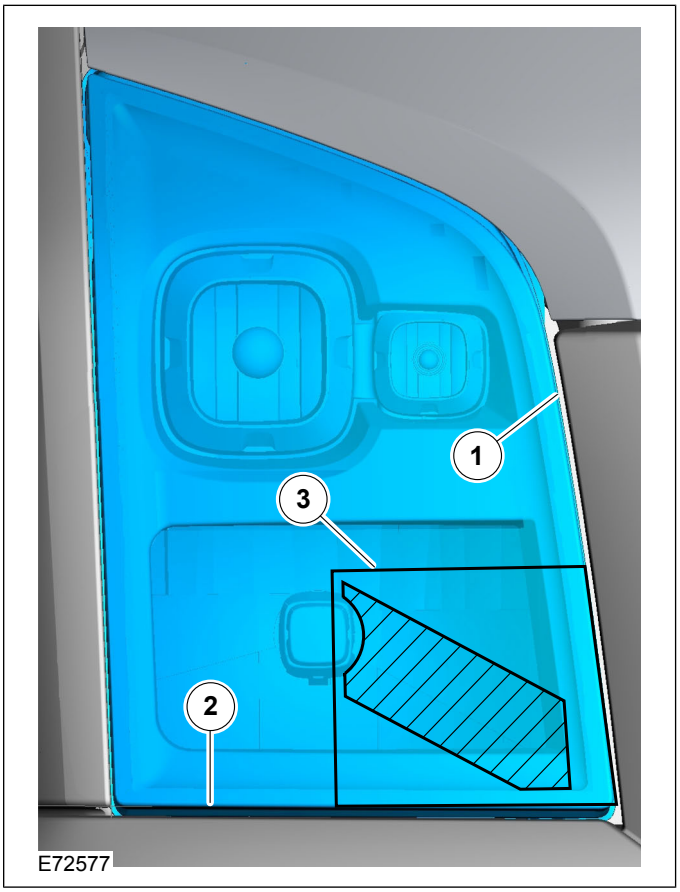
1. **Print out the correct templates at the end of this work instruction.**
2. **Measure the X measurement on the printed template.**
3. **Calculate the enlargement/reduction factor Y for the photocopier using the formula: Y = Z÷X×100.**
   - X = measurement on the printed template in millimeters
   - Y = enlargement/reduction factor in percent.
   - Z = original dimension in mm = 50.
4. **Photocopy the printed templates with the calculated enlargement/reduction factor.**
   - Compare the X measurement on the photocopy with the original measurement.
5. **Cut out the prepared templates for the headlamps.**
6. **Cut out the shaded areas.**

LHD vehicle

7. **NOTE:Right-hand headlamp only.**

   Place the template onto the headlamp lens and align.

   1. Side alignment line on the headlamp lens
   2. Lower alignment line on the headlamp lens
   3. Template



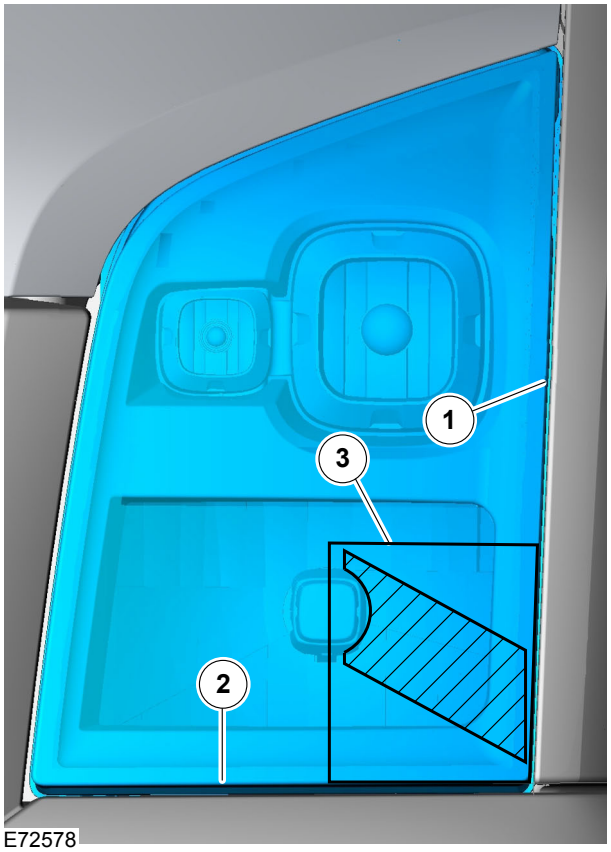
8. **NOTE:Left-hand headlamp only.**

   Place the template onto the headlamp lens and align.

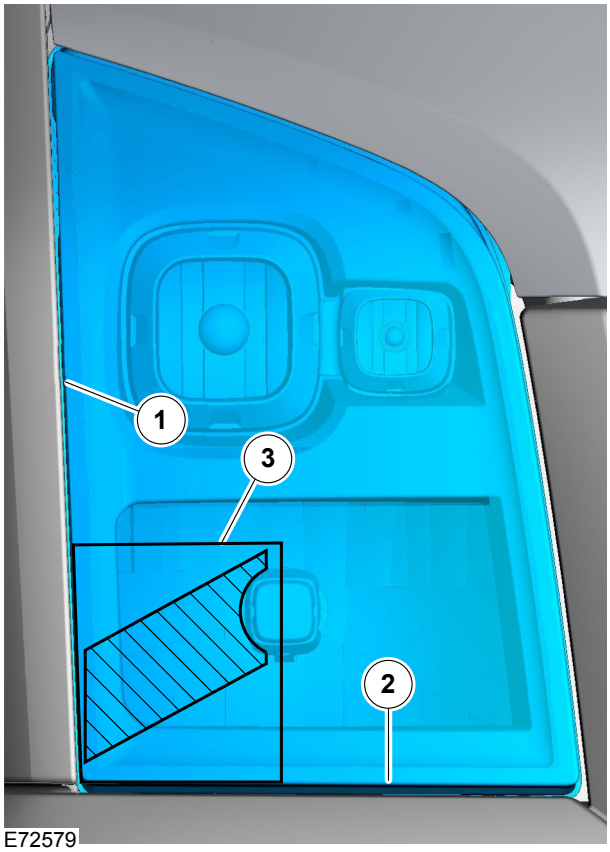
   1. Side alignment line on the headlamp lens
   2. Lower alignment line on the headlamp lens

GENERAL PROCEDURES

3. Template



3. Template



RHD

9. NOTE:Right-hand headlamp only.

Place the template onto the headlamp lens and align.

1. Side alignment line on the headlamp lens
2. Lower alignment line on the headlamp lens

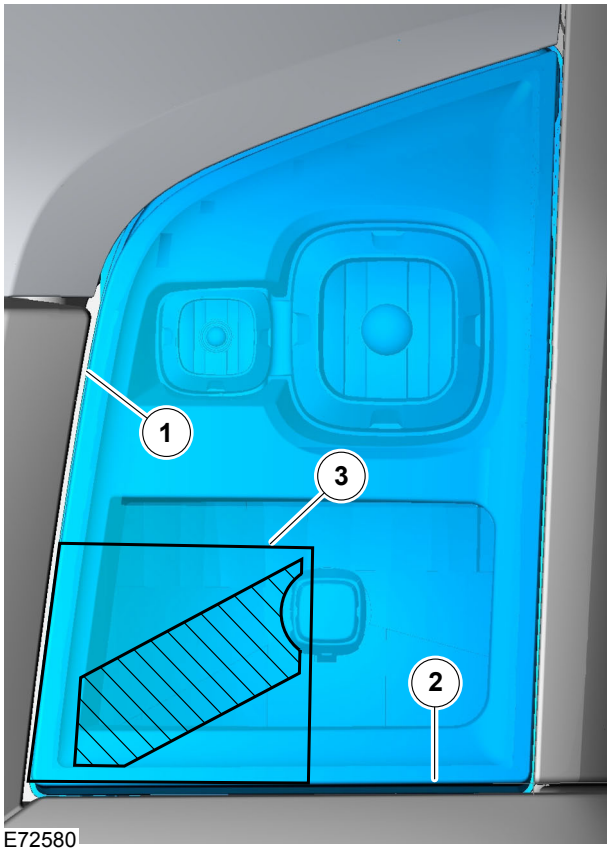
10. NOTE:Left-hand headlamp only.

Place the template onto the headlamp lens and align.

1. Side alignment line on the headlamp lens
2. Lower alignment line on the headlamp lens

GENERAL PROCEDURES

3. Template



All vehicles

11. CAUTION:Make sure that the headlamp lens is not scratched.

Copy the template outline to the headlamp lens using a suitable marker pen.

12. Remove the template.

13. NOTE:Make sure not to exceed the area contours when masking the headlamps.

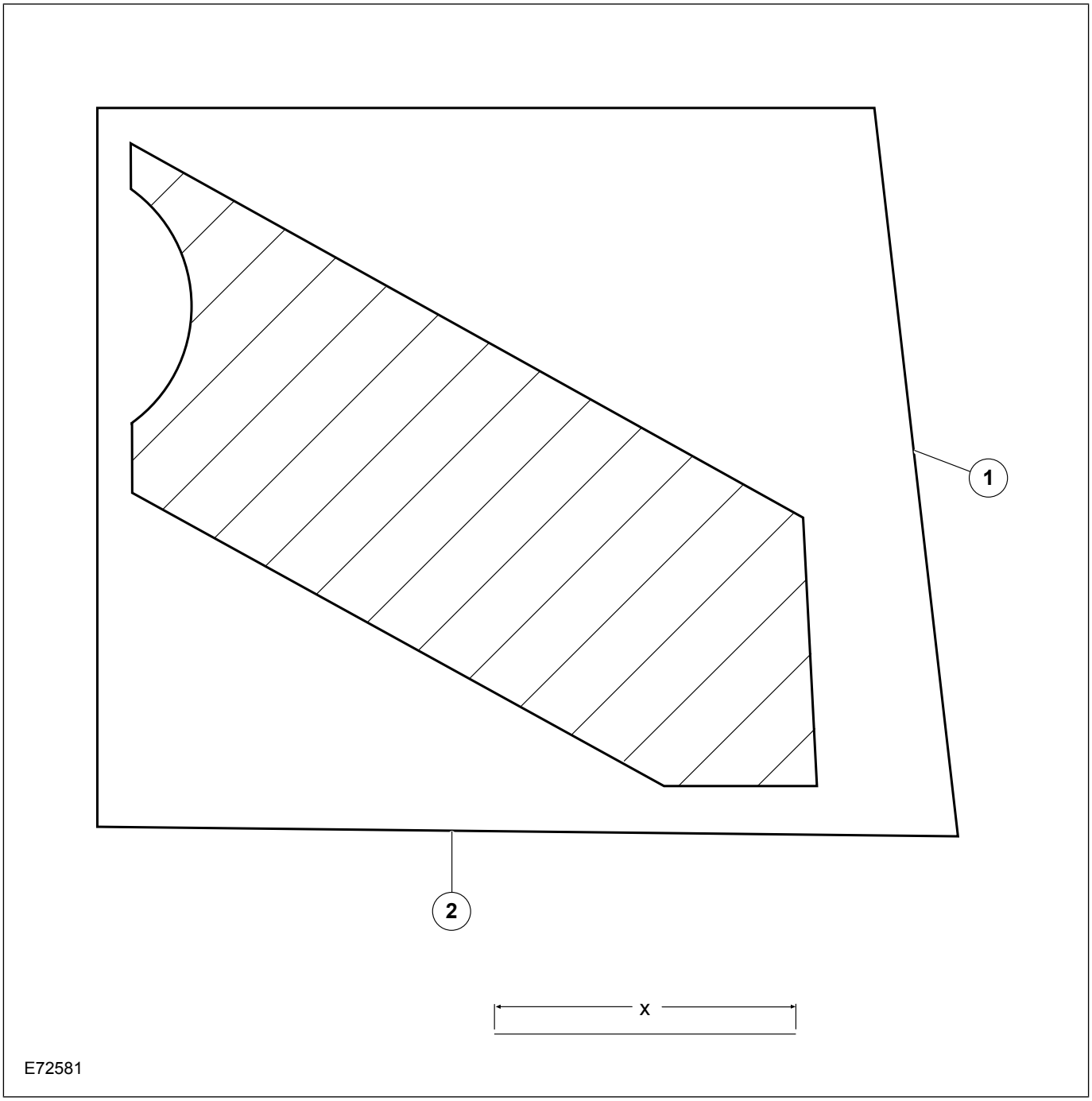
Cover the marked area with a black opaque adhesive tape.

14. Repeat steps 11 to 13 for the headlamp on the other side.

15. Template for LHD vehicles, right-hand headlamp

1. Side alignment line on the headlamp lens
2. Lower alignment line on the headlamp lens

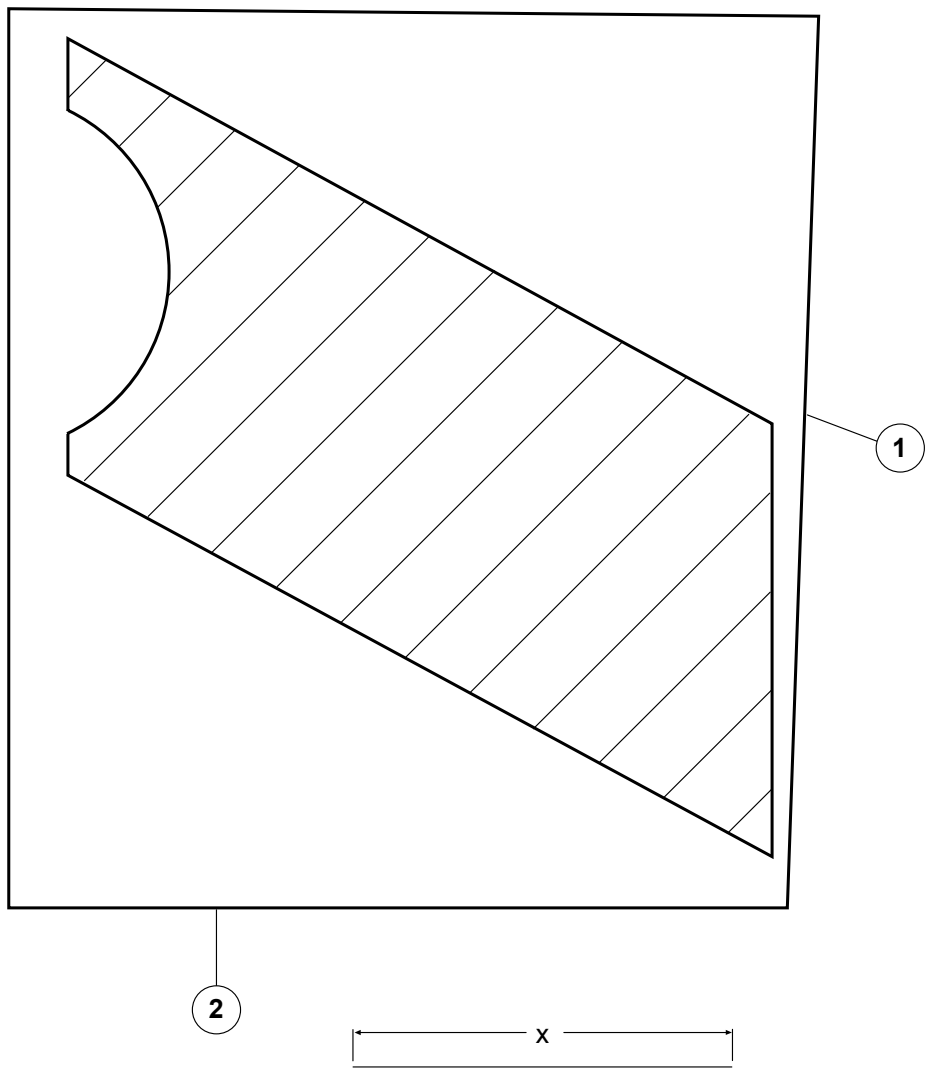
GENERAL PROCEDURES



16. Template for LHD vehicles, left-hand headlamp

1. Side alignment line on the headlamp lens
2. Lower alignment line on the headlamp lens

GENERAL PROCEDURES

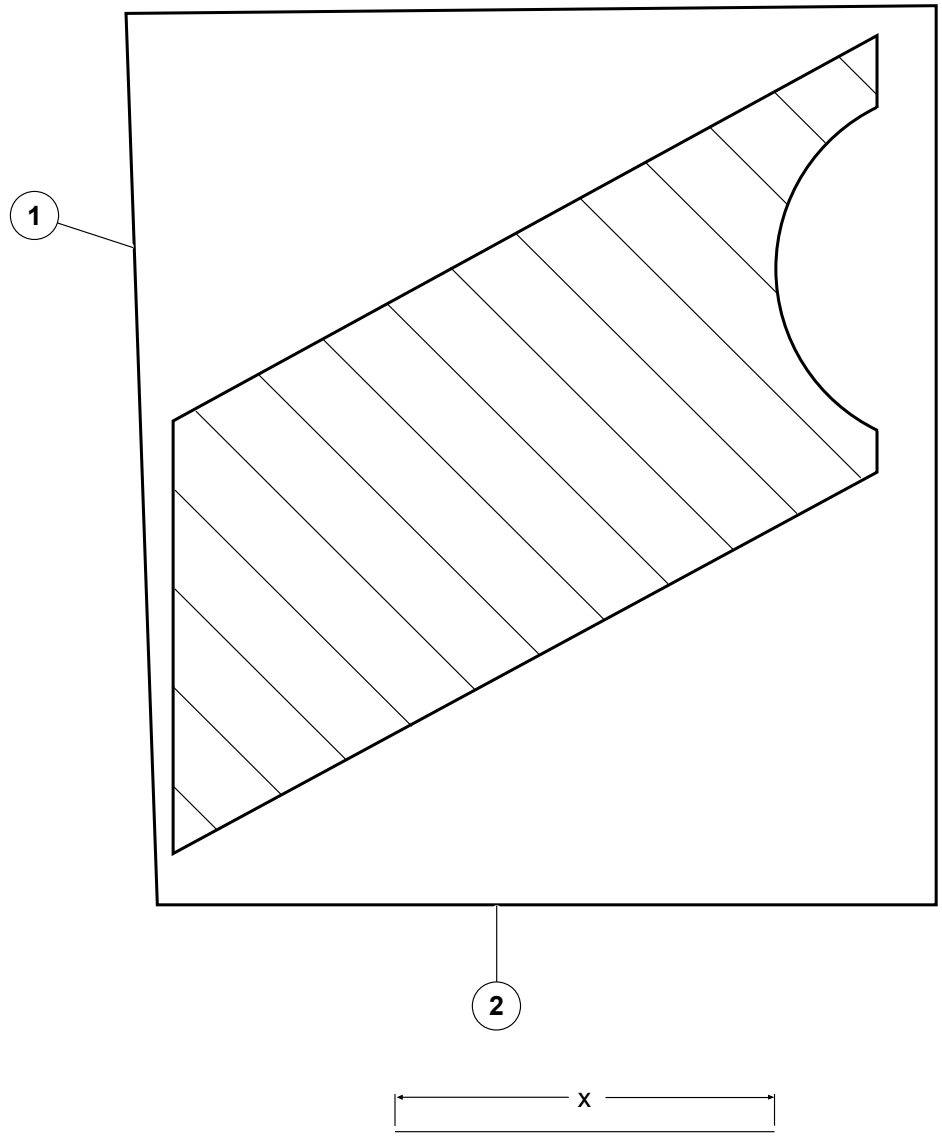


E72582

17. Template for RHD vehicles, right-hand headlamp

1. Side alignment line on the headlamp lens
2. Lower alignment line on the headlamp lens

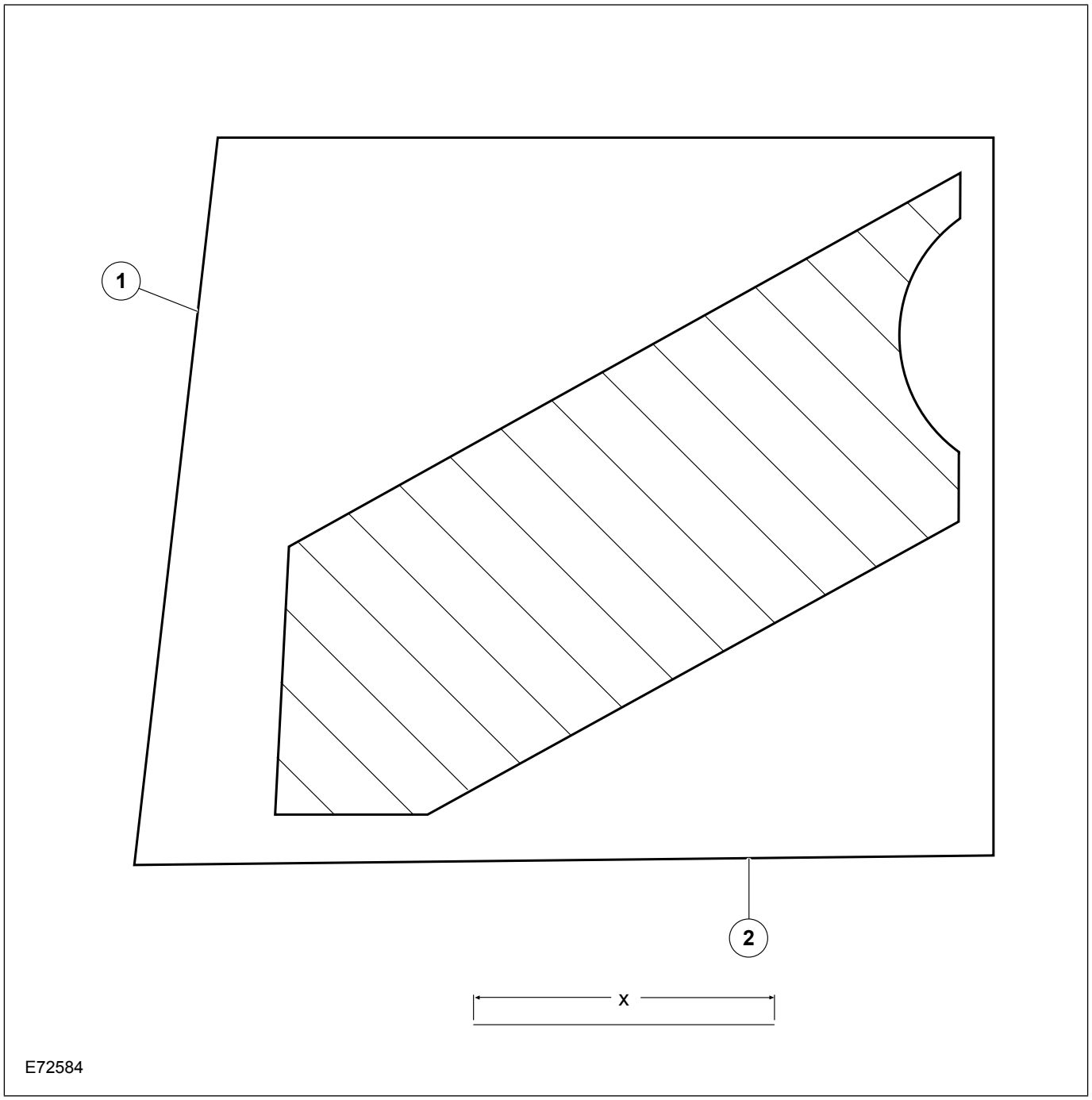
GENERAL PROCEDURES



18. Template for LHD vehicles, left-hand headlamp

1. Side alignment line on the headlamp lens
2. Lower alignment line on the headlamp lens

GENERAL PROCEDURES



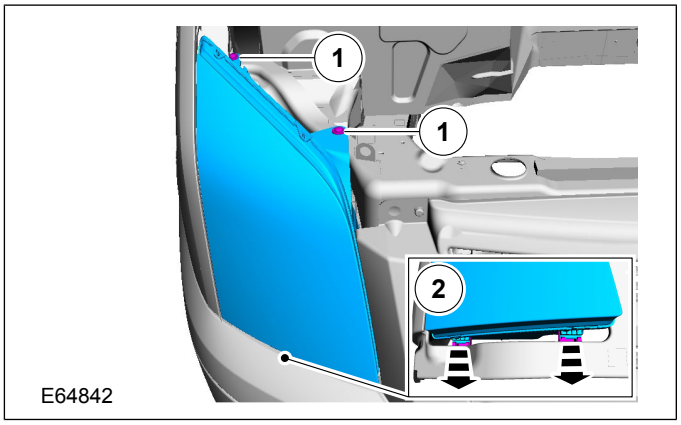
REMOVAL AND INSTALLATION

Headlamp Assembly

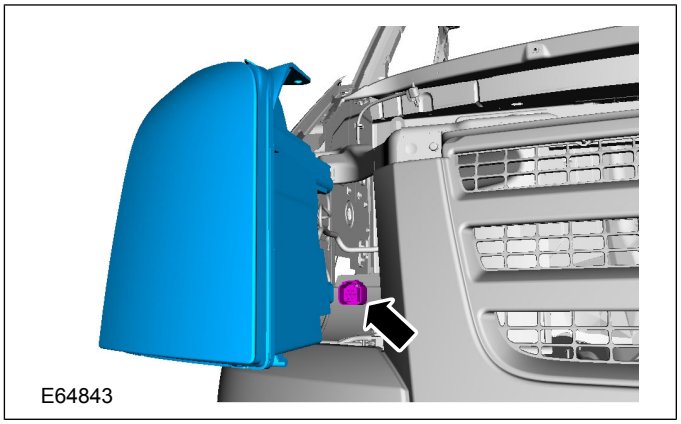
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. • Torque: 4 Nm



2.



Installation

1. For installation, reverse the removal procedure.

2. **NOTE:**In the event of a defective headlamp, the headlamp leveling motor must be removed and installed on the new headlamp.

Remove the headlamp leveling motor.

Refer to:Headlamp Leveling Motor (417-01 Exterior Lighting, Removal and Installation).

3. Align headlamp beams.

Refer to:Headlamp Adjustment (417-01 Exterior Lighting, General Procedures).

REMOVAL AND INSTALLATION

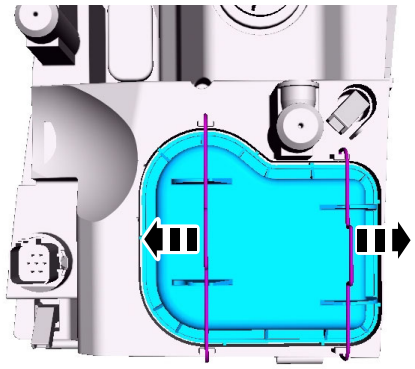
Headlamp Leveling Motor

Removal

1. Remove the headlamp.

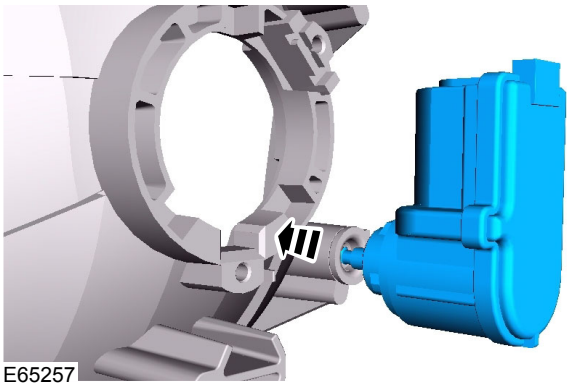
   Refer to:Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).

2.



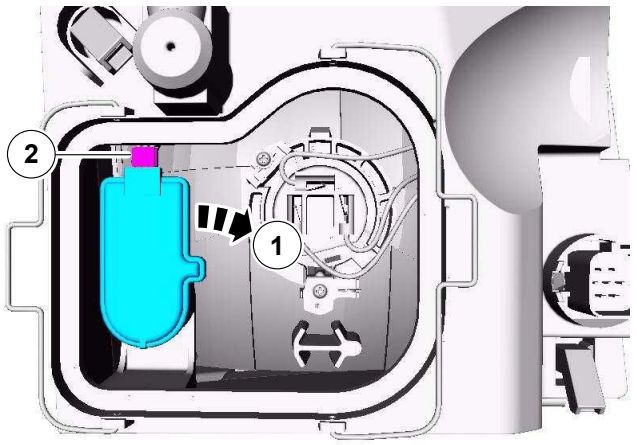
E64957

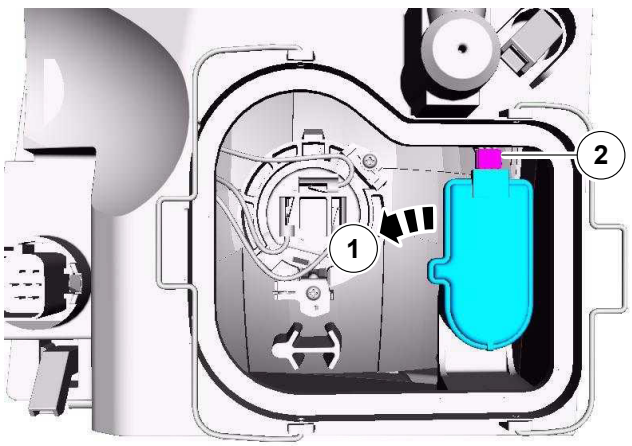
3. Press out the headlamp reflector from the ball head of the headlamp leveling motor.



E65257

4.





E64958

Installation

1. **CAUTIONS:**

   Make sure that the internal headlamp wiring harness is not trapped when installing the headlamp rear cover.

   Ensure that the ball head of the headlamp leveling motor is pushed correctly into the guide.

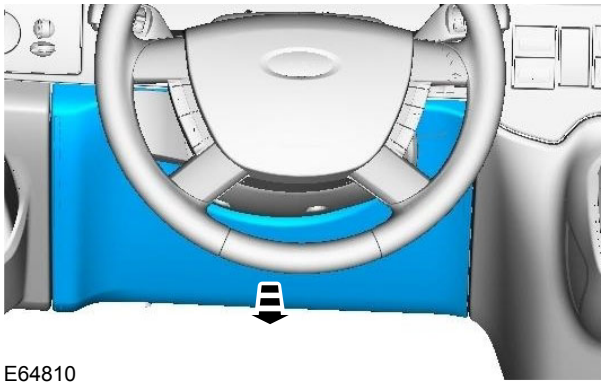
   To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

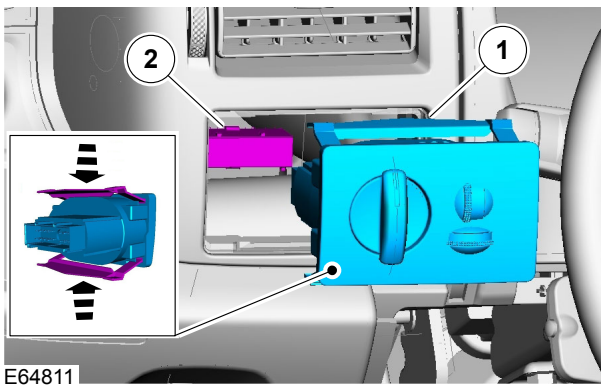
Headlamp Switch

Removal

1.



2. • Unclip the headlamp light switch through the cutout in the footwell trim.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

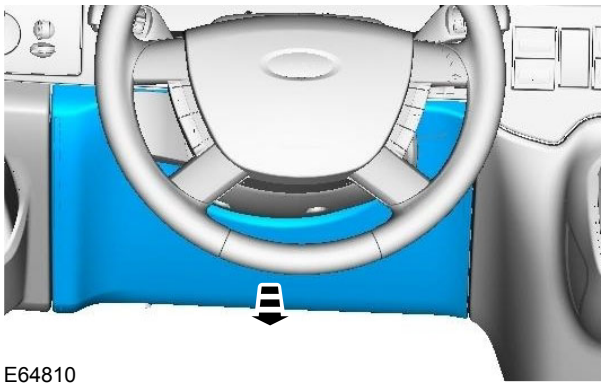
Stoplamp Switch

Removal

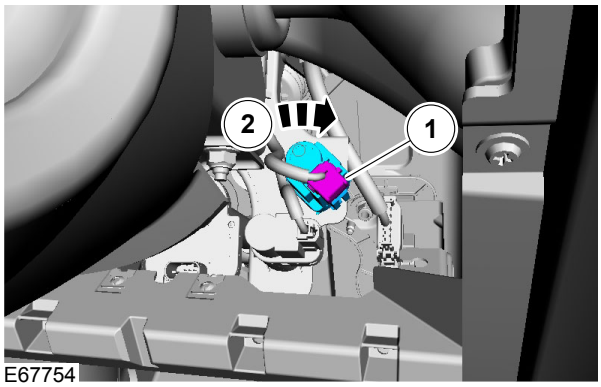
CAUTION:Make sure that during removal of the stop lamp switch and the BPP switch, the brake pedal is pulled right up to its stop and held there. Failure to observe this instruction can cause damage to the switches.

NOTE: In order to synchronize the stop lamp switch and the brake pedal position switch (BPP-switch) the BPP-switch must be removed, and it must be reinstalled before the stop lamp switch is installed.

1.



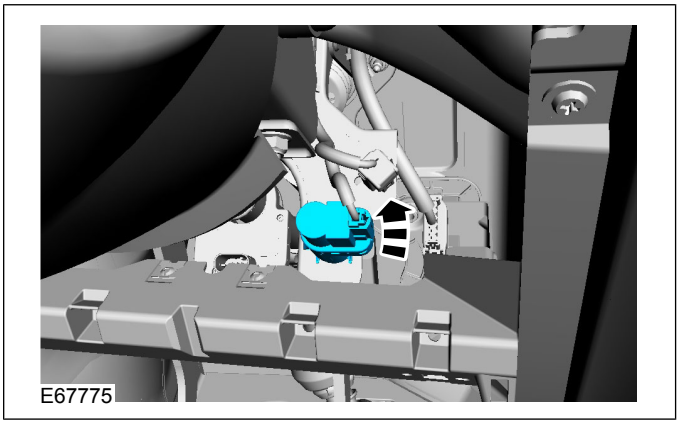
2. • Twist and pull out the stop light switch.



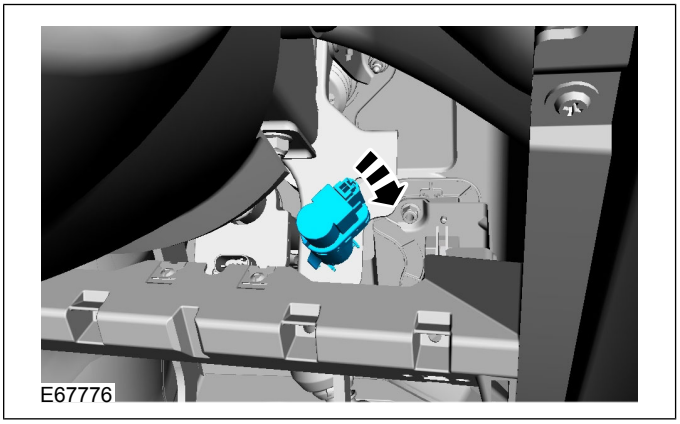
Installation

CAUTION:Make sure that the brake pedal remains in the rest position.

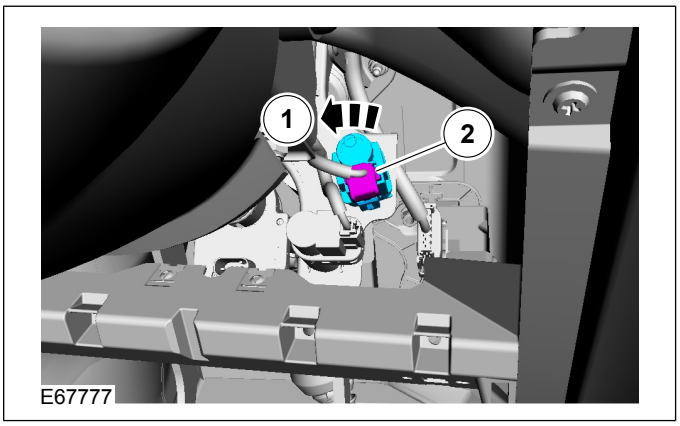
1. • Twist and pull out the BPP switch.



2. • Push in the BPP switch and twist it as far as it will go.



3. • Push in the stop light switch and twist it as far as it will go.



4. After installing the stop lamp switch, check the synchronization of the stop lamp switch and the BPP switch using the Worldwide Diagnosis System (WDS).

REMOVAL AND INSTALLATION

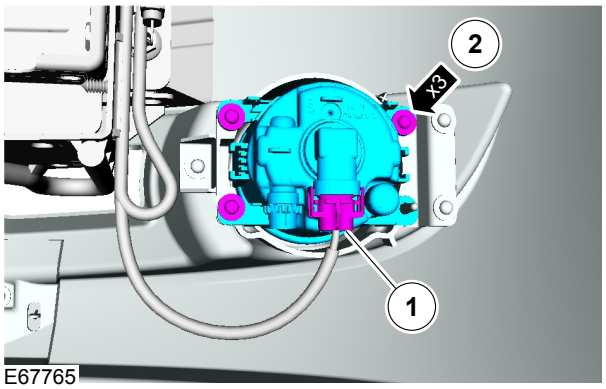
Front Fog Lamp

Removal

1. Raise the vehicle for access

   Refer to: Lifting (100-02, Description and Operation).

2.



Installation

1. To install, reverse the removal procedure.
2. Adjust the front fog lamp.

   Refer to:Nebelscheinwerfer einstellen (417-01, General Procedures).

SECTION 417-02 Interior Lighting

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DIAGNOSIS AND TESTING

Interior Lighting..... 417-02-2
Inspection and Verification..... 417-02-2
Symptom Chart..... 417-02-2
Pinpoint Tests..... 417-02-3

DIAGNOSIS AND TESTING

Interior Lighting

Refer to Wiring Diagrams Section417-02,for schematic and connector information.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical damage.

Visual Inspection Chart

Electrical
Fuse(s)
Wiring harness
Electrical connector(s)
Lamp(s)
Switch(es)
Central Junction Box (CJB)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• The front interior lamp is inoperative	• Fuse. • Bulb. • Circuit(s). • Interior lamp switch. • Front interior lamp. • CJB.	• GO to Pinpoint Test A.
• The second interior lamp is inoperative	• Fuse. • Bulb. • Circuit(s). • Interior lamp switch. • Second interior lamp. • CJB.	• GO to Pinpoint Test B.
• First row center interior lamp is inoperative	• Fuse. • Bulb. • Circuit(s). • Interior lamp switch. • Center interior lamp. • CJB.	• GO to Pinpoint Test C.
• Second row center interior lamp is inoperative	• Fuse. • Bulb. • Circuit(s). • Interior lamp switch. • Center interior lamp. • CJB.	• GO to Pinpoint Test D.
• Third row center interior lamp is inoperative	• Fuse. • Bulb. • Circuit(s). • Interior lamp switch. • Center interior lamp. • CJB.	• GO to Pinpoint Test E.

DIAGNOSIS AND TESTING

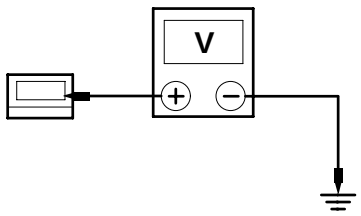
Symptom	Possible Sources	Action
• The left-hand sliding door footwell lamp is inoperative	• Fuse. • Bulb. • Circuit(s). • Footwell lamp switch. • Footwell lamp. • CJB.	• GO to Pinpoint Test F.
• The right-hand sliding door footwell lamp is inoperative	• Fuse. • Bulb. • Circuit(s). • Footwell lamp switch. • Footwell lamp. • CJB.	• GO to Pinpoint Test G.
• The rear door footwell lamp is inoperative	• Fuse. • Bulb. • Circuit(s). • Footwell lamp switch. • Footwell lamp. • CJB.	• GO to Pinpoint Test H.
• The cargo lamp in inoperative (Tourneo)	• Fuse. • Bulb. • Circuit(s). • Cargo lamp switch. • Cargo lamp. • CJB.	• GO to Pinpoint Test I.
• The interior lamps do not turn on with one door open	• Fuse. • Circuit(s). • Interior lamp switch. • CJB.	• For front door, GO to Pinpoint Test A. • For left-hand sliding door, GO to Pinpoint Test F. • For right-hand sliding door, GO to Pinpoint Test G. • For rear door/liftgate, GO to Pinpoint Test H.
• The interior lamp does not automatically turn off after 10 minutes when the lamp is in the ILLUMINATED ENTRY position (if equipped)	• Circuit. • CJB.	• CHECK circuit SBP72 (VT/RD) for short to ground. If the circuit is OK, INSTALL a new CJB. TEST the system for normal operation.
• The interior lamp does not automatically turn off after 30 minutes when the lamp is in the ON position (if equipped)	• CJB.	• INSTALL a new CJB. TEST the system for normal operation.

Pinpoint Tests

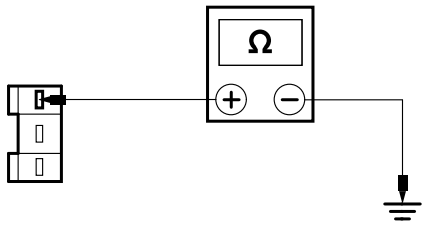
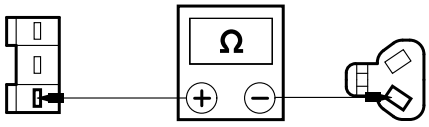
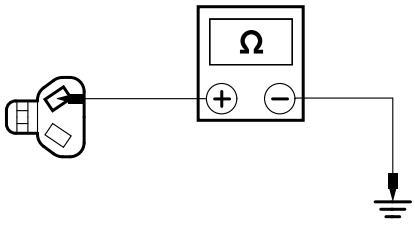
NOTE: Use a digital multimeter for all electrical measurements.

DIAGNOSIS AND TESTING

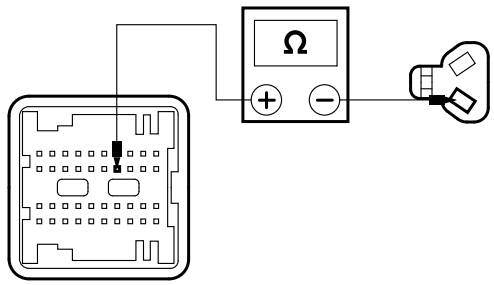
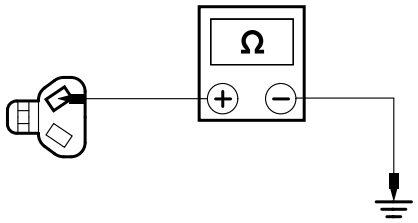
PINPOINT TEST A : THE FRONT INTERIOR LAMP IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK THE OPERATION OF THE FRONT INTERIOR LAMP	
	1 Check the operation of the front interior lamp in both the ON and ILLUMINATED ENTRY positions (if equipped). • Is the front interior lamp inoperative in both positions? → **Yes** GO to A2. → **No** If inoperative in the ILLUMINATED ENTRY position from the left-hand front door (chassis cab with manual locking). GO to A4. If inoperative in the ILLUMINATED ENTRY position from the right-hand front door (chassis cab with manual locking). GO to A6. If inoperative in the ILLUMINATED ENTRY position from the driver door (all except chassis cab with manual locking). GO to A8. If inoperative in the ILLUMINATED ENTRY position from the passenger door (all except chassis cab with manual locking).GO to A12.
A2: CHECK THE FRONT INTERIOR LAMP FOR POWER	
	1 Disconnect Front Interior Lamp CLN28B.
 VUE0003764	2 Measure the voltage between the front interior lamp CLN28B pin 1, circuit SBP72 (VT/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A3. → **No** REPAIR circuit SBP72 (VT/RD). TEST the system for normal operation.
A3: CHECK THE FRONT INTERIOR LAMP FOR GROUND	
	1 Disconnect Front Interior Lamp CLN28A.

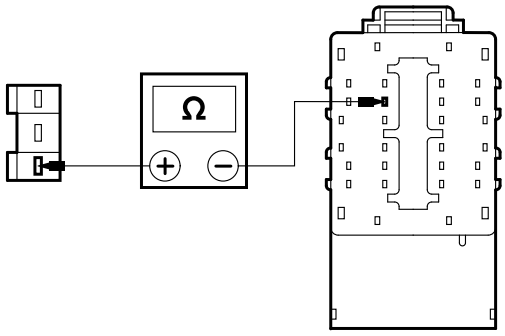
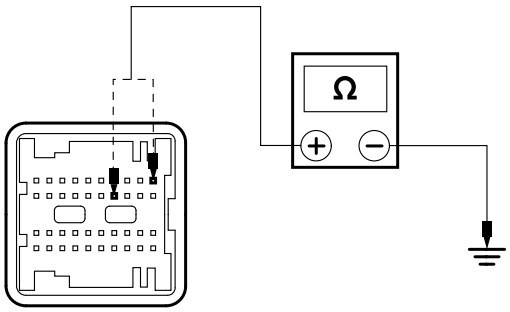
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69765	2 Measure the resistance between: • the front interior lamp CLN28A pin 1, circuit GD151 (BK/GN), harness side and ground (all except chassis cab). • the front interior lamp CLN28A pin 1, circuit GD138 (BK/WH), harness side and ground (chassis cab only). • Is the resistance less than 1 ohm? → **Yes** INSTALL a new front interior lamp. TEST the system for normal operation. → **No** REPAIR circuit GD151D (BK/GN) or circuit GD138 (BK/WH) as necessary. TEST the system for normal operation.
A4: CHECK CIRCUIT CPL01 (VT/GN) FOR OPEN CIRCUIT - LEFT-HAND FRONT DOOR (CHASSIS CAB WITH MANUAL LOCKING ONLY)	
	1 Disconnect Front Interior Lamp CLN28A.
	2 Disconnect Left-Hand Front Door Switch CPL26.
 E73256	3 Measure the resistance between the front interior lamp CLN28A pin 3, circuit CPL01 (VT/GN), harness side and the left-hand front door switch CPL26 pin 1, circuit CPL01 (VT/GN), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to A5. → **No** REPAIR the circuit. TEST the system for normal operation.
A5: CHECK THE LEFT-HAND FRONT DOOR SWITCH FOR GROUND (CHASSIS CAB WITH MANUAL LOCKING ONLY)	
 E73257	1 Measure the resistance between the left-hand front door switch CPL26 pin 2, circuit GD133 (BK), harness side and ground. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new left-hand front door switch → **No** REPAIR circuit GD133 (BK). TEST the system for normal operation.

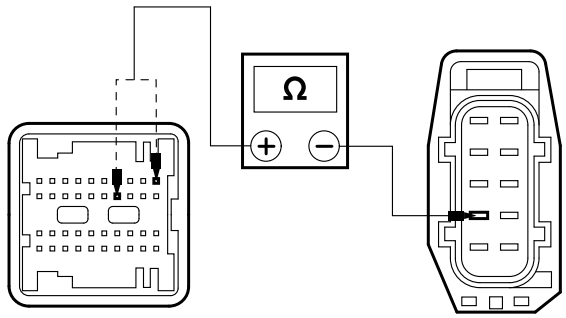
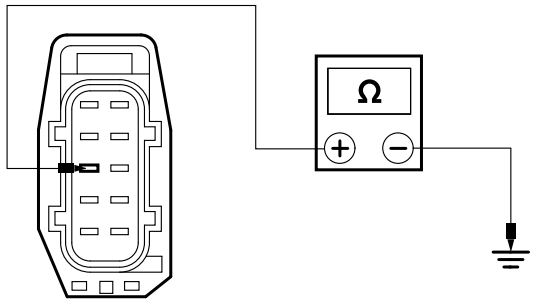
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A6: CHECK CIRCUIT CPL01 (VT/GN) FOR OPEN CIRCUIT - RIGHT-HAND FRONT DOOR (CHASSIS CAB WITH MANUAL LOCKING ONLY)	
	1 Disconnect CJB CBP02C.
	2 Disconnect Left-Hand Front Door Switch CPL31.
 E73632	3 Measure the resistance between the CJB CBP02C pin 14, circuit CPL01 (VT/GN), harness side and the right-hand front door switch CPL31 pin 1, circuit CPL01 (VT/GN), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to A7. → **No** REPAIR the circuit. TEST the system for normal operation.
A7: CHECK THE RIGHT-HAND FRONT DOOR SWITCH FOR GROUND (CHASSIS CAB WITH MANUAL LOCKING ONLY)	
 E73257	1 Measure the resistance between the right-hand front door switch CPL31 pin 2, circuit GD138 (BK/WH), harness side and ground • Is the resistance less than 1 ohm? → **Yes** INSTALL a new right-hand front door switch → **No** REPAIR circuit GD138 (BK/WH). TEST the system for normal operation.
A8: CHECK CIRCUIT CLN03 (YE/GY) FOR OPEN CIRCUIT - DRIVER DOOR (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect CJB CBP02B.
	2 Disconnect Front Interior Lamp CLN28A.

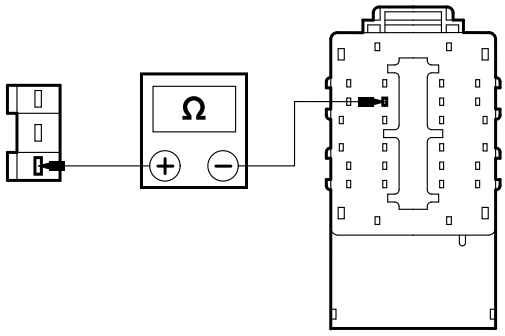
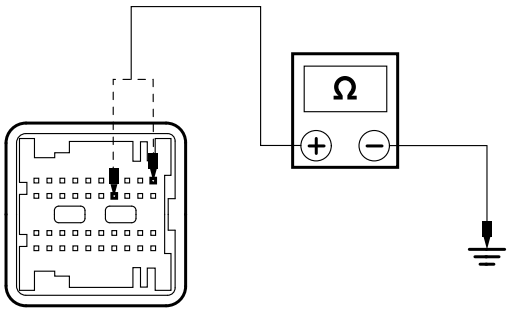
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69990	3 Measure the resistance between the front interior lamp CLN28A pin 3, circuit CLN03 (YE/GY), harness side and the CJB CBP02B pin 22, circuit CLN03 (YE/GY), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to A9. → **No** REPAIR the circuit. TEST the system for normal operation.
A9: CHECK THE FRONT INTERIOR LAMP CIRCUIT FOR GROUND WITH THE DRIVER DOOR OPEN AND CLOSED (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect CJB CBP02C.
 E73124	2 Measure the resistance between: • (LHD) the CJB CBP02C pin 14, circuit CPL26 (GN/VT), harness side and ground with the driver door closed and the driver door open. • (RHD) the CJB CBP02C pin 1, circuit CPL31 (WH), harness side and ground with the driver door closed and the driver door open. • Is the resistance less than 1 ohm with the driver door closed and greater than 10,000 ohms with the driver door open? → **Yes** INSTALL a new CJB. TEST the system for normal operation. → **No** GO to A10.
A10: CHECK CIRCUIT CPL26 (GN/VT) OR CIRCUIT CPL31 (GN/BK) - DRIVER DOOR FOR OPEN CIRCUIT (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect Driver Door Latch CPL22.

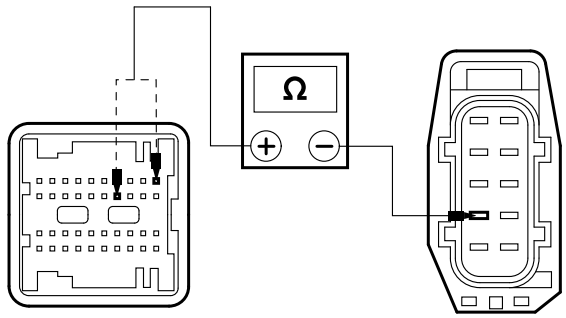
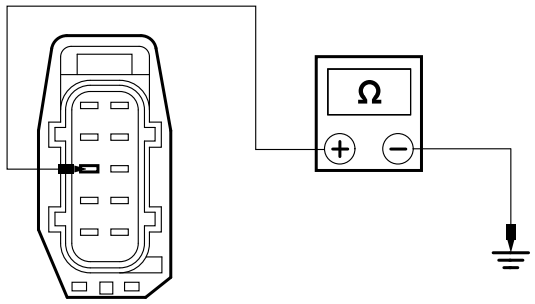
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73633	2 Measure the resistance between: • (LHD) the CJB CBP02C pin 14, circuit CPL26 (GN/VT), harness side and the driver door latch CPL22 pin 8, circuit CPL26 (GN/VT), harness side. • (RHD) the CJB CBP02C pin 1, circuit CPL31 (GN/BK), harness side and the driver door latch CPL22 pin 8, circuit CPL31 (GN/BK), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to A11. → **No** REPAIR circuit CPL26 (GN/VT) or circuit CPL31 (GN/BK) as necessary. TEST the system for normal operation.
A11: CHECK THE DRIVER DOOR LATCH FOR GROUND (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
 E73262	1 Measure the resistance between: • the driver door latch CPL22 pin 6, circuit GD133 (BK), harness side and ground (Jumbo). • the driver door latch CPL22 pin 6, circuit GD138 (BK/WH), harness side and ground (Tourneo). • the driver door latch CPL22 pin 6, circuit GD138 (BK/WH), harness side and ground (Chassis cab with power locking). • Is the resistance less than 1 ohm? → **Yes** INSTALL a new driver door latch. REFER to:Front Door Latch (501-14 Handles, Locks, Latches and Entry Systems, Removal and Installation). TEST the system for normal operation. If the concern persists, INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit GD133 (BK) or circuit GD138 (BK/WH) as necessary. TEST the system for normal operation.
A12: CHECK CIRCUIT CLN03 (YE/GY) FOR OPEN CIRCUIT (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect CJB CBP02B.
	2 Disconnect Front Interior Lamp CLN28A.

DIAGNOSIS AND TESTING

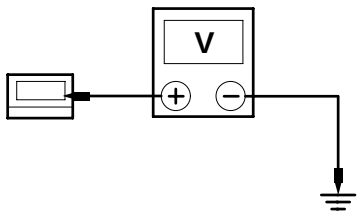
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69990	3 Measure the resistance between the front interior lamp CLN28A pin 3, circuit CLN03 (YE/GY), harness side and the CJB CBP02B pin 22, circuit CLN03 (YE/GY), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to A13. → **No** REPAIR the circuit. TEST the system for normal operation.
A13: CHECK THE FRONT INTERIOR LAMP CIRCUIT FOR GROUND WITH THE PASSENGER DOOR OPEN AND CLOSED (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect CJB CBP02C.
 E73124	2 Measure the resistance between: • (LHD) the CJB CBP02C pin 1, circuit CPL31 (WH), harness side and ground with the passenger door closed and the passenger door open. • (RHD) the CJB CBP02C pin 14, circuit CPL26 (GN/VT), harness side and ground with the passenger door closed and the passenger door open. • Is the resistance less than 5 ohms with the passenger door closed and greater that 10,000 ohms with the passenger door open? → **Yes** INSTALL a new CJB. TEST the system for normal operation. → **No** GO to A14.
A14: CHECK CIRCUIT CPL26 (GN/VT) OR CIRCUIT CPL31 (WH) FOR OPEN CIRCUIT (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect Passenger Door Latch CPL22.

DIAGNOSIS AND TESTING

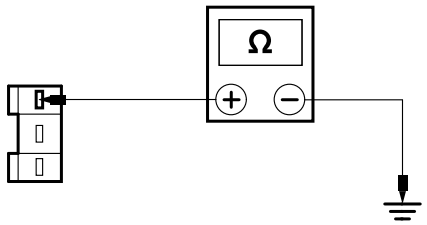
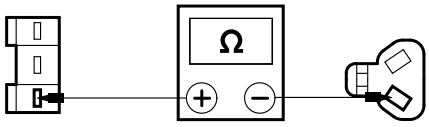
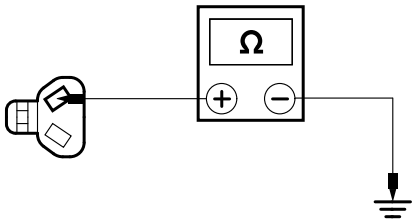
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73633	2 Measure the resistance between: • (LHD) the CJB CBP02C pin 14, circuit CPL26 (GN/VT), harness side and the passenger door latch CPL22 pin 8, circuit CPL26 (GN/VT), harness side. • (RHD) the CJB CBP02C pin 1, circuit CPL31 (WH), harness side and the passenger door latch CPL22 pin 8, circuit CPL31 (WH), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to A15. → **No** REPAIR circuit CPL31 (WH) or circuit CPL26 (GN/VT). TEST the system for normal operation.
A15: CHECK THE PASSENGER DOOR LATCH FOR GROUND (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
 E73262	1 Measure the resistance between: • the passenger door latch CPL22 pin 6, circuit GD138 (BK/WH), harness side and ground (Jumbo). • the passenger door latch CPL22 pin 6, circuit GD133 (BK), harness side and ground (Tourneo). • the passenger door latch CPL22 pin 6, circuit GD133 (BK), harness side and ground (Chassis cab with power locking). • Is the resistance less than 1 ohm? → **Yes** INSTALL a new passenger door latch. REFER to:Front Door Latch (501-14 Handles, Locks, Latches and Entry Systems, Removal and Installation). TEST the system for normal operation. If the concern persists, INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit GD133 (BK) or circuit GD138 (BK/WH) as necessary. TEST the system for normal operation.

DIAGNOSIS AND TESTING

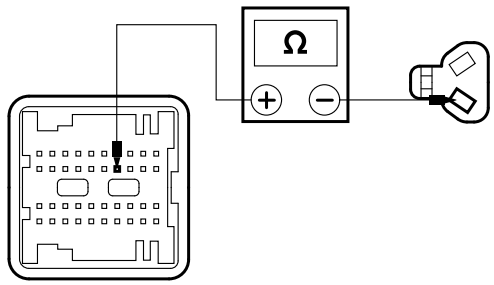
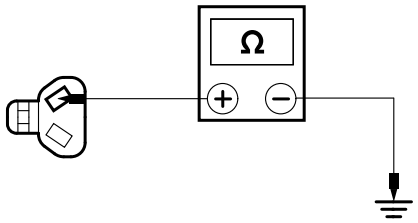
PINPOINT TEST B : THE SECOND INTERIOR LAMP IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK THE OPERATION OF THE SECOND INTERIOR LAMP	
	1 Check the operation of the second interior lamp in both the ON and ILLUMINATED ENTRY positions (if equipped). • Is the second interior lamp inoperative in both positions? → **Yes** GO to B2. → **No** If inoperative in the ILLUMINATED ENTRY position from the left-hand front door (chassis cab with manual locking). GO to B4. If inoperative in the ILLUMINATED ENTRY position from the right-hand front door (chassis cab with manual locking). GO to B6. If inoperative in the ILLUMINATED ENTRY position from the driver door (all except chassis cab with manual locking). GO to B8. If inoperative in the ILLUMINATED ENTRY position from the passenger door (all except chassis cab with manual locking). GO to B12.
B2: CHECK THE SECOND INTERIOR LAMP FOR POWER	
	1 Disconnect Second Interior Lamp CLN28D.
 VUE0003764	2 Measure the voltage between the second interior lamp CLN28D pin 1, circuit SBP72 (VT/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to B3. → **No** REPAIR circuit SBP72 (VT/RD). TEST the system for normal operation.
B3: CHECK THE SECOND INTERIOR LAMP FOR GROUND	
	1 Disconnect Second Interior Lamp CLN28C.

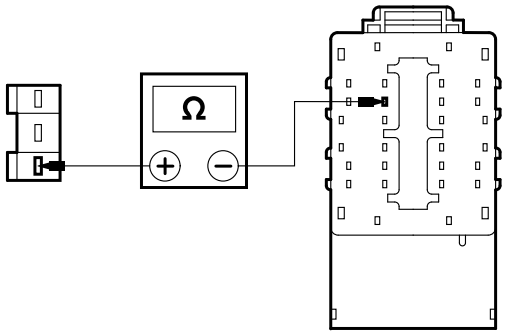
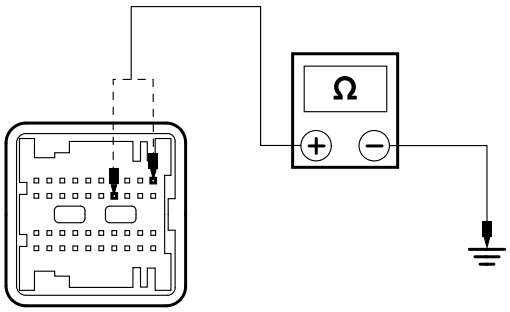
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69765	2 Measure the resistance between: • the second interior lamp CLN28C pin 1, circuit GD151 (BK/GN), harness side and ground (all except chassis cab). • the second interior lamp CLN28C pin 1, circuit GD138 (BK/WH), harness side and ground (chassis cab only). • Is the resistance less than 1 ohm? → **Yes** INSTALL a new second interior lamp. TEST the system for normal operation. → **No** REPAIR circuit GD151 (BK/GN) or circuit GD138 (BK/WH). TEST the system for normal operation.
B4: CHECK CIRCUIT CPL01 (VT/GN) FOR OPEN CIRCUIT - LEFT-HAND FRONT DOOR (CHASSIS CAB WITH MANUAL LOCKING ONLY)	
	1 Disconnect Second Interior Lamp CLN28C.
	2 Disconnect Left-Hand Front Door Switch CPL26.
 E73256	3 Measure the resistance between the second interior lamp CLN28C pin 3, circuit CPL01 (VT/GN), harness side and the left-hand front door switch CPL26 pin 1, circuit CPL01 (VT/GN), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to B5. → **No** REPAIR the circuit. TEST the system for normal operation.
B5: CHECK THE LEFT-HAND FRONT DOOR SWITCH FOR GROUND (CHASSIS CAB WITH MANUAL LOCKING ONLY)	
 E73257	1 Measure the resistance between the left-hand front door switch CPL26 pin 2, circuit GD133 (BK), harness side and ground. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new left-hand front door switch → **No** REPAIR circuit GD133 (BK). TEST the system for normal operation.

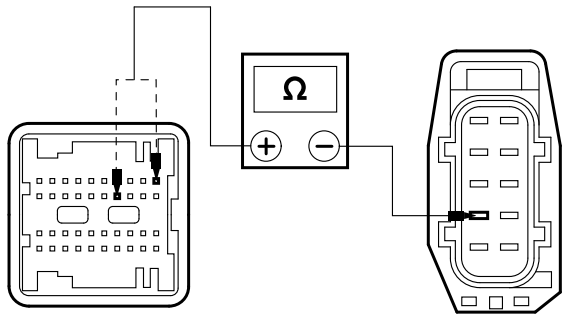
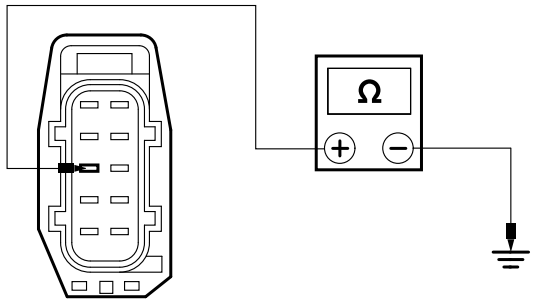
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B6: CHECK CIRCUIT CPL01 (VT/GN) FOR OPEN CIRCUIT - RIGHT-HAND FRONT DOOR (CHASSIS CAB WITH MANUAL LOCKING ONLY)	
	1 Disconnect CJB CBP02C.
	2 Disconnect Left-Hand Front Door Switch CPL31.
 E73632	3 Measure the resistance between the CJB CBP02C pin 14, circuit CPL01 (VT/GN), harness side and the right-hand front door switch CPL31 pin 1, circuit CPL01 (VT/GN), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to B7. → **No** REPAIR the circuit. TEST the system for normal operation.
B7: CHECK THE RIGHT-HAND FRONT DOOR SWITCH FOR GROUND (CHASSIS CAB WITH MANUAL LOCKING ONLY)	
 E73257	1 Measure the resistance between the right-hand front door switch CPL31 pin 2, circuit GD138 (BK/WH), harness side and ground • Is the resistance less than 1 ohm? → **Yes** INSTALL a new right-hand front door switch → **No** REPAIR circuit GD138 (BK/WH). TEST the system for normal operation.
B8: CHECK CIRCUIT CLN03 (YE/GY) FOR OPEN CIRCUIT - DRIVER DOOR (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect CJB CBP02B.
	2 Disconnect Second Interior Lamp CLN28C.

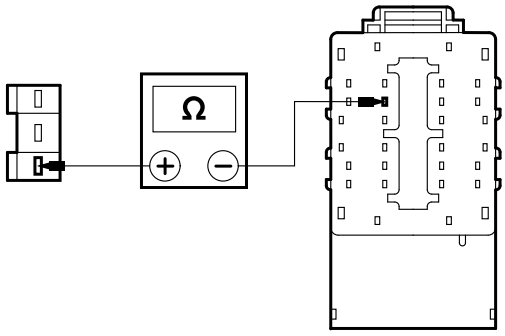
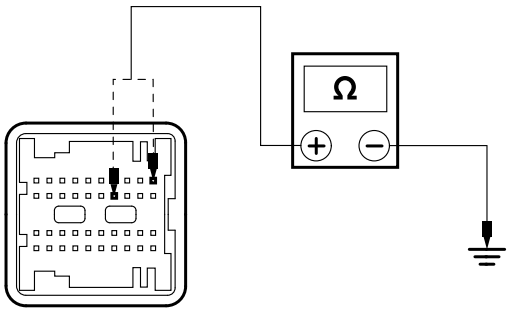
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69990	3 Measure the resistance between the second interior lamp CLN28C pin 3, circuit CLN03 (YE/GY), harness side and the CJB CBP02B pin 22, circuit CLN03 (YE/GY), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B9. → **No** REPAIR the circuit. TEST the system for normal operation.
B9: CHECK THE SECOND INTERIOR LAMP CIRCUIT FOR GROUND WITH THE DRIVER DOOR OPEN AND CLOSED (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect CJB CBP02C.
 E73124	2 Measure the resistance between: • (LHD) the CJB CBP02C pin 14, circuit CPL26 (GN/VT), harness side and ground with the driver door closed and the driver door open. • (RHD) the CJB CBP02C pin 1, circuit CPL31 (GN/BK), harness side and ground with the driver door closed and the driver door open. • Is the resistance less than 1 ohm with the driver door closed and greater that 10,000 ohms with the driver door open? → **Yes** INSTALL a new CJB. TEST the system for normal operation. → **No** GO to B10.
B10: CHECK CIRCUIT CPL26 (GN/VT) OR CIRCUIT CPL31 (GN/BK) - DRIVER DOOR FOR OPEN CIRCUIT (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect Driver Door Latch CPL22.

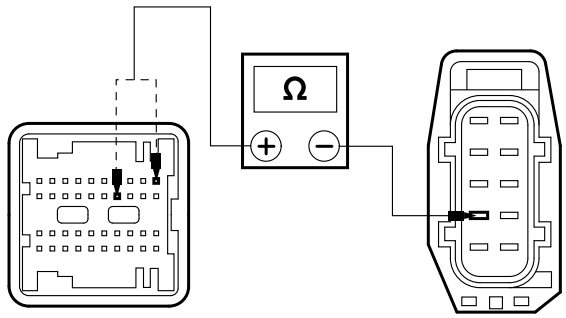
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73633	2 Measure the resistance between: • (LHD) the CJB CBP02C pin 14, circuit CPL26 (GN/VT), harness side and the driver door latch CPL22 pin 8, circuit CPL26 (GN/VT), harness side. • (RHD) the CJB CBP02C pin 1, circuit CPL31 (GN/BK), harness side and the driver door latch CPL22 pin 8, circuit CPL31 (GN/BK), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to B11. → **No** REPAIR circuit CPL26 (GN/VT) or circuit CPL31 (GN/BK) as necessary. TEST the system for normal operation.
B11: CHECK THE DRIVER DOOR LATCH FOR GROUND (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
 E73262	1 Measure the resistance between: • the driver door latch CPL22 pin 6, circuit GD133 (BK), harness side and ground (Jumbo). • the driver door latch CPL22 pin 6, circuit GD138 (BK/WH), harness side and ground (Tourneo). • the driver door latch CPL22 pin 6, circuit GD138 (BK/WH), harness side and ground (Chassis cab with power locking). • Is the resistance less than 1 ohm? → **Yes** INSTALL a new driver door latch. REFER to:Front Door Latch (501-14 Handles, Locks, Latches and Entry Systems, Removal and Installation). TEST the system for normal operation. If the concern persists, INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit GD133 (BK) or circuit GD138 (BK/WH) as necessary. TEST the system for normal operation.
B12: CHECK CIRCUIT CLN03 (YE/GY) FOR OPEN CIRCUIT (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect CJB CBP02B.
	2 Disconnect Second Interior Lamp CLN28C.

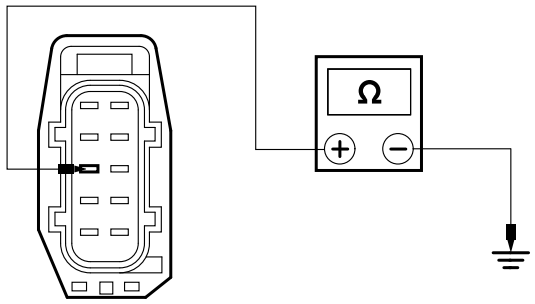
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69990	3 Measure the resistance between the second interior lamp CLN28C pin 3, circuit CLN03 (YE/GY), harness side and the CJB CBP02B pin 22, circuit CLN03 (YE/GY), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to B13. → **No** REPAIR the circuit. TEST the system for normal operation.
B13: CHECK THE SECOND INTERIOR LAMP CIRCUIT FOR GROUND WITH THE PASSENGER DOOR OPEN AND CLOSED (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect CJB CBP02C.
 E73124	2 Measure the resistance between: • (LHD) the CJB CBP02C pin 1, circuit CPL31 (WH), harness side and ground with the passenger door closed and the passenger door open. • (RHD) the CJB CBP02C pin 14, circuit CPL26 (GN/VT), harness side and ground with the passenger door closed and the passenger door open. • Is the resistance less than 1 ohm with the passenger door closed and greater that 10,000 ohms with the passenger door open? → **Yes** INSTALL a new CJB. TEST the system for normal operation. → **No** GO to B14.
B14: CHECK CIRCUIT CPL26 (GN/VT) OR CIRCUIT CPL31 (WH) FOR OPEN CIRCUIT (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)	
	1 Disconnect Passenger Door Latch CPL22.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73633	2 Measure the resistance between: • (LHD) the CJB CBP02C pin 14, circuit CPL26 (GN/VT), harness side and the passenger door latch CPL22 pin 8, circuit CPL26 (GN/VT), harness side. • (RHD) the CJB CBP02C pin 1, circuit CPL31 (WH), harness side and the passenger door latch CPL22 pin 8, circuit CPL31 (WH), harness side. • Is the resistance less than 1 ohm? → **Yes** GO to B15. → **No** REPAIR circuit CPL31 (WH) or cicuit CPL26 (GN/VT). TEST the system for normal operation.

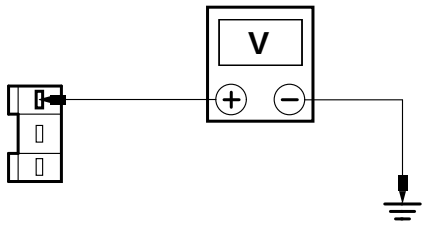
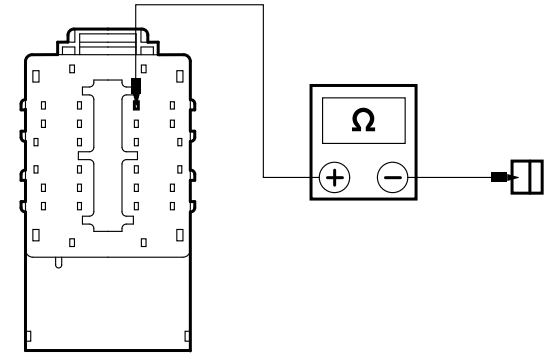
B15: CHECK THE PASSENGER DOOR LATCH FOR GROUND (ALL EXCEPT CHASSIS CAB WITH MANUAL LOCKING)

 E73262	1 Measure the resistance between: • the passenger door latch CPL22 pin 6, circuit GD138 (BK/WH), harness side and ground (Jumbo). • the passenger door latch CPL22 pin 6, circuit GD133 (BK), harness side and ground (Tourneo). • the passenger door latch CPL22 pin 6, circuit GD133 (BK), harness side and ground (Chassis cab with power locking). • Is the resistance less than 1 ohm? → **Yes** INSTALL a new passenger door latch. REFER to:Front Door Latch (501-14 Handles, Locks, Latches and Entry Systems, Removal and Installation). TEST the system for normal operation. If the concern persists, INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit GD133 (BK) or circuit GD138 (BK/WH) as necessary. TEST the system for normal operation.

PINPOINT TEST C : FIRST ROW CENTER INTERIOR LAMP IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CHECK THE FIRST ROW CENTER INTERIOR LAMP FOR POWER	
	1 Disconnect First Row Center Interior Lamp CLN28E.

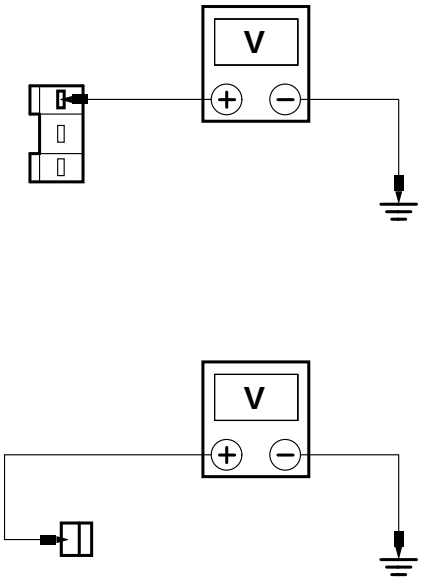
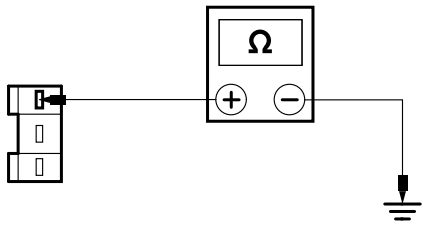
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69770	2 Measure the voltage between the first row center interior lamp CLN28E pin 1, circuit SBP72 (VT/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to C2. → **No** REPAIR circuit SBP72 (VT/RD). TEST the system for normal operation.
C2: CHECK CIRCUIT CLN43 FOR OPEN CIRCUIT	
	1 Disconnect First Row Center Interior Lamp CLN28F.
	2 Disconnect CJB CBP02B.
 E69772	3 Measure the resistance between the first row center interior lamp CLN28F pin 1, circuit CLN43 (WH/BU), harness side and the CJB CBP02B pin 27, circuit CLN43 (WH/BU), harness side. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new first row center interior lamp. TEST the system for normal operation. If the concern persists, INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit CLN43 (WH/BU). TEST the system for normal operation.

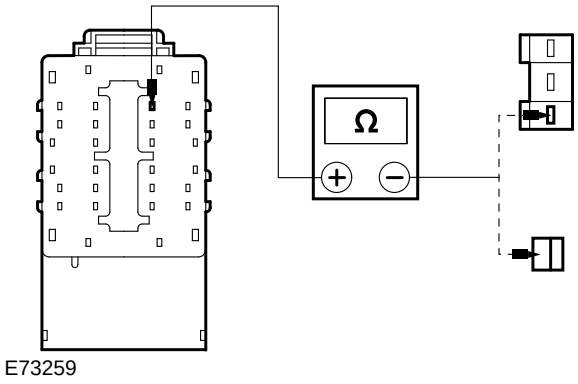
PINPOINT TEST D : SECOND ROW CENTER INTERIOR LAMP IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: CHECK THE SECOND ROW CENTER INTERIOR LAMP FOR POWER	
	1 Disconnect Second Row Center Interior Lamp CLN28G (Jumbo).
	2 Disconnect Second Row Center Interior Lamp CLN28F (Tourneo).

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73258	3 Measure the voltage between: • the second row center interior lamp CLN28G pin 1, circuit SBP72 (VT/RD), harness side and ground (Jumbo). • the second row center interior lamp CLN28F pin 1, circuit SBP72 (VT/RD), harness side and ground (Tourneo). • Is the voltage greater than 10 volts? → **Yes** GO to D2. → **No** REPAIR circuit SBP72 (VT/RD). TEST the system for normal operation.
D2: CHECK THE SECOND ROW CENTER INTERIOR LAMP FOR GROUND	
 E69765	1 Measure the resistance between the second row center interior lamp CLN28E pin 1, circuit GD151 (BK/GN), harness side and ground. • Is the resistance less than 1 ohm? → **Yes** GO to D3. → **No** REPAIR circuit GD151 (BK/GN). TEST the system for normal operation.
D3: CHECK CIRCUIT CLN43 (WH/BU) FOR OPEN CIRCUIT	
	1 Disconnect Second Row Center Interior Lamp CLN28H (Jumbo).
	2 Disconnect Second Row Center Interior Lamp CLN28E (Tourneo).
	3 Disconnect CJB CBP02B.

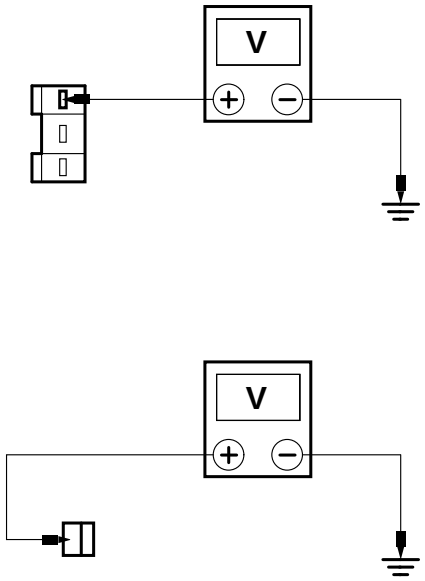
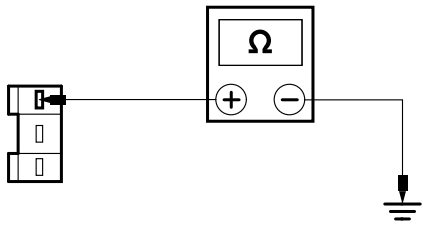
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73259	4 Measure the resistance between: • the second row center interior lamp CLN28H pin 1, circuit CLN43 , harness side and the CJB CBP02B pin 27, circuit CLN43 (WH/BU), harness side (Jumbo). • the second row center interior lamp CLN28H pin 3, circuit CLN43 (WH/BU), harness side and the CJB CBP02B pin 27, circuit CLN43 (WH/BU), harness side (Tourneo). • Is the resistance less than 1 ohm? → **Yes** INSTALL a new second row center interior lamp. TEST the system for normal operation. If the concern persists, INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit CLN43 (WH/BU). TEST the system for normal operation.

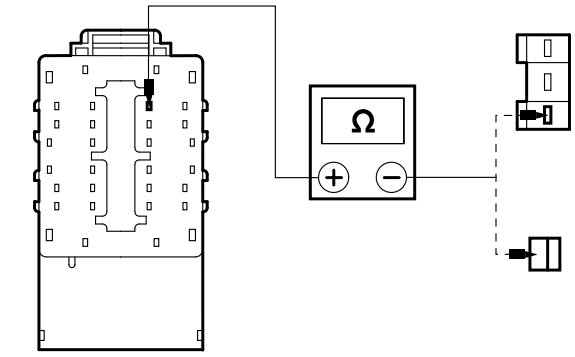
PINPOINT TEST E : THIRD ROW CENTER INTERIOR LAMP IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: CHECK THE THIRD ROW CENTER INTERIOR LAMP FOR POWER	
	1 Disconnect Third Row Center Interior Lamp CLN28J (Jumbo).
	2 Disconnect Third Row Center Interior Lamp CLN28H (Tourneo).

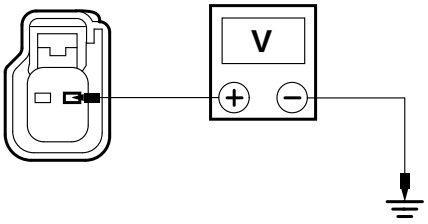
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73258	3 Measure the voltage between: • the third row center interior lamp CLN28J pin 1, circuit SBP72 (VT/RD), harness side and ground. • the third row center interior lamp CLN28H pin 1, circuit SBP72 (VT/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to E2. → **No** REPAIR circuit SBP72 (VT/RD). TEST the system for normal operation.
E2: CHECK THE THIRD ROW CENTER INTERIOR LAMP FOR GROUND	
 E69765	1 Measure the resistance between the third row center interior lamp CLN28G pin 1, circuit GD151 (BK/GN), harness side and ground (Tourneo). • Is the resistance less than 1 ohm? → **Yes** GO to E3. → **No** REPAIR circuit GD151 (BK/GN). TEST the system for normal operation.
E3: CHECK CIRCUIT CLN43 (WH/BU) FOR OPEN CIRCUIT	
	1 Disconnect Third Row Center Interior Lamp CLN28K (Jumbo).
	2 Disconnect Third Row Center Interior Lamp CLN28G (Tourneo).
	3 Disconnect CJB CBP02B.

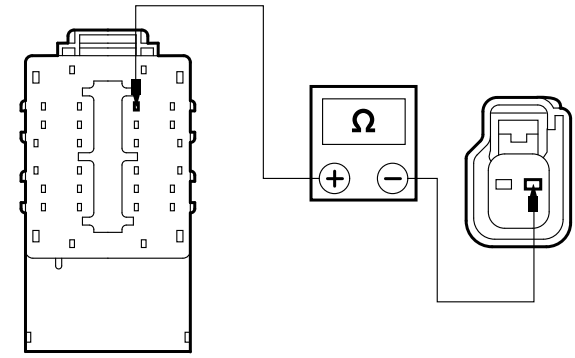
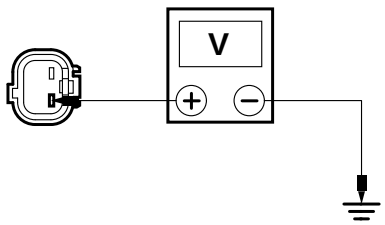
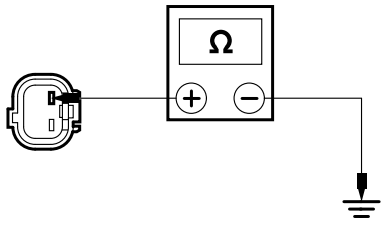
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73259	4 Measure the resistance between: • the third row center interior lamp CLN28K pin 1, circuit CLN43 (WH/BU), harness side and the CJB CBP02B pin 27, circuit CLN43 (WH/BU), harness side (Jumbo). • the third row center interior lamp CLN28G pin 1, circuit CLN43 (WH/BU), harness side and the CJB CBP02B pin 27, circuit CLN43 (WH/BU), harness side (Tourneo). • Is the resistance less than 1 ohm? → **Yes** INSTALL a new third row center interior lamp. TEST the system for normal operation. If the concern persists, INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit CLN43 (WH/BU). TEST the system for normal operation.

PINPOINT TEST F : THE LEFT-HAND SLIDING DOOR FOOTWELL LAMP IS INOPERATIVE

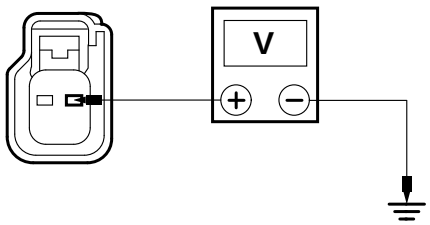
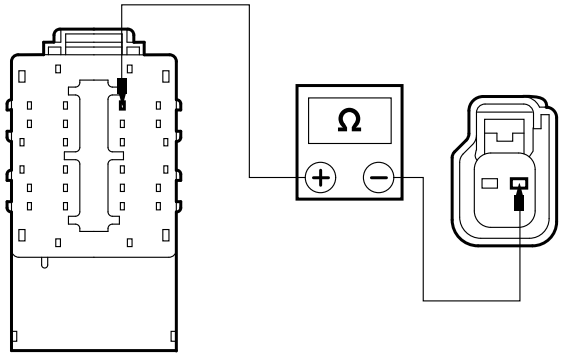
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F1: CHECK THE LEFT-HAND SLIDING DOOR FOOTWELL LAMP FOR POWER	
	1 Disconnect Left-Hand Sliding Door Footwell Lamp CLN28N.
 E69771	2 Measure the voltage between the left-hand sliding door footwell lamp CLN28N pin 1, circuit SBP72 (VT/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to F2. → **No** REPAIR circuit SBP72 (VT/RD). TEST the system for normal operation.
F2: CHECK CIRCUIT CLN43 (WH/BU) FOR OPEN CIRCUIT	
	1 Disconnect Left-Hand Sliding Door Footwell Lamp CLN28P.
	2 Disconnect CJB CBP02B.

DIAGNOSIS AND TESTING

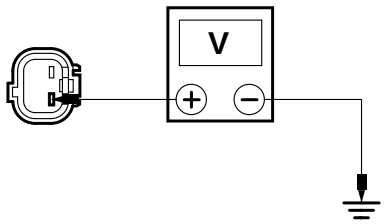
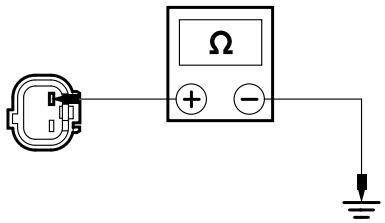
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69784	3 Measure the resistance between the left-hand sliding door footwell lamp CLN28P pin 1, circuit CLN43 (WH/BU), harness side and the CJB CBP02B pin 27, circuit CLN43 (WH/BU), harness side. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new left-hand sliding door footwell lamp. TEST the system for normal operation. If the concern persists, GO to F3. → **No** REPAIR circuit CLN43 (WH/BU). TEST the system for normal operation.
F3: CHECK THE LEFT-HAND SLIDING DOOR SWITCH FOR POWER	
	1 Disconnect Left-Hand Sliding Door Switch CPL36D.
 E70048	2 Measure the voltage between the left-hand sliding door switch CPL36D pin 1, circuit CPL36 (GN), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to F4. → **No** REPAIR circuit CPL36 (GN). TEST the system for normal operation.
F4: CHECK THE LEFT-HAND SLIDING DOOR SWITCH FOR GROUND	
 E70049	1 Measure the resistance between the left-hand sliding door switch CPL36D pin 2, circuit GD149 (BK/GY), harness side and ground. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new left-hand sliding door switch. TEST the system for normal operation. If the concern persists, INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit GD149 (BK/GY). TEST the system for normal operation.

DIAGNOSIS AND TESTING

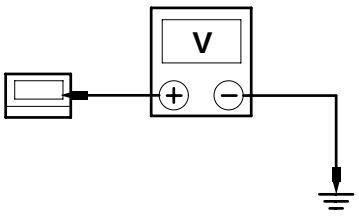
PINPOINT TEST G : THE RIGHT-HAND SLIDING DOOR FOOTWELL LAMP IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G1: CHECK THE RIGHT-HAND SLIDING DOOR FOOTWELL LAMP FOR POWER	
	1 Disconnect Right-Hand Sliding Door Footwell Lamp CLN28Q.
 E69771	2 Measure the voltage between the right-hand sliding door footwell lamp CLN28Q pin 1, circuit SBP72AD (VT/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to G2. → **No** REPAIR circuit SBP72AD (VT/RD). TEST the system for normal operation.
G2: CHECK CIRCUIT CLN43 (WH/BU) FOR OPEN CIRCUIT	
	1 Disconnect Right-Hand Sliding Door Footwell Lamp CLN28R.
	2 Disconnect CJB CBP02B.
 E69784	3 Measure the resistance between the right-hand sliding door footwell lamp CLN28R pin 1, circuit CLN43 (WH/BU), harness side and the CJB CBP02B pin 27, circuit CLN43 (WH/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new right-hand sliding door footwell lamp. TEST the system for normal operation. If the concern persists, GO to G3. → **No** REPAIR circuit CLN43 (WH/BU). TEST the system for normal operation.
G3: CHECK THE RIGHT-HAND SLIDING DOOR SWITCH FOR POWER	
	1 Disconnect Right-Hand Sliding Door Switch CPL39D.

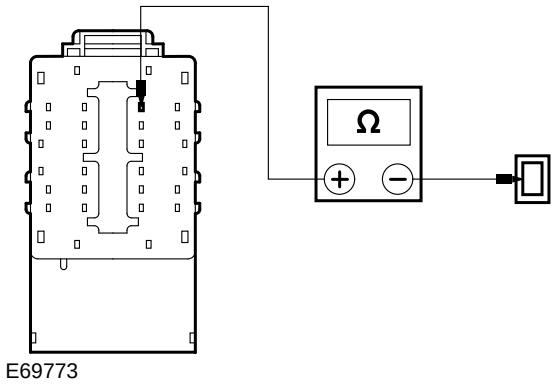
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E70048	2 Measure the voltage between the right-hand sliding door switch CPL39D pin 1, circuit CPL39 (YE), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to G4. → **No** REPAIR circuit CPL39 (YE). TEST the system for normal operation.
G4: CHECK THE RIGHT-HAND SLIDING DOOR SWITCH FOR GROUND	
 E70049	1 Measure the resistance between the right-hand sliding door switch CPL39D pin 2, circuit GD151 (BK/GN), harness side and ground. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new right-hand sliding door switch. TEST the system for normal operation. If the concern persists, INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit GD149 (BK/GY). TEST the system for normal operation.

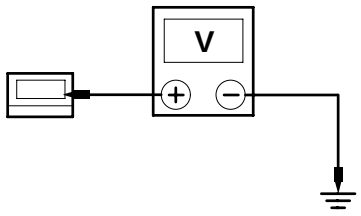
PINPOINT TEST H : THE REAR DOOR FOOTWELL LAMP IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
H1: CHECK THE REAR DOOR FOOTWELL LAMP FOR POWER	
	1 Disconnect Rear Door Footwell Lamp CLN28L.
 VUE0003764	2 Measure the voltage between the rear door footwell lamp CLN28L pin 1, circuit SBP72 (VT/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to H2. → **No** REPAIR circuit SBP72 (VT/RD). TEST the system for normal operation.
H2: CHECK CIRCUIT CLN43 (WH/BU) FOR OPEN CIRCUIT	
	1 Disconnect Rear Door Footwell Lamp CLN28M.

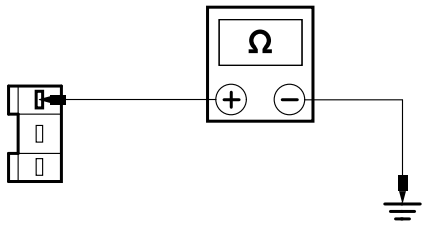
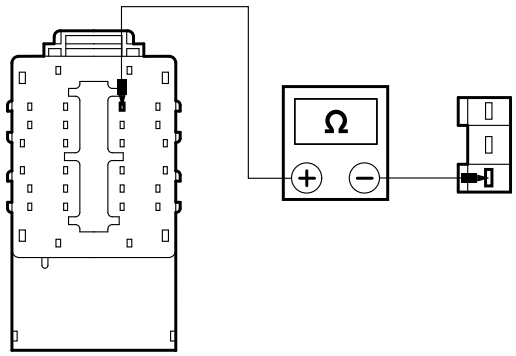
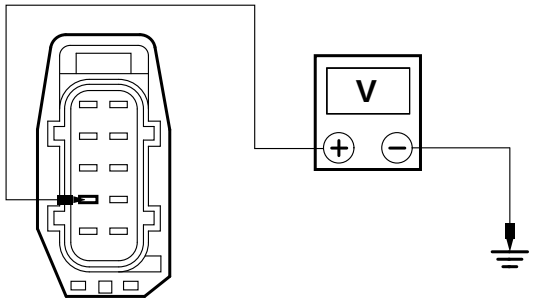
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect CJB CBP02B.
 E69773	3 Measure the resistance between the rear door footwell lamp CLN28M pin 1, circuit CLN43 (WH/BU), harness side and the CJB CBP02B pin 27, circuit CLN43 (WH/BU), harness side. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new rear door footwell lamp. TEST the system for normal operation. If the concern persists, INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit CLN43 . TEST the system for normal operation.

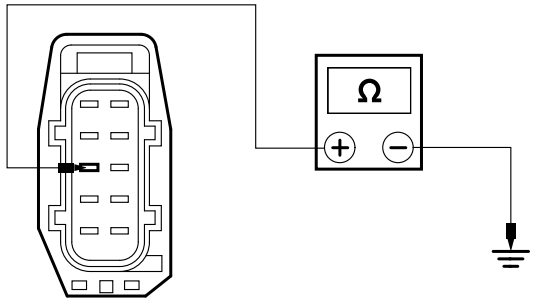
PINPOINT TEST I : THE CARGO LAMP IS INOPERATIVE (TOURNEO)

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I1: CHECK THE CARGO LAMP FOR POWER	
	1 Disconnect Cargo Lamp CLN28K.
 VUE0003764	2 Measure the voltage between the cargo lamp CLN28K pin 1, circuit SBP72 (VT/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to I2. → **No** REPAIR circuit SBP72 (VT/RD). TEST the system for normal operation.
I2: CHECK THE CARGO LAMP FOR GROUND	
	1 Disconnect Cargo Lamp CLN28J.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69765	2 Measure the resistance between the cargo lamp CLN28J pin 1, circuit GD151 (BK/GN), harness side and ground. • Is the resistance less than 1 ohm? → **Yes** GO to I3. → **No** REPAIR circuit GD151 (BK/GN). TEST the system for normal operation.
I3: CHECK CIRCUIT CLN43 (WH/BU) FOR OPEN CIRCUIT	
 E73260	1 Measure the resistance between the cargo lamp CLN28J pin 3, circuit CLN43 (WH/BU), harness side and the CJB CBP02B pin 27, circuit CLN43 (WH/BU), harness side. • Is the resistance less than 1 ohm? → **Yes** INSTALL a new cargo lamp. TEST the system for normal operation. If the concern persists, GO to I4. → **No** REPAIR circuit CLN43 (WH/BU). TEST the system for normal operation.
I4: CHECK THE REAR DOOR LATCH FOR POWER	
	1 Disconnect Rear Door Latch CPL44.
 E73261	2 Measure the voltage between the rear door latch CPL44 pin 8, circuit CPL44 (YE/OG), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to I5. → **No** REPAIR circuit CPL44 (YE/OG). TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I5: CHECK THE REAR DOOR LATCH FOR GROUND	
 E73262	1 Measure the resistance between: • the rear door latch CPL44 pin 6, circuit GD151 (BK/GN), harness side and ground (Jumbo). • the rear door latch CPL44 pin 6, circuit GD149 (BK/GY), harness side and ground (Tourneo). • Is the resistance less than 1 ohm? → **Yes** INSTALL a new rear door latch. REFER to:Rear Door Latch - Van/Kombi/Bus (501-14 Handles, Locks, Latches and Entry Systems, Removal and Installation). TEST the system for normal operation. If the concern persists, INSTALL a new CJB. TEST the system for normal operation. → **No** REPAIR circuit GD151 (BK/GN) or circuit GD149 (BK/GY) as necessary. TEST the system for normal operation.

SECTION 418-00 Module Communications Network

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Communications Network..... 418-00-2
General..... 418-00-2
Network Components..... 418-00-3

DIAGNOSIS AND TESTING

Communications Network..... 418-00-7
Inspection and Testing..... 418-00-7
Symptom chart..... 418-00-7
Pinpoint Tests..... 418-00-9
Component checks..... 418-00-128

DESCRIPTION AND OPERATION

Communications Network

General

In a communications network (data bus system), various modules of different systems are connected to one another via one or several lines.

The sole purpose of the data bus system is the transmission of data between the connected modules themselves, as well as between the connected modules and the Worldwide Diagnostic System (WDS).

In a data bus system, complete data blocks are transmitted instead of single on/off pulses. In addition to the actual information, these data blocks also contain data regarding the address of the module to be addressed, the size of the data block and information for monitoring the content of each individual data block.

Data bus systems offer various advantages:

- Simplified data transmission between the modules due to a standardised protocol
- Fewer sensors and connectors
- Improved diagnostic options
- Lower costs

The WDS is connected to the various data bus systems and to the voltage supply via the standard 16-pin data link connector (DLC). The signal for the module programming is also transferred via the DLC.

In a data bus system, if there is a break in one or both lines or there is a short to ground or to voltage, then communication between the modules and with the WDS is disturbed or is no longer possible at all.

In order to be able to establish communication with one another, the modules of the individual systems must use the same language. This language is called a protocol.

At the moment, Ford uses four different data bus systems. Depending upon model and equipment level, all four data bus systems may be used. Each of these data bus systems has its own protocol.

Data bus systems:

- Standard Corporate Protocol (SCP) bus. This consists of two twisted wires. It provides the communication between the powertrain control module (PCM) and the WDS through the DLC. Depending upon engine version and year of manufacture, a third wire (ACP bus) is used for programming the PCM. This bus is only used in conjunction with the SCP bus.
- International Organisation for Standardisation ISO 9141 bus. This consists of a single wire and is used exclusively for communication between the modules and the WDS. The fault memories of the various modules are read out via the ISO 9141 bus.
- The Local Interconnect Network (LIN) bus is a standard especially for the cost-efficient communication between intelligent sensors and actuators in motor vehicles. LIN is used in every situation where the band width and versatility of CAN is not needed. A LIN network consists of a LIN master and one or more LIN slaves. The LIN master, which is represented by the GEM in Transit, has information on the chronological order of all data to be transmitted. This data will be transferred by the corresponding LIN slaves (e.g. ultrasonic sensors) when they are prompted by the LIN master. The LIN is a single conductor bus, i.e. the data is transmitted in the cable on one wire. Normally the supply voltage is also passed through the same cable. The ground of the voltage supply is also the ground of the data transmission. A LIN network does not use a terminating resistor.
- Controller Area Network (CAN) bus. This consists of two twisted wires and operates serially (data is transmitted sequentially). It is used for communication between the modules themselves and between the modules and the WDS. The modules are connected to the data bus in parallel. New modules can be incorporated easily, without modifying the other wiring or modules. The transmitted data is received by every module connected to the CAN bus. As each data packet has an identifier (label), in which the priority of the message is determined as well as the content identification, each module can detect whether or not the data is relevant for its own information processing. This enables several modules to be addressed with a particular data packet and supplied with data simultaneously. For this purpose, it is ensured that important data (for example from the anti-lock braking system (ABS)) are transmitted first. The other modules are only able to submit their data to the data bus after the high-priority messages have been received.

DESCRIPTION AND OPERATION

In order to guarantee a high degree of error protection, two 120 Ohm terminating resistors are installed in the CAN bus. These are integrated in the first module connected to the CAN bus and in the last module connected to the CAN bus respectively and are used for suppression as well as the elimination of voltage peaks. In order to ensure correct functioning of the data bus system, the modules must always be connected with an integral terminating resistor.

The advantages of the CAN bus are:

- Minimization of wiring requirements
- High degree of error protection (fault / fail-proof)
- Robustness
- Good extendibility
- Prioritization of messages
- Inexpensive
- Automatic repetition of faulty messages
- Independent system monitoring and the ability to automatically disconnect faulty modules from the data bus.

In vehicles built from MY 2003.75, an additional second CAN bus system is used depending upon vehicle model. The only significant difference is a lower transmission rate and at present it is mainly used for the convenience electronics. In order to be able to differentiate between individual CAN bus systems, the CAN bus system with the high transmission rate is designated as high-speed (HS) CAN bus and the CAN bus system with the lower transmission rate as mid-speed (MS) CAN bus. As for all CAN bus systems, two 120 Ohm terminating resistors are also installed on the MS CAN bus to increase error protection. In order to enable communication between the modules on the HS CAN bus and the modules on the MS CAN bus, one module is connected to both data bus systems. The connection of both data bus systems is designated as a gateway. In this gateway, the received data is converted to the transmission rate required for the relevant data bus and is transmitted. This ensures an optimal distribution of information between both data bus systems.

Network Components

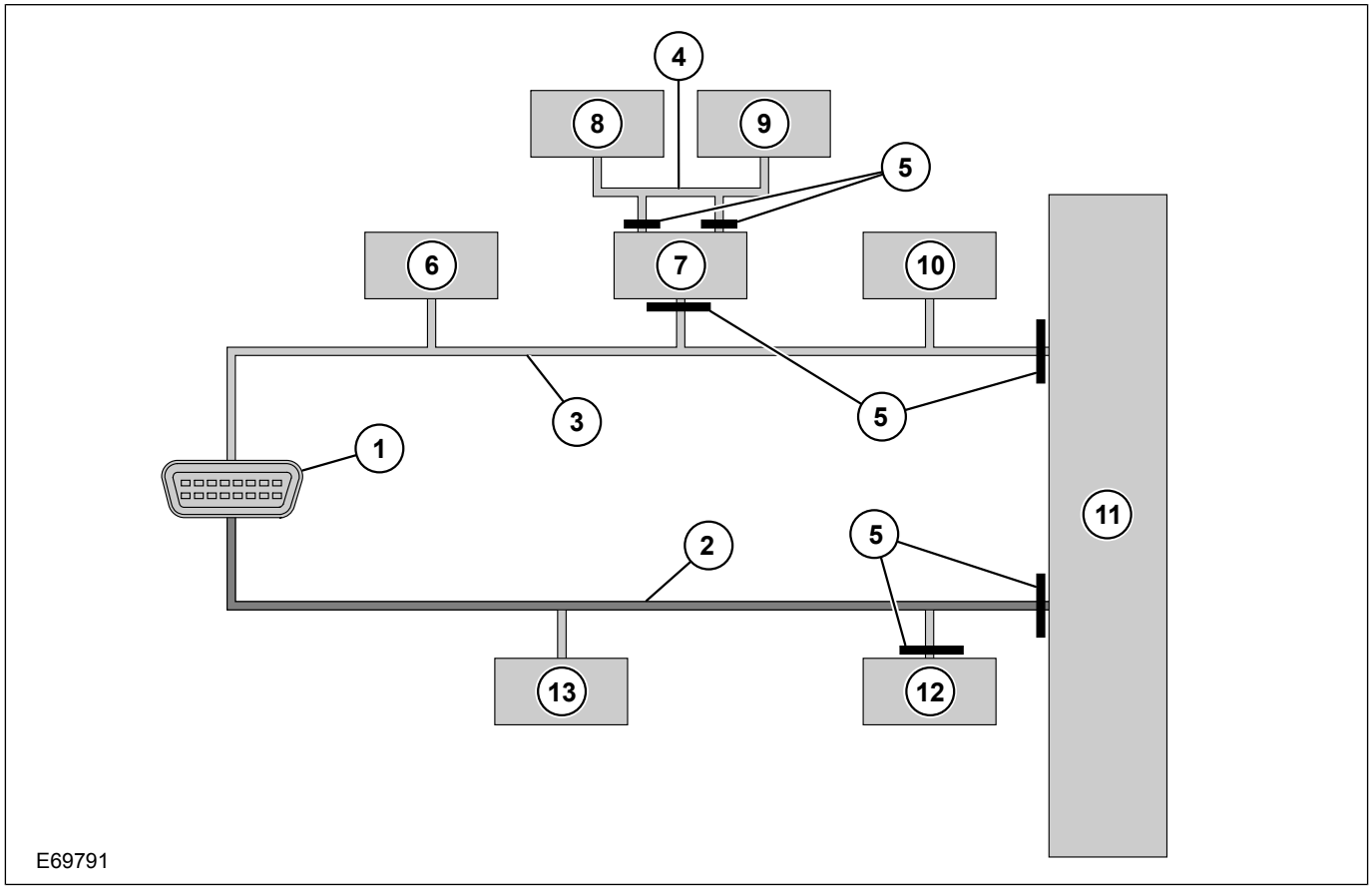
Depending on the equipment level, three data bus systems are used on Transit built from MY2006.5.

Because of the increased number of modules and the resulting still further increase in data transfer, two other CAN bus systems are used in addition to the HS CAN bus (the mid-speed CAN bus (MS CAN bus) and the multimedia CAN bus (MM CAN bus)). These operate at a lower speed and mainly provide communication in the comfort electronics and multimedia system areas. Two gateways are used in order to enable data exchange between the HS CAN bus, the MS CAN bus and the MM CAN bus. These act as interfaces between the three CAN data bus systems and are each installed in the GEM and in the electronic instrument cluster. The number of modules connected to the three CAN data bus systems depends on the equipment level of the vehicle. One 120 Ohm terminating resistor of the HS CAN bus is installed in the PCM and another in the instrument cluster. One 120 Ohm terminating resistor of the MS CAN bus is installed in the GEM and one in the electronic instrument cluster respectively. Both 120 Ohm terminating resistors of the MM CAN bus are installed in the electronic instrument cluster. These terminating resistors are used for suppression of noise in the data bus system. In order to be able to ensure correct functioning of the data bus system, the modules must always be connected with an integral terminating resistor.

The number of modules connected to the three data bus systems depends on the equipment level of the vehicle.

DESCRIPTION AND OPERATION

CAN bus



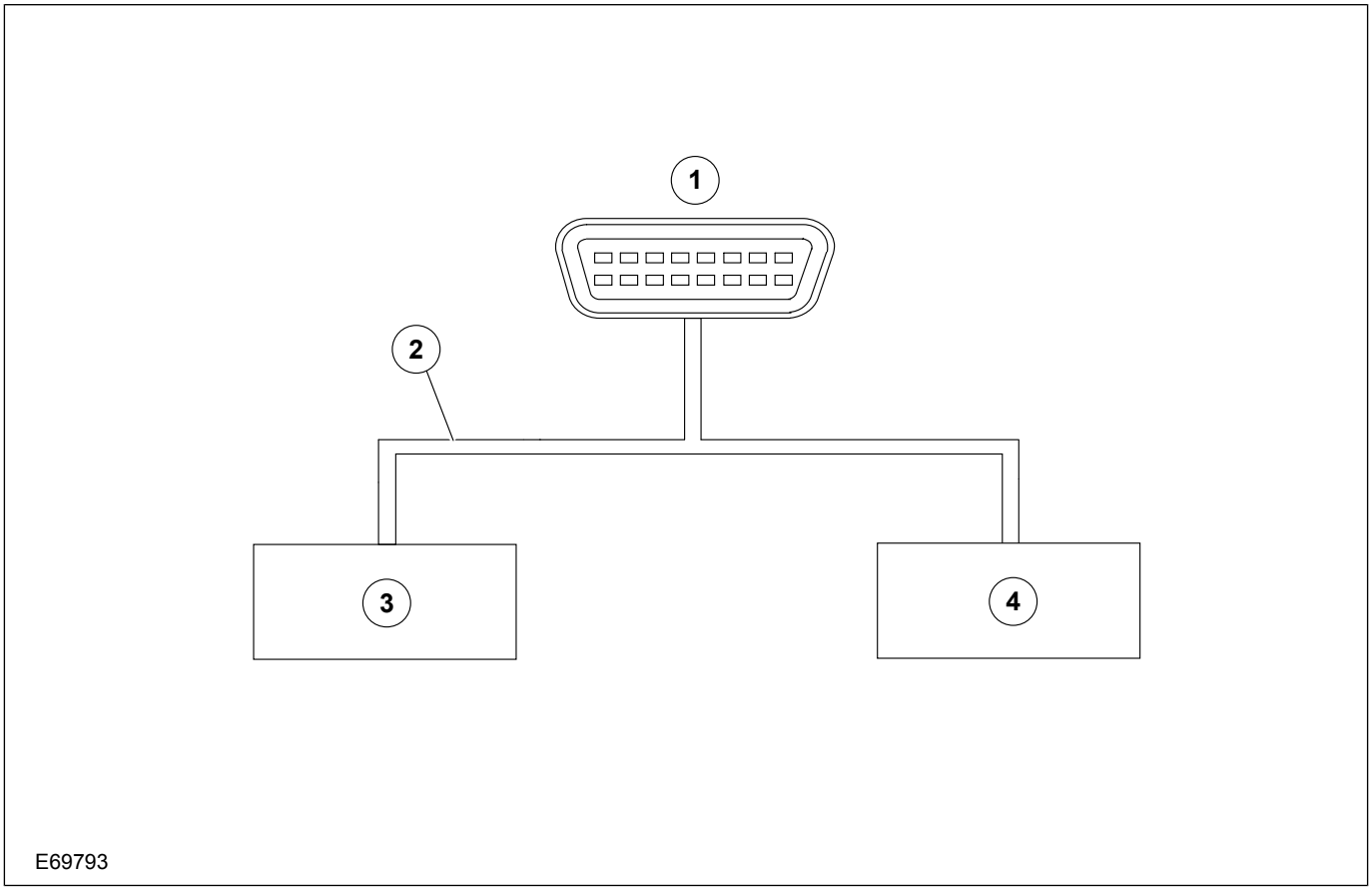
Item	Description
1	DLC
2	HS CAN bus
3	MS CAN bus
4	MM CAN bus
5	Terminating resistor
6	Parking aid module
7	Electronic instrument cluster
8	Radio
9	Bluetooth voice control module
10	Restraints control module (RCM)
11	General electronics module (GEM)

Item	Description
12	Powertrain control module (PCM)
13	ABS module or ESP module

One 120 Ohm terminating resistor of the HS CAN bus is installed in the PCM and another in the electronic instrument cluster. One 120 Ohm terminating resistor of the MS CAN bus is installed in the GEM and one in the instrument cluster respectively. Both 120 Ohm terminating resistors of the MM CAN bus are installed in the electronic instrument cluster. These terminating resistors are used for suppression of noise in the data bus system. In order to be able to ensure correct functioning of the data bus system, the modules must always be connected with an integral terminating resistor.

DESCRIPTION AND OPERATION

ISO 9141 bus

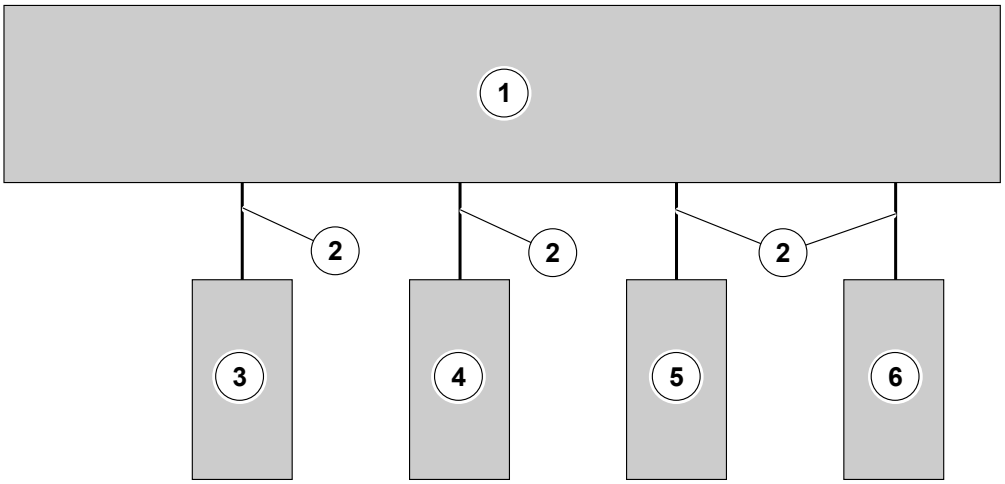


Item	Description
1	DLC
2	ISO 9141 bus
3	Fuel fired booster heater /programmable fuel fired booster heater
4	Restraints control module (RCM)

The modules connected to the ISO 9141 bus depend upon the equipment level of the vehicle. The ISO 9141 bus is used solely for reading out the fault memory of the modules connected to the bus. The ISO 9141 bus connects the various modules through the DLC to the WDS (Worldwide Diagnostic System).

DESCRIPTION AND OPERATION

LIN bus



E69792

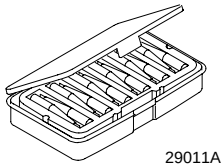
Item	Description
1	General electronics module (GEM)
2	LIN bus
3	Rain sensor/light sensor
4	Interior scanning sensor
5	Remote unlocking module
6	Anti-theft alarm horn with integral battery

The GEM acts as LIN master and has information on the chronological order of all data to be transmitted.

DIAGNOSIS AND TESTING

Communications Network

Special Tool(s)

 29011A	Terminal probe kit 418-S035

General Equipment

Digital multimeter
Worldwide Diagnostic System (WDS)

Inspection and Testing

1. CHECK the concern.
2. Visually CHECK for any obvious mechanical or electrical damage.

Visual Inspection

Electrical
• Fuses • Wiring harness • Connector

3. RECTIFY any obvious causes for a concern found during the visual inspection before performing any further tests. CHECK the operation of the system.
4. If the concern persists after the visual inspection, PERFORM a fault diagnosis with the diagnostic unit and RECTIFY any displayed faults in accordance with the displayed fault description. CHECK the operation of the system.
5. On a vehicle without stored fault(s), continue according to the Symptom Chart and the corresponding symptom.
6. Following checking or elimination of the fault and after completion of operations, the fault memories of all vehicle modules must be READ OUT and any stored faults must be DELETED. READ OUT all fault memories again following a road test.

Symptom chart

Symptom chart

NOTE: After connecting the motors, initialize the power window motors.

Symptom	Possible Sources	Action
• Restraints control module not communicating with the diagnostic unit	• Fuse(s) • Circuit(s). • Restraints control module.	• GO to Pinpoint Test A.
• Fuel-fired booster heater/programmable fuel-fired booster heater not communicating with the diagnostic tester	• Fuse(s) • Circuit(s). • Fuel-fired booster heater/programmable fuel-fired booster heater.	• GO to Pinpoint Test B.
• Parking aid module not communicating with the diagnostic tester	• Fuse(s) • Circuit(s). • Parking aid module.	• GO to Pinpoint Test C.
• Rain sensor/light sensor not communicating with the diagnostic unit.	• Fuse(s) • Circuit(s). • Rain sensor/light sensor.	• GO to Pinpoint Test D.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Audio module not communicating with the diagnostic unit	• Fuse(s) • Circuit(s). • Audio module.	• GO to Pinpoint Test E.
• Keyless vehicle module not communicating with the diagnostic tester	• Fuse(s) • Circuit(s). • Keyless vehicle module	• GO to Pinpoint Test F.
• Interior monitoring sensor not communicating with the diagnostic unit.	• Fuse(s) • Circuit(s). • Interior monitoring sensor	• GO to Pinpoint Test G.
• Control module for the mobile electronic auxiliary equipment (PSE) not communicating with the diagnostic tester.	• Fuse(s) • Circuit(s). • Control module for mobile electronic auxiliary equipment.	• GO to Pinpoint Test H.
• ABS module or electronic stability program (ESP) module not communicating with the diagnostic tester	• Fuse(s) • Circuit(s). • ABS module or ESP module.	• GO to Pinpoint Test I.
• Anti-theft alarm signal horn with integrated battery not communicating with the diagnostic unit.	• Fuse(s) • Circuit(s). • Anti-theft alarm signal horn with integrated battery	• GO to Pinpoint Test J.
• Electronic instrument cluster not communicating with the diagnostic tester.	• Fuse(s) • Circuit(s). • Electronic instrument cluster.	• GO to Pinpoint Test K.
• Powertrain control module (PCM) not communicating with the diagnostic tester	• Fuse(s) • Circuit(s). • Powertrain control module (PCM).	• GO to Pinpoint Test L.
• Generic electronic module (GEM) not communicating with the diagnostic tester	• Fuse(s) • Circuit(s). • Generic electronic module (GEM).	• GO to Pinpoint Test M.
• Faulty communications between the modules - MS CAN bus.	• Circuit(s). • Plugs. • Electronic instrument cluster. • Generic electronic module (GEM). • Parking aid module. • Restraints control module.	• GO to Pinpoint Test O.
• Faulty communications between the modules - MM CAN bus.	• Circuit(s). • Plugs. • Electronic instrument cluster. • Audio module. • Control module for mobile electronic auxiliary equipment.	• GO to Pinpoint Test N.

DIAGNOSIS AND TESTING

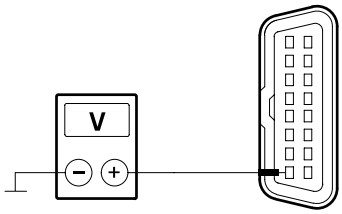
Symptom	Possible Sources	Action
• Faulty communications between the modules - HS CAN bus.	• Circuit(s). • Plugs. • ABS module or ESP module. • Generic electronic module (GEM). • Powertrain control module (PCM).	• GO to Pinpoint Test P.

Pinpoint Tests

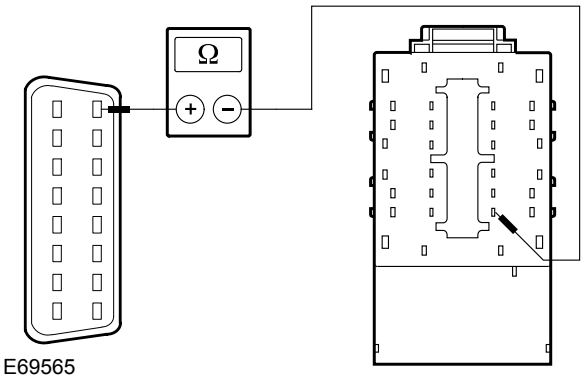
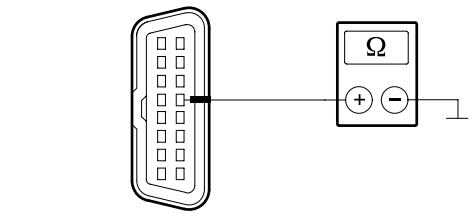
PINPOINT TEST A : RESTRAINTS CONTROL MODULE NOT COMMUNICATING WITH THE DIAGNOSTIC UNIT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNINGS: **The stored voltage must be discharged in order to prevent unintentional deployment of the airbag/belt pretensioner. After disconnecting the battery, wait at least 1 minute before starting work on the supplemental restraint system (SRS). Failure to observe this instruction can lead to injury.**	
In order to prevent the risk of accidental deployment, do not program any keycodes while working on the supplemental restraint system. Failure to observe this instruction can lead to injury.	
Only test the connectors of airbags or other supplemental restraint systems using the correct test probe adapter. Failure to observe this instruction can lead to injury.	
A1: CHECK COMMUNICATION WITH THE GENERIC ELECTRONIC MODULE (GEM)	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.
	3 Select the generic electronic module (GEM) with the diagnostic tester. • Is it possible to establish communication with the GEM? → **Yes** GO to A7. → **No** GO to A2.
A2: CHECK FUSE F72	
	1 Ignition switch in position 0.

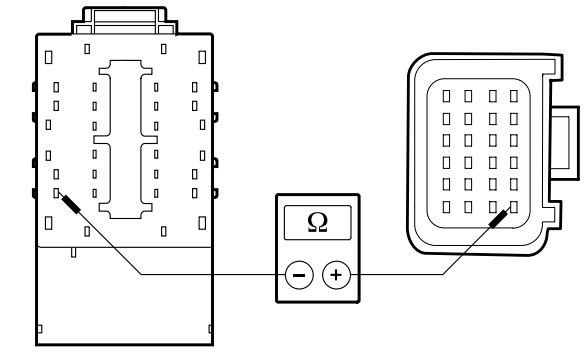
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK FuseF72 (CJB). • Is the fuse OK? → **Yes** GO to A3. → **No** RENEW fuse F72 (10 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
A3: CHECK THE VOLTAGE AT FUSE F72	
	1 Connect Fuse F72 (CJB).
	2 Measure the voltage between fuse F72 (10 A) and ground. • Does the meter display battery voltage? → **Yes** GO to A4. → **No** REPAIR the voltage supply to fuse F72 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A4: CHECK THE VOLTAGE AT THE DATA LINK CONNECTOR (DLC)	
 VFE0028957	1 Measure the voltage between the DLC, connector CDB04, pin 16, circuit VDB03A (GY/BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A6. → **No** GO to A5.
A5: CHECK FOR OPEN CIRCUIT BETWEEN THE DLC AND THE CENTRAL JUNCTION BOX (CJB)	
	1 Disconnect Connector CBP02E from the CJB.

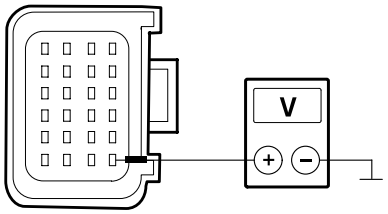
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69565	2 Measure the resistance between the DLC, connector CDB04, pin 16, circuit VDB03A (GY/BN), wiring harness side and the CJB, connector CBP02E, pin 7, circuit VDB03A (GY/BN), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit VDB03A (GY/BN) between the DLC and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
A6: CHECK THE GROUND CONNECTION OF THE DLC	
	1 Ignition switch in position 0.
 VFE0028965	2 Measure the resistance between the DLC, connector CDB04, pin 4, circuit GD115B (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** LOCATE and REPAIR the break in circuit GD116B (BK/VT) between the DLC, pin 5, circuit, and ground connection GP16 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit GD115B (BK/GY) between the DLC and ground connection GP15 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A7: CHECK FUSE F68	
	1 Ignition switch in position 0.
	2 CHECK Fuse F68 (CJB). • Is the fuse OK? → **Yes** GO to A8. → **No** RENEW fuse F68 (10 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.

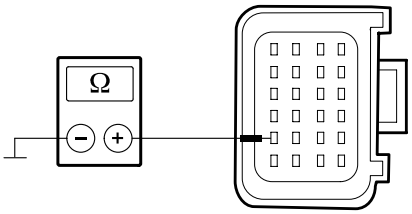
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A8: CHECK THE VOLTAGE AT FUSE F68	
	1 Connect Fuse F68 (CJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F68 (10 A) and ground. • Does the meter display battery voltage? → **Yes** GO to A10. → **No** REPAIR the voltage supply to fuse F68 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A9: CHECK FOR OPEN CIRCUIT BETWEEN THE CJB AND THE RESTRAINTS CONTROL MODULE	
	1 Ignition switch in position 0.
	2 Disconnect Connector C2BP02B from the CJB.
 E83622	3 Measure the resistance between the CJB, connector C2BP02B, pin 5, circuit SBP68A (GN/RD), wiring harness side and the restraints control module, connector CR114A, pin 1, circuit SBP68A (GN/RD)(box van/combi: Circuit SBP68B (GN/RD)), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit SBP68B (GN/RD) between the restraints control module and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

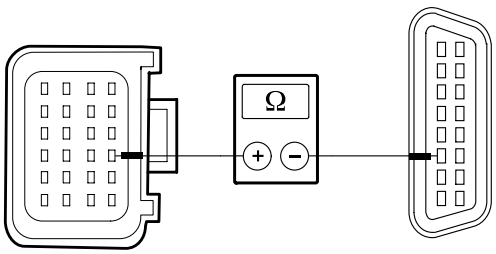
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A10: CHECK THE VOLTAGE AT THE SUPPLEMENTAL RESTRAINT SYSTEM MODULE	
WARNINGS: **The stored voltage must be discharged in order to prevent unintentional deployment of the airbag/belt pretensioner. After disconnecting the battery, wait at least 1 minute before starting work on the supplemental restraint system (SRS). Failure to observe this instruction can lead to injury.**	
In order to prevent the risk of accidental deployment, do not program any keycodes while working on the supplemental restraint system. Failure to observe this instruction can lead to injury.	
Only test the connectors of airbags or other supplemental restraint systems using the correct test probe adapter. Failure to observe this instruction can lead to injury.	
	1 Ignition switch in position 0.
	2 Disconnect Ground cable from battery.
	3 Disconnect Connector CR114A from the restraints control module.
	4 Connect ground cable to battery.
	5 Ignition switch in position II.
	6 Measure the voltage between the restraints control module, connector CR114A, pin 1, circuit SBP68A (RD/GN)(box van/combi: circuit SBP68B (GN/RD)), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A11. → **No** GO to A9.
A11: CHECK THE GROUND CONNECTION OF THE RESTRAINTS CONTROL MODULE	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

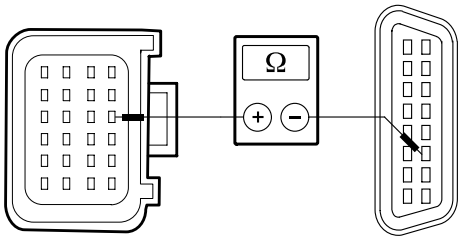
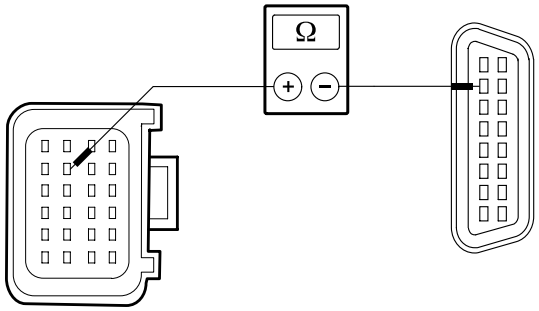
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the restraints control module, connector CR114A, pin 20, circuit GD112A (BK/GN), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to A12. → **No** LOCATE and REPAIR the break in the circuit between the restraints control module and ground connection GP12 with the aid of the Wiring Diagrams. CHECK the operation of the system.

A12: CHECK FOR OPEN CIRCUIT BETWEEN THE RESTRAINTS CONTROL MODULE (RCM) AND THE DATA LINK CONNECTOR (DLC)

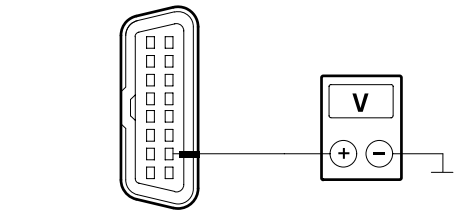
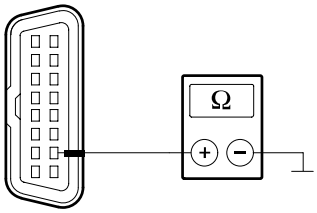
CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.

	1 Measure the resistance between the restraints control module, connector CR114A, pin 3, circuit VDB06C (GY/OG), wiring harness side and the DLC, connector CDB04, pin 3, circuit VDB06J (GY/OG), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to A13. → **No** LOCATE and REPAIR the break in the circuit between the restraints control module and soldered connection S2DB06A with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A13: CHECK FOR OPEN CIRCUIT BETWEEN THE SUPPLEMENTAL RESTRAINT CONTROL MODULE AND DLC	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.**	
	1 Measure the resistance between the restraints control module, connector CR114A, pin 4, circuit VDB07C (VT/OG), wiring harness side and the DLC, connector CDB04, pin 11, circuit VDB07J (VT/OG), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to A14. → **No** LOCATE and REPAIR the break in the circuit between the restraints control module and soldered connection S2DB07A with the aid of the Wiring Diagrams. CHECK the operation of the system.
A14: CHECK FOR OPEN CIRCUIT BETWEEN THE SUPPLEMENTAL RESTRAINT CONTROL MODULE AND DLC	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.**	
	1 Measure the resistance between the restraints control module, connector CR114A, pin 17, circuit VDB10D (GY), wiring harness side and the DLC, connector CDB04, pin 7, circuit VDB10A (GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to A15. → **No** LOCATE and REPAIR the break in the circuit between the restraints control module and the DLC using the Wiring Diagrams. CHECK the operation of the system.
A15: TEST THE ISO 9141 BUS FOR A SHORT TO VOLTAGE	
	1 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0029118	2 Measure the voltage between the DLC, connector CDB04, pin 7, circuit VDB10A (GY), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and RECTIFY the short to voltage supply in the circuits connected to soldered connection S2BD10 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to A16.
A16: CHECK THE ISO 9141 BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
 E0029119	2 Measure the resistance between the DLC, connector CDB04, pin 7, circuit VDB10A (GY), wiring harness side and ground. • Is a resistance of more than 10,000 Ohm measured? → **Yes** CHECK and if necessary RENEW the restraint control module. CHECK the operation of the system. → **No** LOCATE and RECTIFY the short to ground in the circuits connected to soldered connection S2BD10 with the aid of the Wiring Diagrams. CHECK the operation of the system.

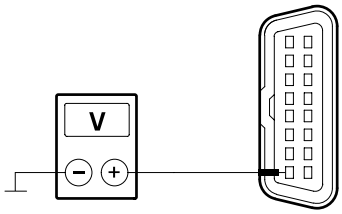
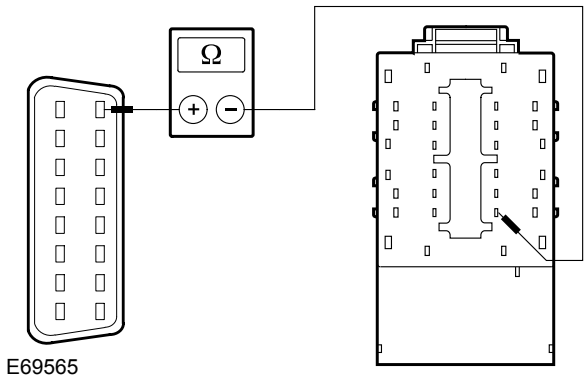
PINPOINT TEST B : FUEL-FIRED BOOSTER HEATER/PROGRAMMABLE FUEL-FIRED BOOSTER HEATER NOT COMMUNICATING WITH THE DIAGNOSTIC TESTER

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK THE COMMUNICATIONS WITH THE RESTRAINTS CONTROL MODULE	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.

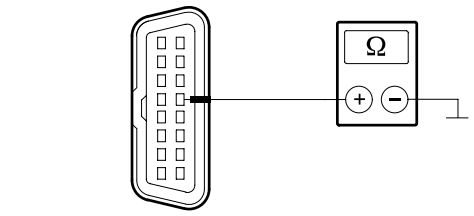
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Select the restraints control module (RCM) with the diagnostic tester. • Is it possible to establish communication with the restraints control module (RCM)? → **Yes** GO to B7. → **No** GO to B2.
B2: CHECK FUSE F72	
	1 Ignition switch in position 0.
	2 CHECK Fuse F72 (CJB). • Is the fuse OK? → **Yes** GO to B3. → **No** RENEW fuse F72 (10 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
B3: CHECK THE VOLTAGE AT FUSE F72	
	1 Connect Fuse F72 (CJB).
	2 Measure the voltage between fuse F72 (10 A) and ground. • Does the meter display battery voltage? → **Yes** GO to B4. → **No** REPAIR the voltage supply to fuse F72 with the aid of the Wiring Diagrams. CHECK the operation of the system.

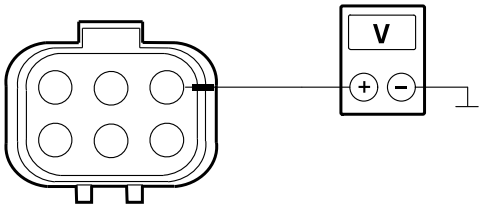
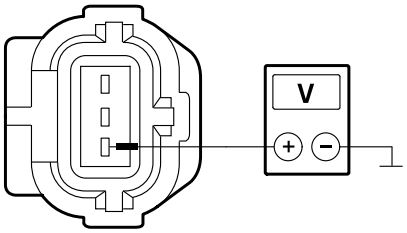
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B4: CHECK THE VOLTAGE AT THE DATA LINK CONNECTOR (DLC)	
 VFE0028957	1 Measure the voltage between the DLC, connector CDB04, pin 16, circuit VDB03A (GY/BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B6. → **No** GO to B5.
B5: CHECK FOR OPEN CIRCUIT BETWEEN THE DLC AND THE CENTRAL JUNCTION BOX (CJB)	
	1 Disconnect Connector CBP02E from the CJB.
 E69565	2 Measure the resistance between the DLC, connector CDB04, pin 16, circuit VDB03A (GY/BN), wiring harness side and the CJB, connector CBP02E, pin 7, circuit VDB03A (GY/BN), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit VDB03A (GY/BN) between the DLC and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
B6: CHECK THE GROUND CONNECTION OF THE DLC	
	1 Ignition switch in position 0.

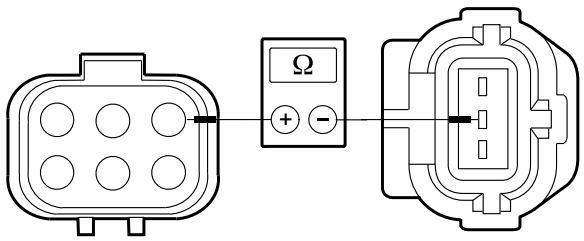
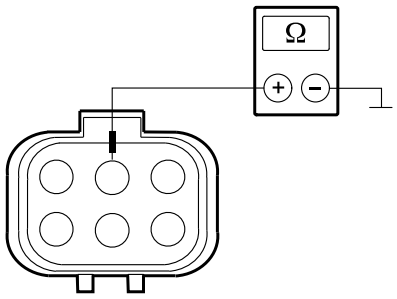
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0028965	2 Measure the resistance between the DLC, connector CDB04, pin 4, circuit GD115B (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** LOCATE and REPAIR the break in circuit GD116B (BK/VT) between the DLC, pin 5, circuit, and ground connection GP16 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit GD115B (BK/GY) between the DLC and ground connection GP15 with the aid of the Wiring Diagrams. CHECK the operation of the system.
B7: CHECK FUSE F24	
	1 Ignition switch in position 0.
	2 CHECK Fuse F24 (EJB). • Is the fuse OK? → **Yes** GO to B8. → **No** RENEW fuse F24 (20 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
B8: CHECK THE VOLTAGE AT FUSE F24	
	1 Connect Fuse F24 (EJB).
	2 Measure the voltage between fuse F24 (20 A) and ground. • Does the meter display battery voltage? → **Yes** Vehicles with a fuel-fired booster heater GO to B9. Vehicles with a programmable fuel-fired booster heater GO to B14. → **No** REPAIR the voltage supply to fuse F24 with the aid of the Wiring Diagrams. CHECK the operation of the system.

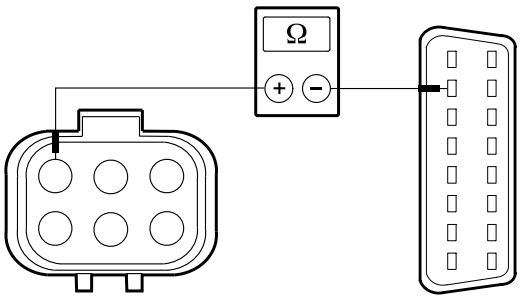
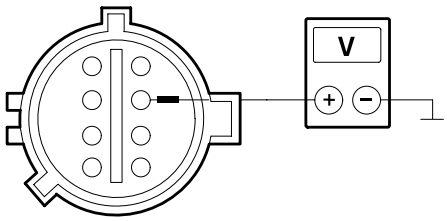
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B9: CHECK THE VOLTAGE AT THE FUEL-FIRED BOOSTER HEATER	
	1 Disconnect Connector CHC01 from the fuel-fired booster heater.
	2 Measure the voltage between the fuel-fired booster heater, connector CHC01, pin 1, circuit CE226D (YE/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B12. → **No** GO to B10.
B10: CHECK THE VOLTAGE AT THE INERTIA FUEL SAFETY-SHUT-OFF SWITCH	
	1 Disconnect Connector CE227 from the inertia fuel safety shut-off switch.
	2 Measure the voltage between the inertia fuel safety shut-off switch, connector CE227, pin 3, circuit SBB24B (RD/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B11. → **No** LOCATE and REPAIR the break in the circuit between the inertia fuel safety shut-off switch and the EJB with the aid of the Wiring Diagrams. CHECK the operation of the system.

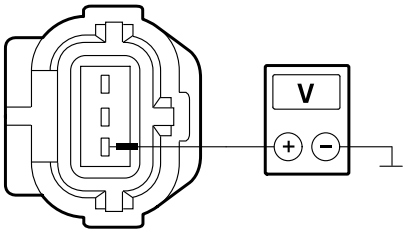
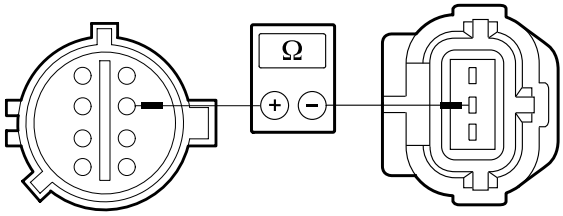
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B11: CHECK FOR OPEN CIRCUIT BETWEEN THE FUEL-FIRED BOOSTER HEATER AND THE INERTIA FUEL SAFETY SHUT-OFF SWITCH	
 E69570	1 Measure the resistance between the fuel-fired booster heater, connector CHC01, pin 1, circuit CE226D (YE/VT), wiring harness side and the inertia fuel safety shut-off switch, connector CE227, pin 2, circuit CE226A (YE/VT), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary RENEW the inertia fuel safety shut-off switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the open circuit between the fuel-fired booster heater and the inertia fuel safety shut-off switch using the Wiring Diagrams. CHECK the operation of the system.
B12: CHECK THE GROUND CONNECTION OF THE FUEL-FIRED BOOSTER HEATER	
	1 Measure the resistance between the fuel-fired booster heater, connector CHC01, pin 2, circuit GD122K (BK/OG), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to B13. → **No** LOCATE and REPAIR the open circuit between the fuel-fired booster heater and ground connection GP22 using the Wiring Diagrams. CHECK the operation of the system.

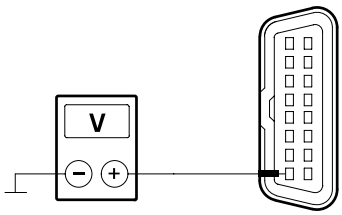
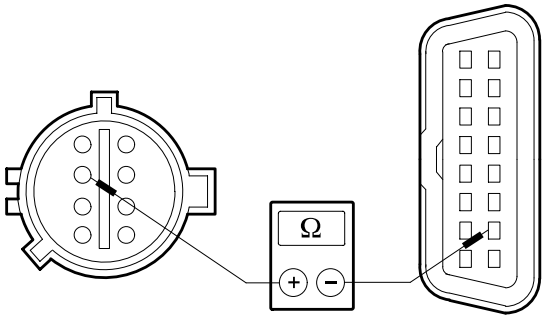
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B13: CHECK FOR OPEN CIRCUIT BETWEEN THE FUEL-FIRED BOOSTER HEATER AND THE DLC	
CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.	
	1 Measure the resistance between the fuel-fired booster heater, connector CHC01, pin 3, circuit VDB10G (GY), wiring harness side and the DLC, connector CDB04, pin 7, circuit VDB10A (GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to B19. → **No** LOCATE and REPAIR the break in the circuit between the fuel-fired booster heater and the DLC with the aid of the Wiring Diagrams. CHECK the operation of the system.
B14: CHECK THE VOLTAGE AT THE PROGRAMMABLE FUEL-FIRED BOOSTER HEATER	
	1 Disconnect Connector CHF01 from the programmable fuel-fired booster heater .
	2 Measure the voltage between the programmable fuel-fired booster heater, connector CHC01, pin 2, circuit CE226D (YE/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B17. → **No** GO to B15.
B15: CHECK THE VOLTAGE AT THE INERTIA FUEL SAFETY-SHUT-OFF SWITCH	
	1 Disconnect Connector CE227 from the inertia fuel safety shut-off switch.

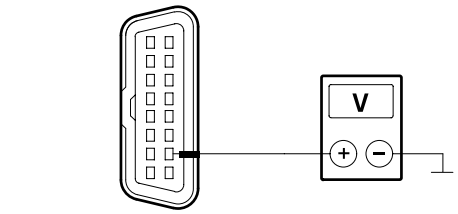
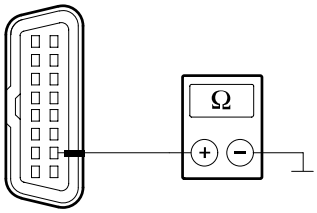
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the voltage between the inertia fuel safety shut-off switch, connector CE227, pin 3, circuit SBB24B (RD/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to B16. → **No** LOCATE and REPAIR the break in the circuit between the inertia fuel safety shut-off switch and the EJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
B16: CHECK FOR OPEN CIRCUIT BETWEEN THE PROGRAMMABLE FUEL-FIRED BOOSTER HEATER AND THE INERTIA FUEL SAFETY SHUT-OFF SWITCH	
 E69574	1 Measure the resistance between the programmable fuel-fired booster heater, connector CHF01, pin 2, circuit CE226D (YE/VT), wiring harness side and the inertia fuel safety shut-off switch, connector CE227, pin 2, circuit CE226A (YE/VT), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary RENEW the inertia fuel safety shut-off switch. CHECK the operation of the system. → **No** LOCATE and REPAIR the open circuit between the programmable fuel-fired booster heater and the inertia fuel safety shut-off switch using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B17: CHECK THE GROUND CONNECTION OF THE PROGRAMMABLE FUEL-FIRED BOOSTER HEATER	
 VFE0028957	1 Measure the resistance between the programmable fuel-fired booster heater, connector CHF01, pin 3, circuit GD122K (BK/OG), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to B18. → **No** LOCATE and REPAIR the open circuit between the programmable fuel-fired booster heater and ground connection GP22 using the Wiring Diagrams. CHECK the operation of the system.
B18: CHECK FOR OPEN CIRCUIT BETWEEN THE PROGRAMMABLE FUEL-FIRED BOOSTER HEATER AND THE DLC	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.**	
 E0034250	1 Measure the resistance between the programmable fuel-fired booster heater, connector CHC01, pin 6, circuit VDB10G (GY), wiring harness side and the DLC, connector CDB04, pin 7, circuit VDB10A (GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to B19. → **No** LOCATE and REPAIR the break in the circuit between the programmable fuel-fired booster heater and the DLC with the aid of the Wiring Diagrams. CHECK the operation of the system.
B19: TEST THE ISO 9141 BUS FOR A SHORT TO VOLTAGE	
	1 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0029118	2 Measure the voltage between the DLC, connector CDB04, pin 7, circuit VDB10A (GY), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and RECTIFY the short to voltage supply in the circuits connected to soldered connection S2DB10 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to B20.
B20: CHECK THE ISO 9141 BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
 E0029119	2 Measure the resistance between the DLC, connector CDB04, pin 7, circuit VDB10A (GY), wiring harness side and ground. • Is a resistance of more than 10,000 Ohm measured? → **Yes** CHECK and if necessary RENEW the fuel-fired booster heater or the programmable fuel-fired booster heater. CHECK the operation of the system. → **No** LOCATE and RECTIFY the short to ground in the circuits connected to soldered connection S2DB10 with the aid of the Wiring Diagrams. CHECK the operation of the system.

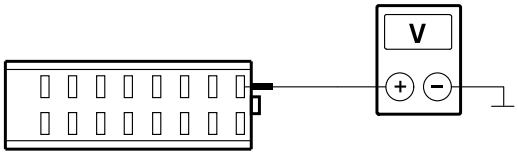
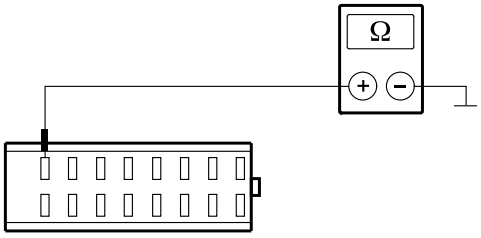
PINPOINT TEST C : PARKING AID MODULE NOT COMMUNICATING WITH THE DIAGNOSTIC UNIT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CHECK COMMUNICATION WITH THE GENERIC ELECTRONIC MODULE (GEM)	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.

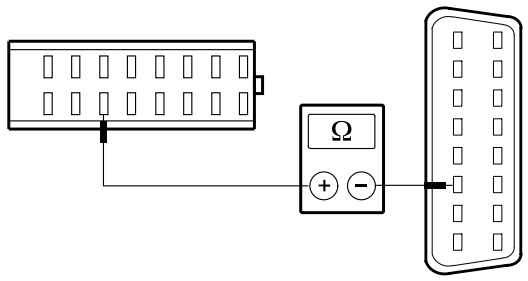
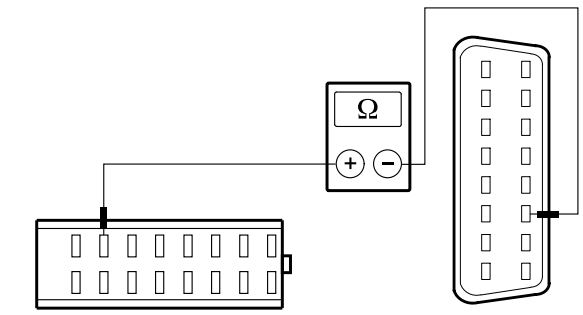
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Select the generic electronic module (GEM) with the diagnostic tester. • Is it possible to establish communication with the GEM? → **Yes** GO to C2. → **No** GO to Pinpoint Test N.
C2: CHECK FUSE F63	
	1 Ignition switch in position 0.
	2 CHECK Fuse F63 (CJB). • Is the fuse OK? → **Yes** GO to C3. → **No** RENEW fuse F63 (5 A). CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short to ground with the aid of the Wiring Diagrams.
C3: CHECK THE VOLTAGE AT FUSE F63	
	1 Connect Fuse F63 (CJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F63 (5 A) and ground. • Does the meter display battery voltage? → **Yes** GO to C4. → **No** REPAIR the voltage supply to fuse F63 with the aid of the Wiring Diagrams. CHECK the operation of the system.
C4: CHECK THE VOLTAGE AT THE PARKING AID MODULE	
	1 Ignition switch in position 0.
	2 Disconnect Connector CMP01A from the parking aid module.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between the parking aid module, connector CMP01A, pin 1, circuit SBP63C (WH/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to C6. → **No** GO to C5.
C5: CHECK FOR OPEN CIRCUIT BETWEEN THE PARKING AID MODULE AND THE CENTRAL JUNCTION BOX (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Connector CBP02D from the CJB.
	3 Measure the resistance between the parking aid module, connector CMP01A, pin 1, circuit SBP63C (WH/RD), wiring harness side and the CJB, connector CBP02D, pin 11, circuit SBP63A (WH/RD), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the parking aid module and CJB using the wiring diagrams. CHECK the operation of the system.
C6: CHECK THE GROUND CONNECTION OF THE PARKING AID MODULE	
	1 Ignition switch in position 0.
	2 Measure the resistance between the parking aid module, connector CMP01A, pin 8, circuit GD116F (BK/VT), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to C7. → **No** LOCATE and REPAIR the break in the circuit between the parking aid module and ground connection G16 using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C7: CHECK FOR OPEN CIRCUIT BETWEEN THE PARKING AID MODULE AND THE DATA LINK CONNECTOR (DLC)	
CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.	
	1 Measure the resistance between the parking aid module, connector CMP01A, pin 14, circuit VDB06H (GY/OG), wiring harness side and the DLC, connector CDB04, pin 3, circuit VDB06J (GY/OG), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to C8. → **No** LOCATE and RECTIFY the break in the circuit between the parking aid module and soldered connection S2DB06B using the Wiring Diagrams. CHECK the operation of the system.
C8: CHECK FOR OPEN CIRCUIT BETWEEN THE PARKING AID MODULE AND THE DLC	
CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.	
 E69580	1 Measure the resistance between the parking aid module, connector CMP01A, pin 7, circuit VDB07H (VT/OG), wiring harness side and the DLC, connector CDB04, pin 11, circuit VDB07J (VT/OG), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the parking aid module if necessary INSTALL a new one. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the parking aid module and soldered connection S2DB07B using the Wiring Diagrams. CHECK the operation of the system.

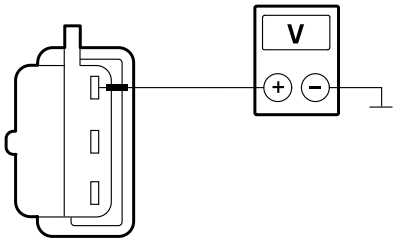
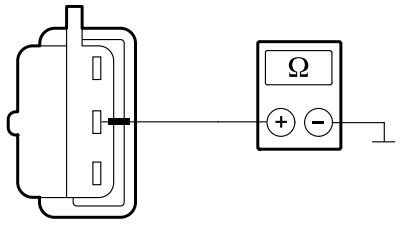
PINPOINT TEST D : RAIN SENSOR/LIGHT SENSOR NOT COMMUNICATING WITH THE DIAGNOSTIC UNIT.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: CHECK COMMUNICATION WITH THE GENERIC ELECTRONIC MODULE (GEM)	
	1 Ignition switch in position 0.

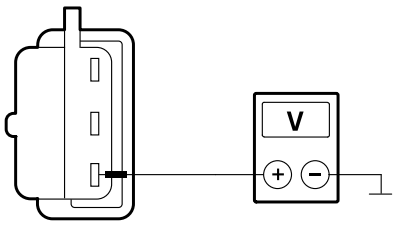
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Connect the diagnostic tool.
	3 Select the generic electronic module (GEM) with the diagnostic tester. • Is it possible to establish communication with the GEM? → **Yes** GO to D2. → **No** GO to Pinpoint Test M.
D2: CHECK FUSE F63	
	1 Ignition switch in position 0.
	2 CHECK Fuse F63 (CJB). • Is the fuse OK? → **Yes** GO to D3. → **No** RENEW fuse F63 (5 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
D3: CHECK THE VOLTAGE AT FUSE F63	
	1 Connect Fuse F63 (CJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F63 (5 A) and ground. • Does the meter display battery voltage? → **Yes** GO to D4. → **No** REPAIR the voltage supply to fuse F63 with the aid of the Wiring Diagrams. CHECK the operation of the system.
D4: CHECK THE VOLTAGE AT THE RAIN SENSOR/LIGHT SENSOR	
	1 Ignition switch in position 0.
	2 Disconnect Connector CRW06 from the rain sensor/light sensor.
	3 Ignition switch in position II.

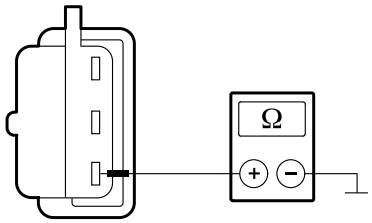
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between the rain sensor/light sensor, connector CRW06, pin 1, circuit SBP63G (WH/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to D6. → **No** GO to D5.
D5: CHECK THE CIRCUIT BETWEEN THE CJB AND THE RAIN SENSOR/LIGHT SENSOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Connector CBP02D from the CJB.
	3 Measure the resistance between the CJB, connector CBP02D, pin 11, circuit SBP63A (WH/RD), wiring harness side and the rain sensor/light sensor, connector CRW06, pin 1, circuit SBP63G (WH/RD), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the rain sensor/light sensor and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
D6: CHECK THE GROUND CONNECTION OF THE RAIN SENSOR/LIGHT SENSOR	
	1 Measure the resistance between the rain sensor/light sensor, connector CRW06, pin 2, circuit GD138AF (BK/WH), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to D7. → **No** LOCATE and RECTIFY the break in the circuit between the rain sensor/light sensor and ground connection GP38 with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D7: CHECK THE CIRCUIT BETWEEN THE RAIN SENSOR/LIGHT SENSOR AND THE CJB FOR OPEN CIRCUIT	
CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.	
	1 Disconnect Connector CBP02C from the CJB.
	2 Measure the resistance between the rain sensor/light sensor, connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side and the CJB, connector CBP02C, pin 37, circuit VRW26A (BN/YE), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to D8. → **No** LOCATE and RECTIFY the break in the circuit between the rain sensor/light sensor and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
D8: CHECK THE LIN BUS FOR A SHORT TO VOLTAGE SUPPLY	
	1 Ignition switch in position II.
 E69584	2 Measure the voltage between the rain sensor/light sensor, connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and RECTIFY the short to voltage in the circuit between the rain sensor/light sensor and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to D9.
D9: CHECK THE LIN BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69601	2 Measure the resistance between the rain sensor/light sensor, connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side and ground. • Is a resistance of more than 10,000 Ohm measured? → **Yes** CHECK and if necessary RENEW the rain sensor/light sensor. CHECK the operation of the system. → **No** LOCATE and RECTIFY the short to ground in the circuit between the rain sensor/light sensor and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST E : AUDIO MODULE NOT COMMUNICATING WITH THE DIAGNOSTIC UNIT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: CHECK THE COMMUNICATIONS WITH THE ELECTRONIC INSTRUMENT CLUSTER	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.
	3 Select the electronic instrument cluster with the diagnostic tester. • Is it possible to establish communications with the electronic instrument cluster? → **Yes** GO to E2. → **No** GO to Pinpoint Test N.
E2: CHECK FUSE F73	
	1 Ignition switch in position 0.
	2 CHECK Fuse F73 (CJB). • Is the fuse OK? → **Yes** GO to E3. → **No** RENEW fuse F73 (15 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E3: CHECK THE VOLTAGE AT FUSE F73	
	1 Connect Fuse F73 (CJB).
	2 Measure the voltage between fuse F73 (15 A) and ground. • Does the meter display battery voltage? → **Yes** GO to E4. → **No** REPAIR the voltage supply to fuse F73 with the aid of the Wiring Diagrams. CHECK the operation of the system.
E4: CHECK FUSE F82	
	1 CHECK Fuse F82 (CJB). • Is the fuse OK? → **Yes** GO to E5. → **No** RENEW fuse F82 (2 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
E5: CHECK THE VOLTAGE AT FUSE F82	
	1 Ignition switch in position I.
	2 Connect Fuse F82 (CJB).
	3 Measure the voltage between fuse F82 (2 A) and ground. • Does the meter display battery voltage? → **Yes** GO to E6. → **No** REPAIR the voltage supply to fuse F82 with the aid of the Wiring Diagrams. CHECK the operation of the system.
E6: CHECK THE VOLTAGE AT THE AUDIO MODULE (TERMINAL 30)	
	1 Ignition switch in position 0.
	2 Disconnect Connector CME03B from the audio module.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between the audio module, connector CME03B, pin 15, circuit SBP73A (RD)(vehicles with control module for mobile electronic auxiliary equipment: circuit SBP73C (RD)), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to E8. → **No** GO to E7.
E7: CHECK THE CIRCUIT BETWEEN THE AUDIO MODULE AND THE CJB FOR OPEN CIRCUIT	
	1 Disconnect Connector CBP02E from the CJB.
	2 Measure the resistance between the audio module, connector CME03B, pin 15, circuit SBP73A (RD)(vehicles with control module for mobile electronic auxiliary equipment: circuit SBP73C (RD)), wiring harness side and the CJB, connector CBP02E, pin 31, circuit SBP73A (RD), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the audio module and the CJB using the Wiring Diagrams. CHECK the operation of the system.
E8: CHECK THE VOLTAGE AT THE AUDIO MODULE (TERMINAL 15)	
	1 Ignition switch in position II.
	2 Measure the voltage between the audio module, connector CME03B, pin 16, circuit SBP82B (YE/RD)(vehicles with control module for mobile electronic auxiliary equipment: circuit SBP82D (RD/BK)), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to E10. → **No** GO to E9.
E9: CHECK THE CIRCUIT BETWEEN THE AUDIO MODULE AND THE CJB FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the audio module, connector CME03B, pin 16, circuit SBP82B (YE/RD)(vehicles with control module for mobile electronic auxiliary equipment: circuit SBP82D (RD/BK)), wiring harness side and the CJB, connector CBP02E, pin 11, circuit SBP82A (YE/RD), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the audio module and the CJB using the Wiring Diagrams. CHECK the operation of the system.
E10: CHECK THE GROUND CONNECTION OF THE AUDIO MODULE	
	1 Ignition switch in position 0.
	2 Measure the resistance between the audio module, connector CME03B, pin 11, circuit GD114B (BK/BU)(vehicles with control module for mobile electronic auxiliary equipment: circuit GD114D (BK/OG)), wiring harness side and ground.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the resistance between the audio module, connector CME03B, pin 12, circuit GD114A (BK/BU)(vehicles with control module for mobile electronic auxiliary equipment: circuit GD114E (BK/OG)), wiring harness side and ground. • Is a resistance of less than 2 Ohm measured in both cases? → **Yes** GO to E11. → **No** - If a resistance of more than 2 Ohm is measured in one of the measurements: LOCATE and REPAIR the break in the relevant circuit between the audio module and soldered connection S2D114A with the aid of the Wiring Diagrams. CHECK the operation of the system. - If a resistance of more than 2 Ohm is measured in both of the measurements: LOCATE and REPAIR the open circuit between soldered connection S2D114A and ground connection GP14 with the aid of the Wiring Diagrams. CHECK the operation of the system.
E11: CHECK THE CIRCUIT BETWEEN THE AUDIO MODULE AND THE INSTRUMENT CLUSTER FOR OPEN CIRCUIT	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.**	
	1 Disconnect Connector CMC01 from the instrument cluster.
	2 Measure the resistance between the audio module, connector CME03B, pin 10, circuit VDB14B (VT/GY), wiring harness side and the instrument cluster, connector CMC01, pin 5, circuit VDB14C (VT/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to E12. → **No** LOCATE and REPAIR the break in the circuit between the audio module and the instrument cluster using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E12: CHECK THE CIRCUIT BETWEEN THE AUDIO MODULE AND THE INSTRUMENT CLUSTER FOR OPEN CIRCUIT	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.**	
	1 Measure the resistance between the audio module, connector CME03B, pin 9, circuit VDB13B (BU/GY), wiring harness side and the instrument cluster, connector CMC01, pin 6, circuit VDB13C (BU/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to E13. → **No** LOCATE and REPAIR the break in the circuit between the audio module and the instrument cluster using the Wiring Diagrams. CHECK the operation of the system.
E13: CHECK THE CIRCUIT BETWEEN THE AUDIO MODULE AND THE INSTRUMENT CLUSTER FOR OPEN CIRCUIT	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.**	
	1 Measure the resistance between the audio module, connector CME03B, pin 10, circuit VDB14B (VT/GY), wiring harness side and the instrument cluster, connector CMC01, pin 7, circuit VDB14D (VT/GY), wiring harness side. • Is a resistance of less than 2 Ohm measured? → **Yes** GO to E14. → **No** LOCATE and REPAIR the break in the circuit between the audio module and the instrument cluster using the Wiring Diagrams. CHECK the operation of the system.

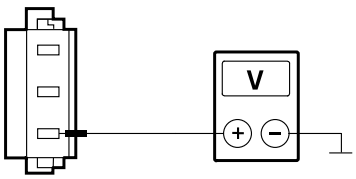
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E14: CHECK THE CIRCUIT BETWEEN THE AUDIO MODULE AND THE INSTRUMENT CLUSTER FOR OPEN CIRCUIT	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.**	
	1 Measure the resistance between the audio module, connector CME03B, pin 9, circuit VDB13B (BU/GY), wiring harness side and the instrument cluster, connector CMC01, pin 8, circuit VDB13D (BU/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary RENEW the audio module. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the audio module and the instrument cluster using the Wiring Diagrams. CHECK the operation of the system.

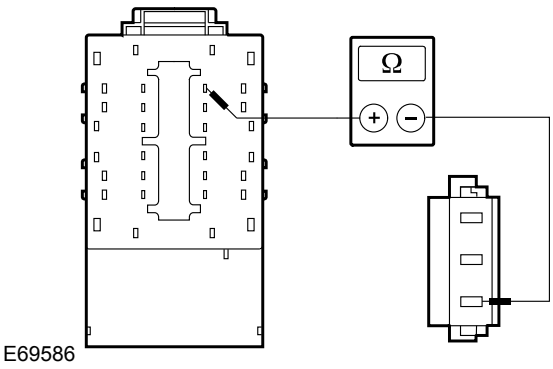
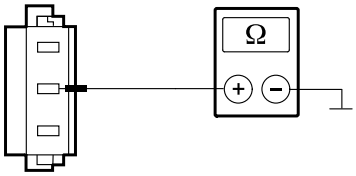
PINPOINT TEST F : KEYLESS VEHICLE MODULE NOT COMMUNICATING WITH THE DIAGNOSTIC TESTER

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F1: CHECK COMMUNICATION WITH THE GENERIC ELECTRONIC MODULE (GEM)	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.
	3 Select the generic electronic module (GEM) with the diagnostic unit. • Is it possible to establish communication with the GEM? → **Yes** GO to F2. → **No** GO to Pinpoint Test M.
F2: CHECK FUSE F74	
	1 Ignition switch in position 0.

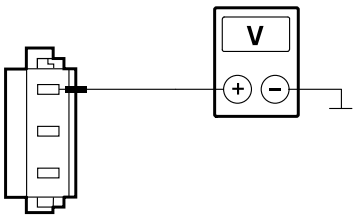
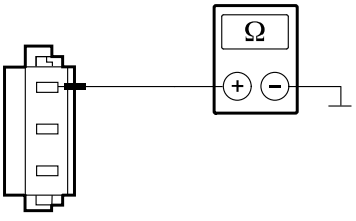
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK Fuse F74 (CJB) • Is the fuse OK? → **Yes** GO to F3. → **No** RENEW fuse F74 (5 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
F3: CHECK THE VOLTAGE AT FUSE F74	
	1 Connect Fuse F74 (CJB).
	2 Measure the voltage between fuse F74 (5 A) and ground. • Does the meter display battery voltage? → **Yes** GO to F5. → **No** REPAIR the voltage supply to fuse F74 with the aid of the Wiring Diagrams. CHECK the operation of the system.
F4: CHECK THE VOLTAGE AT THE KEYLESS VEHICLE MODULE	
	1 Disconnect Connector CPL56 from the keyless vehicle module.
	2 Measure the voltage between the keyless vehicle module, connector CPL56, pin 3, circuit SBP74K (YE/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to F6. → **No** GO to F5.
F5: CHECK FOR OPEN CIRCUIT BETWEEN THE CJB AND THE KEYLESS VEHICLE MODULE	
	1 Disconnect Connector CBP02E from the CJB.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69586	2 Measure the resistance between the CJB, connector CBP02E, pin 27, circuit SBP74A (YE/RD), wiring harness side and the keyless vehicle module, connector CPL56, pin 3, circuit SBP74K (YE/RD), wiring harness side. • Is a resistance of less than 2 Ohm measured? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the keyless vehicle module and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
F6: CHECK THE GROUND CONNECTION OF THE KEYLESS VEHICLE MODULE	
	1 Measure the resistance between the keyless vehicle module, connector CPL56, pin 2, circuit GD138P (BK/WH), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to F7. → **No** LOCATE and RECTIFY the break in the circuit between the keyless vehicle module and ground connection GP38 with the aid of the Wiring Diagrams. CHECK the operation of the system.
F7: CHECK FOR OPEN CIRCUIT BETWEEN THE KEYLESS VEHICLE MODULE AND THE CJB	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.**	
	1 Disconnect Connector CBP02C from the CJB.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the keyless vehicle module, connector CPL56, pin 1, circuit CPK29C (GY/BU), wiring harness side and the CJB, connector C2BP02C, pin 38, circuit CPK29A (GY/BU), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to F8. → **No** LOCATE and RECTIFY the break in the circuit between the keyless vehicle module and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
F8: CHECK THE LIN BUS FOR A SHORT TO VOLTAGE SUPPLY	
	1 Ignition switch in position II.
 E69588	2 Measure the voltage between the keyless vehicle module, connector CPL56, pin 1, circuit CPK29C (GY/BU), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and REPAIR the short to voltage in the circuit between the keyless vehicle module and the CJB with the aid of the wiring diagrams. CHECK the operation of the system. → **No** GO to F9.
F9: CHECK THE LIN BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
 E69589	

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the keyless vehicle module, connector CPL56, pin 1, circuit CPK29C (GY/BU), wiring harness side and ground. • Is a resistance of more than 10,000 Ohm measured? → **Yes** CHECK and if necessary RENEW the keyless vehicle module. CHECK the operation of the system. → **No** LOCATE and REPAIR the short to ground in the circuit between the keyless vehicle module and the CJB with the aid of the wiring diagrams. CHECK the operation of the system.

PINPOINT TEST G : INTERIOR MONITORING SENSOR NOT COMMUNICATING WITH THE GENERIC ELECTRONIC MODULE (GEM).

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G1: CHECK COMMUNICATION WITH THE GENERIC ELECTRONIC MODULE (GEM)	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.
	3 Select the generic electronic module (GEM) with the diagnostic tester. • Is it possible to establish communication with the GEM? → **Yes** GO to G2. → **No** GO to Pinpoint Test M.
G2: CHECK FUSE F74	
	1 Ignition switch in position 0.
	2 CHECK Fuse F74 (CJB). • Is the fuse OK? → **Yes** GO to G3. → **No** RENEW fuse F74 (5 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G3: CHECK THE VOLTAGE AT FUSE F74	
	1 Connect Fuse F74 (CJB).
	2 Measure the voltage between fuse F74 (5 A) and ground. • Does the meter display battery voltage? → **Yes** GO to G4. → **No** REPAIR the voltage supply to fuse F74 with the aid of the Wiring Diagrams. CHECK the operation of the system.
G4: CHECK THE VOLTAGE AT THE INTERIOR MONITORING SENSOR	
	1 Disconnect Connector CRT12 from the interior monitoring sensor.
	2 Measure the voltage between the interior monitoring sensor, connector CRT12, pin 3, circuit SBP74L (YE/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to G6. → **No** GO to G5.
G5: CHECK THE CIRCUIT BETWEEN THE CJB AND THE INTERIOR MONITORING SENSOR FOR OPEN CIRCUIT	
	1 Disconnect Connector C2BP02E from the CJB.
	2 Measure the resistance between the CJB, connector C2BP02E, pin 27, circuit SBP74A (YE/RD), wiring harness side and the interior monitoring sensor, connector CRT12, pin 3, circuit SBP74L (YE/RD), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the interior monitoring sensor and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G6: CHECK THE GROUND CONNECTION OF THE INTERIOR MONITORING SENSOR	
	1 Measure the resistance between the interior monitoring sensor, connector CRT12, pin 1, circuit GD138AG (BK/WH), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to G7. → **No** LOCATE and REPAIR the break in the circuit between the interior monitoring sensor and ground connection GP38 with the aid of the Wiring Diagrams. CHECK the operation of the system.
G7: CHECK THE CIRCUIT BETWEEN THE INTERIOR MONITORING SENSOR AND THE CJB FOR OPEN CIRCUIT	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.**	
	1 Disconnect Connector C2BP02C from the CJB.
	2 Measure the resistance between the interior monitoring sensor, connector CRT12, pin 2, circuit VRT26C (VT), wiring harness side and the CJB, connector C2BP02C, pin 39, circuit VRT26A (VT), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to G8. → **No** LOCATE and REPAIR the break in the circuit between the interior monitoring sensor and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
G8: CHECK THE LIN BUS FOR A SHORT TO VOLTAGE SUPPLY	
	1 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the voltage between the interior monitoring sensor, connector CRT12, pin 2, circuit VRT26C (VT), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and RECTIFY the short to voltage in the circuit between the interior monitoring sensor and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to G9.
G9: CHECK THE LIN BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Measure the resistance between the interior monitoring sensor, connector CRT12, pin 2, circuit VRT26C (VT), wiring harness side and ground. • Is a resistance of more than 10,000 Ohm measured? → **Yes** CHECK and if necessary RENEW the interior monitoring sensor. CHECK the operation of the system. → **No** LOCATE and RECTIFY the short to ground in the circuit between the interior monitoring sensor and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.

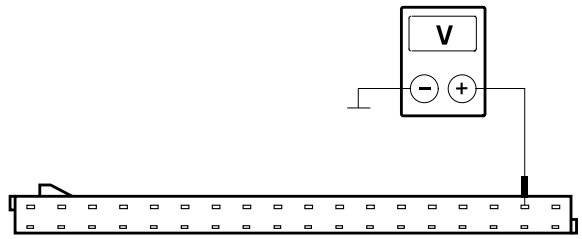
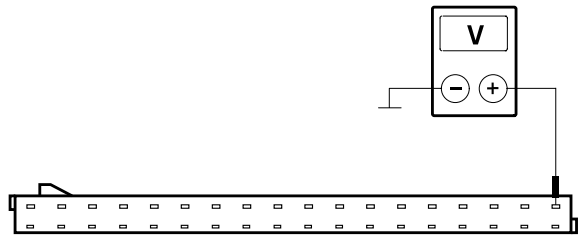
PINPOINT TEST H : CONTROL MODULE FOR MOBILE ELECTRONIC AUXILIARY EQUIPMENT NOT COMMUNICATING WITH THE DIAGNOSTIC TESTER.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
H1: CHECK THE COMMUNICATIONS WITH THE ELECTRONIC INSTRUMENT CLUSTER	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.

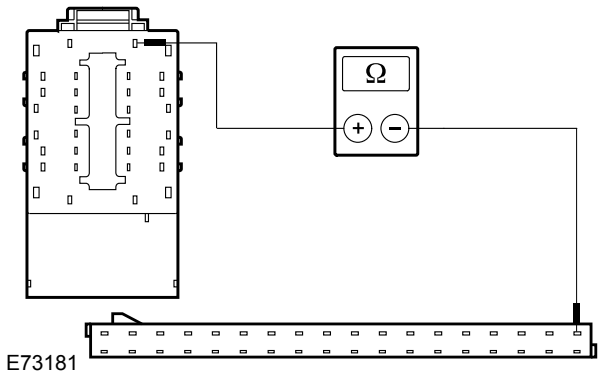
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Select the electronic instrument cluster with the diagnostic tester. • Is it possible to establish communications with the electronic instrument cluster? → **Yes** GO to H2. → **No** GO to Pinpoint Test N.
H2: CHECK FUSE F73	
	1 Ignition switch in position 0.
	2 CHECK Fuse F73 (CJB). • Is the fuse OK? → **Yes** GO to H3. → **No** RENEW fuse F73 (15 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
H3: CHECK THE VOLTAGE AT FUSE F73	
	1 Connect Fuse F73 (CJB).
	2 Measure the voltage between fuse F73 (15 A) and ground. • Does the meter display battery voltage? → **Yes** GO to H4. → **No** REPAIR the voltage supply to fuse F73 with the aid of the Wiring Diagrams. CHECK the operation of the system.
H4: CHECK THE VOLTAGE AT THE CONTROL MODULE FOR MOBILE ELECTRONIC AUXILIARY EQUIPMENT	
	1 Disconnect Connector CMM01A from the control module for mobile electronic auxiliary equipment.

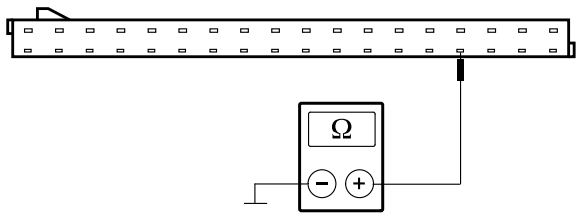
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69590	2 Measure the voltage between the control module for mobile electronic auxiliary equipment, connector CMM01A, pin 17, circuit SBP73D (RD), wiring harness side and ground.
	3 Measure the voltage between the control module for mobile electronic auxiliary equipment, connector CMM01A, pin 18, circuit SBP73E (RD), wiring harness side and ground. • Is battery voltage measured in both cases? → **Yes** GO to H6. → **No** - If battery voltage is not measured during one of the measurements: LOCATE and RECTIFY the break in the affected circuit between the control module for mobile electronic auxiliary equipment and soldered connection S2BP73 with the aid of the Wiring Diagrams. CHECK the operation of the system. - If battery voltage is not measured during both of the measurements: GO to H5.
H5: CHECK FOR OPEN CIRCUIT BETWEEN THE CJB AND THE CONTROL MODULE FOR MOBILE ELECTRONIC AUXILIARY EQUIPMENT	
	1 Disconnect Connector CBP02E from the CJB.

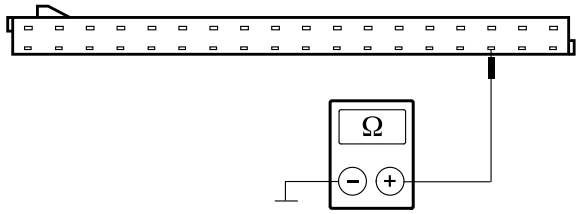
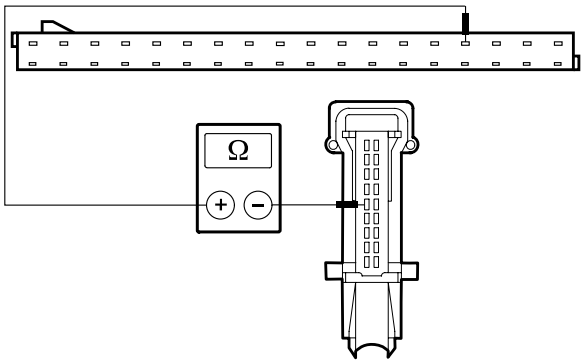
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73181	2 Measure the resistance between the CJB, connector CBP02E, pin 31, circuit SBP73A (RD), wiring harness side and the control module for mobile electronic auxiliary equipment, connector CMM01A, pin 18, circuit SBP73E (RD), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the open circuit between soldered connection S2BP73 and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.

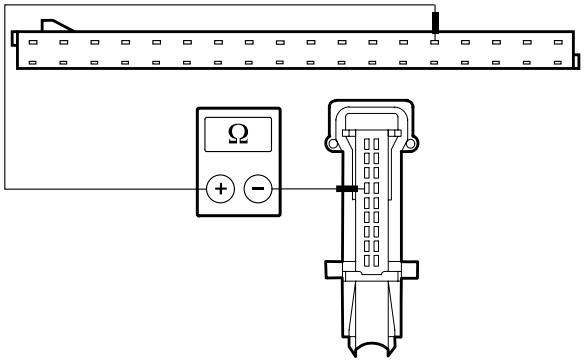
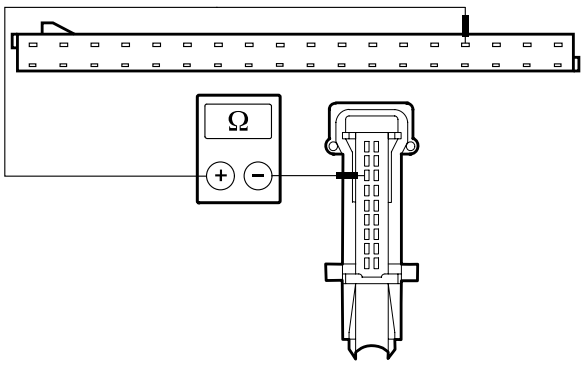
H6: CHECK THE GROUND CONNECTION OF THE CONTROL MODULE FOR MOBILE ELECTRONIC AUXILIARY EQUIPMENT

 E69592	1 Measure the resistance between the control module for mobile electronic auxiliary equipment, connector CMM01A, pin 33, circuit GD114G (BK/BU), wiring harness side and ground.

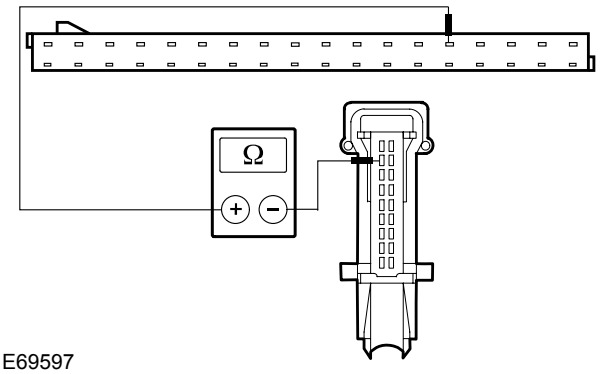
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the control module for mobile electronic auxiliary equipment, connector CMM01A, pin 34, circuit GD114H (BK/BU), wiring harness side and ground. • Is a resistance of less than 2 Ohm measured in both cases? → **Yes** GO to H7. → **No** - If a resistance of more than 2 Ohm is measured in one of the measurements: LOCATE and RECTIFY the break in the relevant circuit between the control module for mobile electronic auxiliary equipment and soldered connection S2D114A with the aid of the Wiring Diagrams. CHECK the operation of the system. - If a resistance of more than 2 Ohm is measured in both of the measurements: LOCATE and REPAIR the open circuit between soldered connection S2D114A and ground connection GP14 with the aid of the Wiring Diagrams. CHECK the operation of the system.
H7: CHECK FOR OPEN CIRCUIT BETWEEN THE CONTROL MODULE FOR MOBILE ELECTRONIC AUXILIARY EQUIPMENT AND THE INSTRUMENT CLUSTER	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.**	
	1 Disconnect Connector CMC01 from the instrument cluster.
	2 Measure the resistance between the control module for mobile electronic auxiliary equipment, connector CMM01A, pin 15, circuit VDB14A (VT/GY), wiring harness side and the instrument cluster, connector CMC01, pin 5, circuit VDB14C (VT/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to H8. → **No** LOCATE and REPAIR the break in the circuit between the control module for mobile electronic auxiliary equipment and the instrument cluster using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
H8: CHECK FOR OPEN CIRCUIT BETWEEN THE CONTROL MODULE FOR MOBILE ELECTRONIC AUXILIARY EQUIPMENT AND THE INSTRUMENT CLUSTER	
CAUTION:The following measurement may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.	
	1 Measure the resistance between the control module for mobile electronic auxiliary equipment, connector CMM01A, pin 14, circuit VDB13A (BU/GY), wiring harness side and the instrument cluster, connector CMC01, pin 6, circuit VDB13C (BU/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to H9. → **No** LOCATE and REPAIR the break in the circuit between the control module for mobile electronic auxiliary equipment and the instrument cluster using the Wiring Diagrams. CHECK the operation of the system.
H9: CHECK FOR OPEN CIRCUIT BETWEEN THE CONTROL MODULE FOR MOBILE ELECTRONIC AUXILIARY EQUIPMENT AND THE INSTRUMENT CLUSTER	
CAUTION:The following measurement may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.	
	1 Measure the resistance between the control module for mobile electronic auxiliary equipment, connector CMM01A, pin 15, circuit VDB14A (VT/GY), wiring harness side and the instrument cluster, connector CMC01, pin 7, circuit VDB14D (VT/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to H10. → **No** LOCATE and REPAIR the break in the circuit between the control module for mobile electronic auxiliary equipment and the instrument cluster using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
H10: CHECK FOR OPEN CIRCUIT BETWEEN THE CONTROL MODULE FOR MOBILE ELECTRONIC AUXILIARY EQUIPMENT AND THE INSTRUMENT CLUSTER	
CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.	
 E69597	1 Measure the resistance between the control module for mobile electronic auxiliary equipment, connector CMM01A, pin 14, circuit VDB13A (BU/GY), wiring harness side and the instrument cluster, connector CMC01, pin 8, circuit VDB13D (BU/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary RENEW the control module for mobile electronic auxiliary equipment. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the control module for mobile electronic auxiliary equipment and the instrument cluster using the Wiring Diagrams. CHECK the operation of the system.

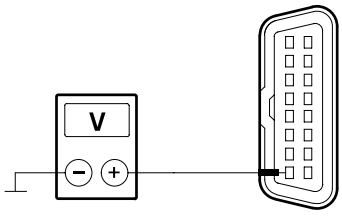
PINPOINT TEST I : ABS MODULE OR ELECTRONIC STABILITY PROGRAM (ESP) MODULE NOT COMMUNICATING WITH THE DIAGNOSTIC TESTER

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I1: CHECK COMMUNICATION WITH THE POWERTRAIN CONTROL MODULE (PCM)	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.
	3 Select the powertrain control module (PCM) with the diagnostic tester. • Is it possible to establish communication with the PCM? → **Yes** GO to I2. → **No** GO to Pinpoint Test P.
I2: CHECK FUSE F13	
	1 Ignition switch in position 0.

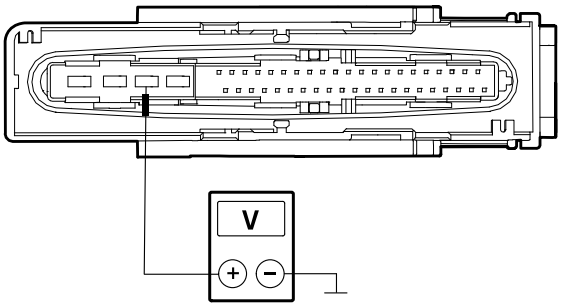
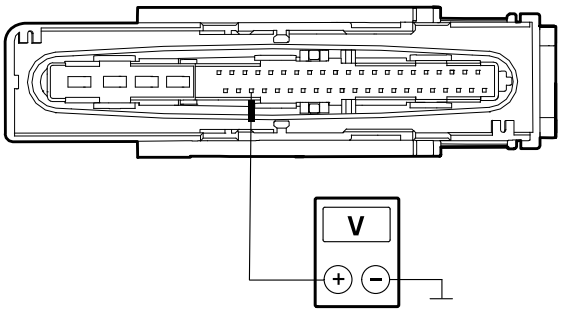
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK Fuse F13 (EJB) • Is the fuse OK? → **Yes** GO to I3. → **No** RENEW fuse F13 (40 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
I3: CHECK THE VOLTAGE AT FUSE F13	
	1 Connect Fuse F13 (EJB).
	2 Measure the voltage between fuse F13 (40 A) and ground. • Does the meter display battery voltage? → **Yes** GO to I4. → **No** REPAIR the voltage supply to fuse F13 with the aid of the Wiring Diagrams. CHECK the operation of the system.
I4: CHECK FUSE F21	
	1 CHECK Fuse F21 (EJB) • Is the fuse OK? → **Yes** GO to I5. → **No** RENEW fuse F21 (25 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
I5: CHECK THE VOLTAGE AT FUSE F21	
	1 Connect Fuse F21 (EJB).
	2 Measure the voltage between fuse F21 (25 A) and ground. • Does the meter display battery voltage? → **Yes** GO to I6. → **No** REPAIR the voltage supply to fuse F21 with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I6: CHECK FUSE F20	
	1 CHECK Fuse F20 (EJB). • Is the fuse OK? → **Yes** GO to I7. → **No** RENEW fuse F20 (10 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
I7: CHECK THE VOLTAGE AT FUSE F20	
	1 Connect Fuse F20 (EJB).
	2 Measure the voltage between fuse F20 (10 A) and ground. • Does the meter display battery voltage? → **Yes** - Vehicles with electronic stability program (ESP): GO to I8. - Vehicles without electronic stability program (ESP): GO to I18. → **No** REPAIR the voltage supply to fuse F20 with the aid of the Wiring Diagrams. CHECK the operation of the system.
I8: CHECK THE VOLTAGE AT THE ESP MODULE	
	1 Ignition switch in position 0.
	2 Disconnect Connector C1CA01 from the electronic stability program module.
 VFE0028957	3 Measure the voltage between the ESP module, connector C1CA01, pin 2, circuit SBB13B (GY/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to I9. → **No** LOCATE and REPAIR the break in the circuit between the ESP module and fuse F13 with the aid of the wiring diagrams. CHECK the operation of the system.

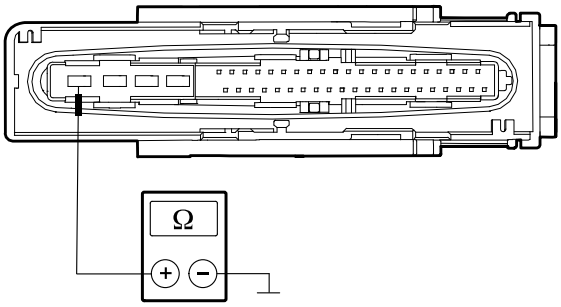
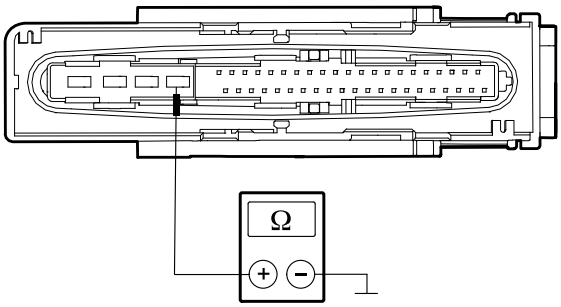
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I9: CHECK THE VOLTAGE AT THE ESP MODULE	
	1 Measure the voltage between the ESP module, connector C1CA01, pin 3, circuit SBB21B (GY/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to I10. → **No** LOCATE and REPAIR the break in the circuit between the ESP module and fuse F21 with the aid of the wiring diagrams. CHECK the operation of the system.
I10: CHECK THE VOLTAGE AT THE ESP MODULE (TERMINAL 15)	
	1 Ignition switch in position II.
	2 Measure the voltage between the ESP module, connector C1CA01, pin 28, circuit CBB20C (YE/VT)(vehicles with traction control: circuit CBB20J (YE/VT)), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to I15. → **No** GO to I11.
I11: CHECK FOR OPEN CIRCUIT BETWEEN THE ESP MODULE AND THE ESP RELAY	
	1 Disconnect ESP relay from socket R5.
	2 Measure the resistance between the ESP module, connector C1CA01, pin 28, circuit CBB20C (YE/VT)(vehicles with traction control: circuit CBB20J (YE/VT)), wiring harness side and the ESP relay, socket R5, pin 5, circuit CBB20A (YE/VT), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to I12. → **No** LOCATE and REPAIR the break in the circuit between the ESP module and the ESP relay with the aid of the Wiring Diagrams. CHECK the operation of the system.

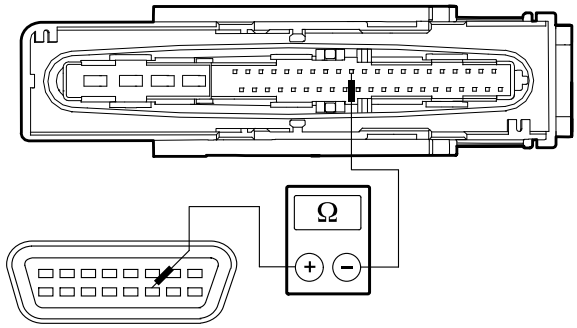
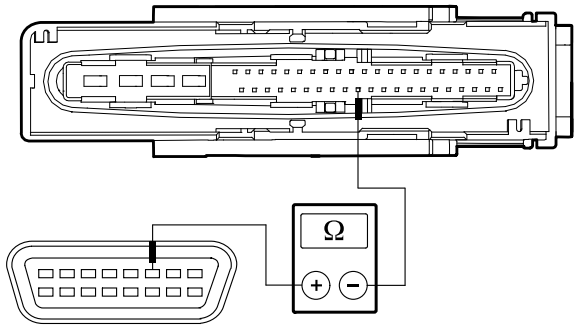
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I12: CHECK THE VOLTAGE AT THE ESP RELAY	
	1 Measure the voltage between the ESP relay, socket R5, pin 3, circuit SBB20A (GN/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to I13. → **No** LOCATE and REPAIR the break in circuit SBB20A (GN/RD) between the ESP relay and fuse F20 with the aid of the Wiring Diagrams. CHECK the operation of the system.
I13: CHECK THE VOLTAGE AT THE ESP RELAY	
	1 Ignition switch in position II.
	2 Measure the voltage between the ESP relay, socket R5, pin 1, circuit CDC32H (BN/YE), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to I14. → **No** LOCATE and RECTIFY the break in circuit CDC32H (BN/YE) between the ESP relay, pin 1 and soldered connection S2DC32 with the aid of the Wiring Diagrams. CHECK the operation of the system.
I14: CHECK THE GROUND CONNECTION OF THE ESP RELAY	
	1 Ignition switch in position 0.
	2 Measure the resistance between the ESP relay, socket R5, pin 2, circuit GD122H (BK)(all expect vehicles with a diesel engine: circuit GD122L (BK)), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** RENEW the ESP relay. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit GD122H (BK) between the ESP relay and ground connection GP22 with the aid of the Wiring Diagrams. CHECK the operation of the system.

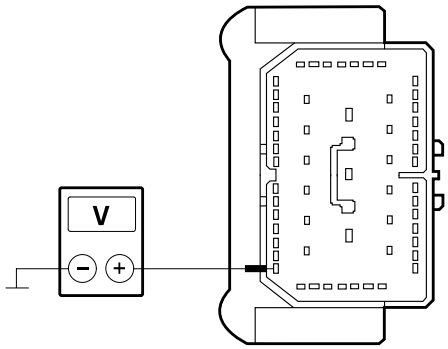
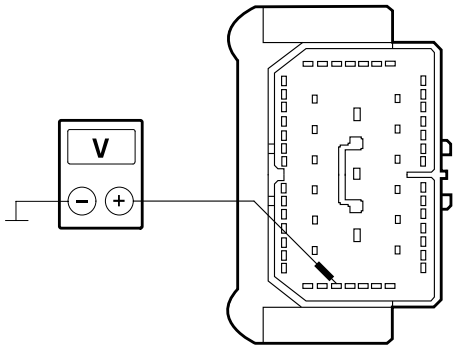
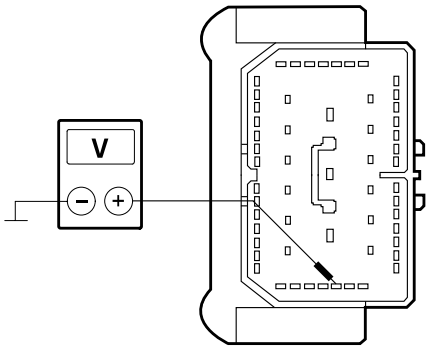
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I15: CHECK THE GROUND CONNECTION OF THE ELECTRONIC STABILITY PROGRAM MODULE	
	1 Ignition switch in position 0.
 E83631	2 Measure the resistance between the ESP module, connector C1CA01, pin 1, circuit GD120A (BK/GN)(vehicles with traction control: circuit GD120A (BK/GN)), wiring harness side and ground.
	3 Measure the resistance between the ESP module, connector C1CA01, pin 4, circuit GD120B (BK/GN), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to I16. → **No** - If a resistance of more than 2 Ohm is measured in one of the measurements: LOCATE and REPAIR the break in the relevant circuit between the ESP module and soldered connection S1D120 with the aid of the Wiring Diagrams. CHECK the operation of the system. - If a resistance of more than 2 Ohm is measured in both of the measurements: LOCATE and REPAIR the open circuit between soldered connection S1D120 and ground connection GP20 with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I16: CHECK FOR OPEN CIRCUIT BETWEEN THE ELECTRONIC STABILITY PROGRAM MODULE AND THE DATA LINK CONNECTOR (DLC)	
CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.	
	1 Measure the resistance between the ESP module, connector C1CA01, pin 14, circuit VDB05H (WH), wiring harness side and the DLC, connector CDB04, pin 14, circuit VDB05B (WH), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to I17. → **No** LOCATE and REPAIR the break in the circuit between the ESP module and soldered connection S1DB05 with the aid of the Wiring Diagrams. CHECK the operation of the system.
I17: CHECK FOR OPEN CIRCUIT BETWEEN THE ELECTRONIC STABILITY PROGRAM MODULE AND THE DLC	
CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.	
 E83634	1 Measure the resistance between the ESP module, connector C1CA01, pin 35, circuit VDB04H (WH/BU), wiring harness side and the DLC, connector CDB04, pin 6, circuit VDB04B (WH/BU), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary RENEW the electronic stability program module. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the ESP module and soldered connection S1DB04 with the aid of the Wiring Diagrams. CHECK the operation of the system.
I18: CHECK THE VOLTAGE AT THE ANTI-LOCK BRAKE SYSTEM MODULE (TERMINAL 30)	
	1 Ignition switch in position 0.
	2 Disconnect Connector CCA10 from the ABS module.

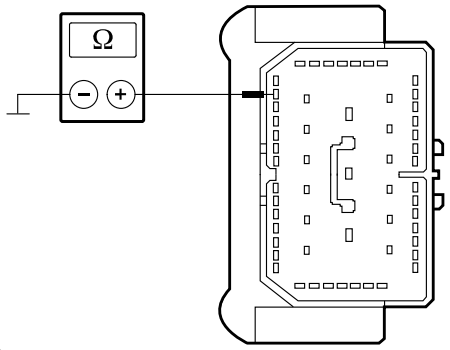
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between the ABS module, connector CCA10, pin 1, circuit SBB13C (GY/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to I19. → **No** LOCATE and REPAIR the break in the circuit between the ABS module and fuse F13 using the wiring diagrams. CHECK the operation of the system.
I19: CHECK THE VOLTAGE AT THE ANTI-LOCK BRAKE SYSTEM MODULE (TERMINAL 30)	
	1 Measure the voltage between the ABS module, connector CCA10, pin 25, circuit SBB21C (GY/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to I20. → **No** LOCATE and REPAIR the break in the circuit between the ABS module and fuse F21 using the wiring diagrams. CHECK the operation of the system.
I20: CHECK THE VOLTAGE AT THE ANTI-LOCK BRAKE SYSTEM MODULE (TERMINAL 15)	
	1 Ignition switch in position II.
	2 Measure the voltage between the ABS module, connector CCA10, pin 32, circuit CBB20J (YE/VT), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to I25. → **No** GO to I21.
I21: CHECK FOR OPEN CIRCUIT BETWEEN THE ABS MODULE AND THE ABS RELAY	
	1 Disconnect ABS relay from socket R5.

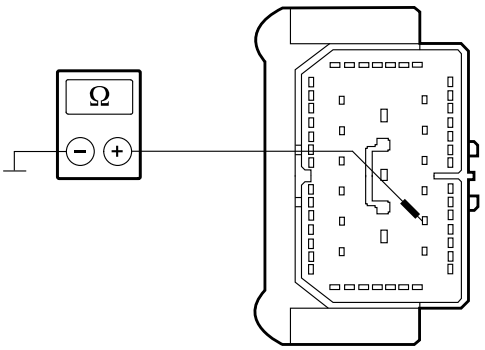
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the ABS module, connector CCA10, pin 32, circuit CBB20J (YE/VT), wiring harness side and the ABS relay, socket R5, pin 5, circuit CBB20A (YE/VT), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to I22. → **No** LOCATE and REPAIR the break in the circuit between the ABS module and the ABS relay with the aid of the Wiring Diagrams. CHECK the operation of the system.
I22: CHECK THE VOLTAGE AT THE ABS RELAY	
	1 Ignition switch in position II.
	2 Measure the voltage between the ABS relay, socket R5, pin 5, circuit SBB20A (GN/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to I23. → **No** LOCATE and REPAIR the break in circuit SBB20A (GN/RD) between the ABS relay and fuse F20 with the aid of the Wiring Diagrams. CHECK the operation of the system.
I23: CHECK THE VOLTAGE AT THE ABS RELAY	
	1 Ignition switch in position II.
	2 Measure the voltage between the ABS relay, socket R5, pin 1, circuit CDC32H (BN/YE), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to I24. → **No** LOCATE and RECTIFY the break in circuit CDC32H (BN/YE) between the ABS relay, pin 1 and soldered connection S2DC32 with the aid of the Wiring Diagrams. CHECK the operation of the system.
I24: CHECK THE GROUND CONNECTION OF THE ABS RELAY	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

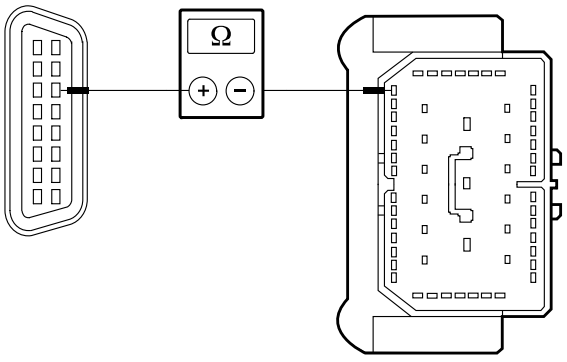
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the ABS relay, socket R5, pin 2, circuit GD122C (BK)(all expect vehicles with a diesel engine: circuit GD122L (BK)), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** RENEW the ABS relay. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit GD122C (BK) between the ABS relay and ground connection GP22 with the aid of the Wiring Diagrams. CHECK the operation of the system.
I25: CHECK THE GROUND CONNECTION OF THE ABS MODULE	
	1 Ignition switch in position 0.
	2 Measure the resistance between the ABS module, connector CCA10, pin 13, circuit GD120F (BK/GN), wiring harness side and ground.

DIAGNOSIS AND TESTING

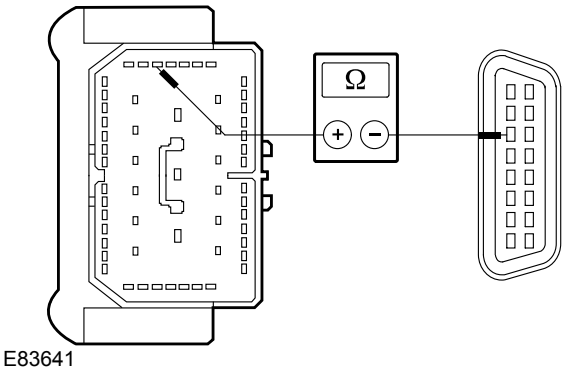
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the resistance between the ABS module, connector CCA10, pin 38, circuit GD120E (BK/GN), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to I26. → **No** - If a resistance of more than 2 Ohm is measured in one of the measurements: LOCATE and REPAIR the break in the relevant circuit between the ABS module and soldered connection S1D120 with the aid of the Wiring Diagrams. CHECK the operation of the system. - If a resistance of more than 2 Ohm is measured in both of the measurements: LOCATE and REPAIR the open circuit between soldered connection S1D120 and ground connection GP20 with the aid of the Wiring Diagrams. CHECK the operation of the system.

I26: CHECK THE CIRCUIT BETWEEN THE ABS MODULE AND THE DATA LINK CONNECTOR (DLC) FOR OPEN CIRCUIT

CAUTION:The following measurement may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.

	1 Measure the resistance between the ABS module, connector CCA10, pin 14, circuit VDB05J (WH), wiring harness side and the DLC, connector CDB04, pin 14, circuit VDB05B (WH), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to I27. → **No** LOCATE and REPAIR the break in the circuit between the ABS module and soldered connection S1DB05 with the aid of the Wiring Diagrams. CHECK the operation of the system.

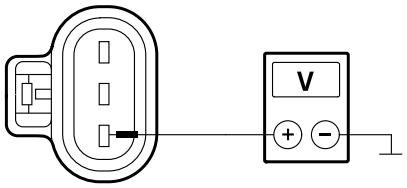
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I27: CHECK FOR OPEN CIRCUIT BETWEEN THE ABS MODULE AND THE DLC	
⚠ CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.	
 E83641	1 Measure the resistance between the ABS module, connector CCA10, pin 26, circuit VDB04J (WH/BU), wiring harness side and the DLC, connector CDB04, pin 6, circuit VDB04B (WH/BU), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the ABS module and RENEW if necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the ABS module and soldered connection S1DB04 with the aid of the Wiring Diagrams. CHECK the operation of the system.

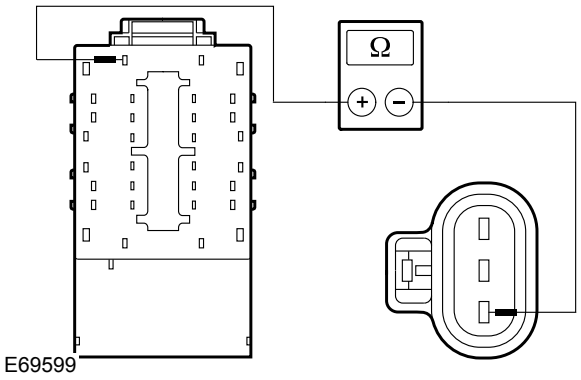
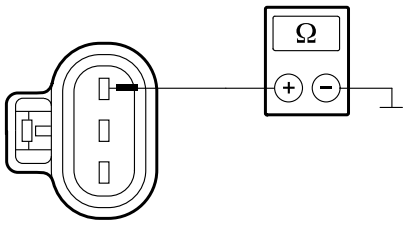
PINPOINT TEST J : ANTI-THEFT ALARM SIGNAL HORN WITH INTEGRATED BATTERY NOT COMMUNICATING WITH THE GENERIC ELECTRONIC MODULE (GEM).

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
J1: CHECK COMMUNICATION WITH THE GENERIC ELECTRONIC MODULE (GEM)	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.
	3 Select the generic electronic module (GEM) with the diagnostic tester. • Is it possible to establish communication with the GEM? → **Yes** GO to J2. → **No** GO to Pinpoint Test M.
J2: CHECK FUSE F70	
	1 Ignition switch in position 0.

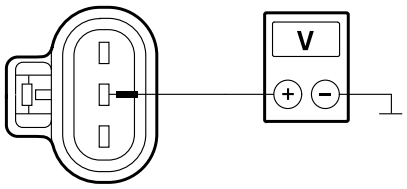
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK Fuse F70 (CJB). • Is the fuse OK? → **Yes** GO to J3. → **No** RENEW fuse F70 (20 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
J3: CHECK THE VOLTAGE AT FUSE F70	
	1 Connect Fuse F70 (CJB).
	2 Measure the voltage between fuse F70 (20 A) and ground. • Does the meter display battery voltage? → **Yes** GO to J4. → **No** REPAIR the voltage supply to fuse F70 with the aid of the Wiring Diagrams. CHECK the operation of the system.
J4: CHECK THE VOLTAGE AT THE ANTI-THEFT ALARM SIGNAL HORN WITH INTEGRATED BATTERY	
	1 Disconnect Connector CRT16 from the anti-theft alarm signal horn with integrated battery.
	2 Measure the voltage between the anti-theft alarm signal horn with integrated battery, connector CRT16, pin 3, circuit SBP70A (RD/BN)(LHD vehicles: circuit SBP70A (BN/RD)), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to J6. → **No** GO to J5.
J5: CHECK THE CIRCUIT BETWEEN THE CJB AND THE ANTI-THEFT ALARM SIGNAL HORN WITH INTEGRATED BATTERY FOR OPEN CIRCUIT	
	1 Disconnect Connector CBP02B from the CJB.

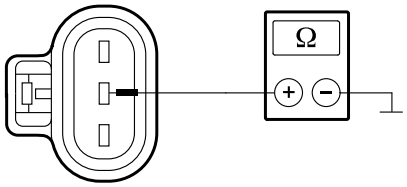
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the CJB, connector CBP02B, pin 30, circuit SBP70A (RD/BN), wiring harness side and the anti-theft alarm signal horn with integrated battery, connector CRT16, pin 3, circuit SBP70A (RD/BN)(LHD vehicles: circuit SBP70A (BN/RD)), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the anti-theft alarm signal horn with integrated battery and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
J6: CHECK THE GROUND CONNECTION OF THE ANTI-THEFT ALARM SIGNAL HORN WITH INTEGRATED BATTERY	
	1 Measure the resistance between the anti-theft alarm signal horn with integrated battery, connector CRT16, pin 1, circuit GD129B (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to J7. → **No** LOCATE and RECTIFY the break in the circuit between the anti-theft alarm signal horn with integrated battery and ground connection GP29 with the aid of the Wiring Diagrams. CHECK the operation of the system.
J7: CHECK THE CIRCUIT BETWEEN THE ANTI-THEFT ALARM SIGNAL HORN WITH INTEGRATED BATTERY AND THE CJB FOR OPEN CIRCUIT	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.**	
	1 Disconnect Connector CBP02C from the CJB.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the anti-theft alarm signal horn with integrated battery, connector CRT16, pin 2, circuit SRT16A (GY/RD), wiring harness side and the CJB, connector CBP02C, pin 29, circuit SRT16A (GY/RD), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to J8. → **No** LOCATE and RECTIFY the break in the circuit between the anti-theft alarm signal horn with integrated battery and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
J8: CHECK THE LIN BUS FOR A SHORT TO VOLTAGE SUPPLY	
	1 Ignition switch in position II.
 E69602	2 Measure the voltage between the anti-theft alarm signal horn with integrated battery, connector CRT16, pin 2, circuit SRT16A (GY/RD), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and RECTIFY the short to voltage in the circuit between the anti-theft alarm signal horn with integrated battery and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to J9.
J9: CHECK THE LIN BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69603	2 Measure the resistance between the anti-theft alarm signal horn with integrated battery, connector CRT16, pin 2, circuit SRT16A (GY/RD), wiring harness side and ground. • Is a resistance of more than 10,000 Ohm measured? → **Yes** CHECK and if necessary RENEW the anti-theft alarm signal horn with integrated battery. CHECK the operation of the system. → **No** LOCATE and RECTIFY the short to ground in the circuit between the anti-theft alarm signal horn with integrated battery and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST K : ELECTRONIC INSTRUMENT CLUSTER NOT COMMUNICATING WITH THE DIAGNOSTIC TESTER.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
K1: CHECK COMMUNICATION WITH THE GENERIC ELECTRONIC MODULE (GEM)	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.
	3 Select the GEM with the diagnostic unit. • Is it possible to establish communication with the GEM? → **Yes** GO to K2. → **No** GO to Pinpoint Test N.
K2: CHECK FUSE F74	
	1 Ignition switch in position 0.
	2 CHECK Fuse F74 (CJB). • Is the fuse OK? → **Yes** GO to K3. → **No** RENEW fuse F74 (5 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
K3: CHECK THE VOLTAGE AT FUSE F74	
	1 Connect Fuse F74 (CJB).
	2 Measure the voltage between fuse F74 (5 A) and ground. • Does the meter display battery voltage? → **Yes** GO to K4. → **No** REPAIR the voltage supply to fuse F74 with the aid of the Wiring Diagrams. CHECK the operation of the system.
K4: CHECK FUSE F82	
	1 CHECK Fuse F82 (CJB). • Is the fuse OK? → **Yes** GO to K5. → **No** RENEW fuse F82 (2 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
K5: CHECK THE VOLTAGE AT FUSE F82	
	1 Connect Fuse F82 (CJB).
	2 Ignition switch in position I.
	3 Measure the voltage between fuse F82 (2 A) and ground. • Does the meter display battery voltage? → **Yes** GO to K6. → **No** REPAIR the voltage supply to fuse F82 with the aid of the Wiring Diagrams. CHECK the operation of the system.
K6: CHECK FUSE F66	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK Fuse F66 (CJB). • Is the fuse OK? → **Yes** GO to K7. → **No** RENEW fuse F66 (5 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
K7: CHECK THE VOLTAGE AT FUSE F66	
	1 Connect Fuse F66 (CJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F66 (5 A) and ground. • Does the meter display battery voltage? → **Yes** GO to K17. → **No** GO to K8.
K8: CHECK FUSE F18	
	1 Ignition switch in position 0.
	2 CHECK Fuse F18 (EJB). • Is the fuse OK? → **Yes** GO to K9. → **No** RENEW fuse F18 (40 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
K9: CHECK THE VOLTAGE AT FUSE F18	
	1 Connect Fuse F18 (EJB).
	2 Ignition switch in position II.

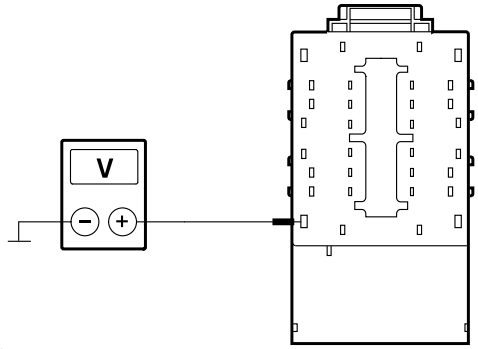
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between fuse F18 (40 A) and ground. • Does the meter display battery voltage? → **Yes** GO to K16. → **No** GO to K10.
K10: CHECK THE CIRCUIT BETWEEN THE IGNITION RELAY AND THE EJB FOR OPEN CIRCUIT	
	1 Disconnect Ignition relay from socket R6.
	2 Measure the resistance between fuse F18, circuit CBB16D (BU/GN), wiring harness side and the ignition relay, socket R6, pin 5, circuit CBB16A (BU/GN), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to K11. → **No** LOCATE and REPAIR the open circuit between fuse F18 and the ignition relay with the aid of the Wiring Diagrams. CHECK the operation of the system.
K11: CHECK THE VOLTAGE AT THE IGNITION RELAY	
	1 Measure the voltage between the ignition relay, socket R6, pin 3, circuit SBB16A (VT/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to K14. → **No** GO to K12.
K12: CHECK FUSE F16	
	1 CHECK Fuse F16 (EJB). • Is the fuse OK? → **Yes** GO to K13. → **No** RENEW fuse F16 (60 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.

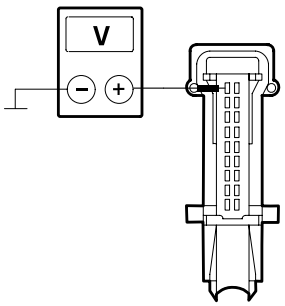
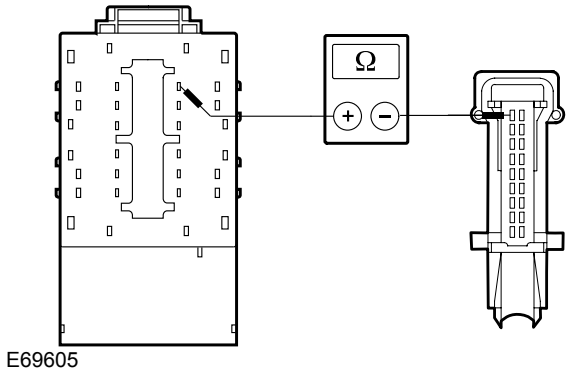
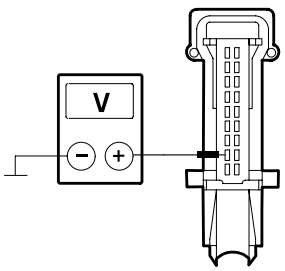
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
K13: CHECK THE VOLTAGE AT FUSE F16	
	1 Connect Fuse F16 (EJB).
	2 Measure the voltage between fuse F16 (60 A) and ground. • Does the meter display battery voltage? → **Yes** LOCATE and REPAIR the break in circuit SBB16A (VT/RD) between the ignition relay and fuse F16 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** CHECK and if necessary RENEW the EJB. CHECK the operation of the system.
K14: CHECK THE VOLTAGE AT THE IGNITION RELAY	
	1 Ignition switch in position II.
	2 Measure the voltage between the ignition relay, socket R6, pin 1, circuit CDC32H (BN/YE)(vehicles with a diesel engine: circuit CDC32H (GY/RD)), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to K15. → **No** LOCATE and RECTIFY the break in the circuit between the ignition relay, pin 1 and the ignition switch with the aid of the Wiring Diagrams. CHECK the operation of the system.
K15: CHECK GROUND CONNECTION AT IGNITION RELAY	
	1 Ignition switch in position 0.

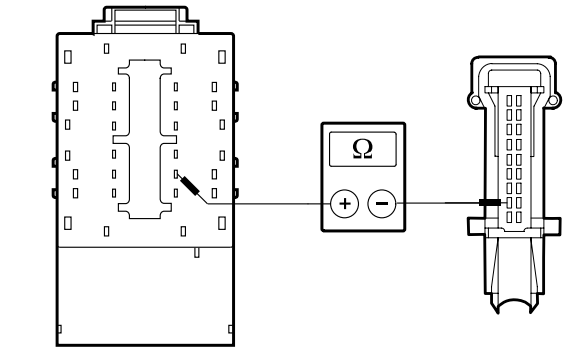
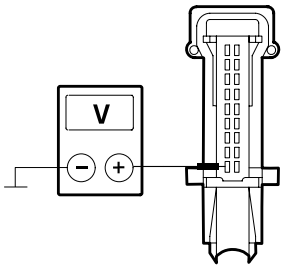
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the ignition relay, socket R6, pin 2, circuit GD122C (BK) (vehicles with a diesel engine: circuit GD122H (BK)), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** RENEW the ignition relay. CHECK the operation of the system. → **No** LOCATE and REPAIR the open circuit between the ignition relay and ground connection GP22 with the aid of the Wiring Diagrams. CHECK the operation of the system.
K16: CHECK THE VOLTAGE AT THE CJB	
	1 Ignition switch in position 0.
	2 Disconnect Connector CBP02B from the CJB.
	3 Ignition switch in position II.
 E83644	4 Measure the voltage between the CJB, connector CBP02B, pin 1, circuit CBB18A (GY/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the open circuit between the CJB and fuse F18 with the aid of the Wiring Diagrams. CHECK the operation of the system.
K17: CHECK THE VOLTAGE AT THE INSTRUMENT CLUSTER	
	1 Ignition switch in position 0.
	2 Disconnect Connector CMC01 from the instrument cluster.

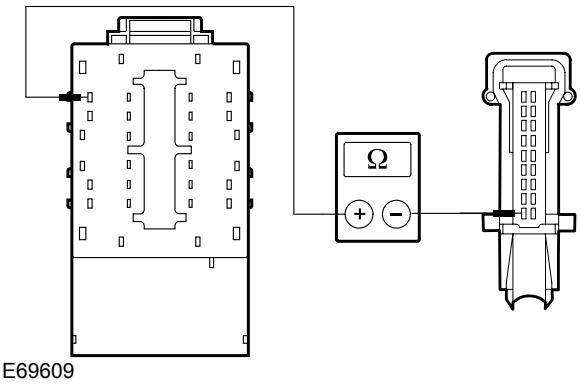
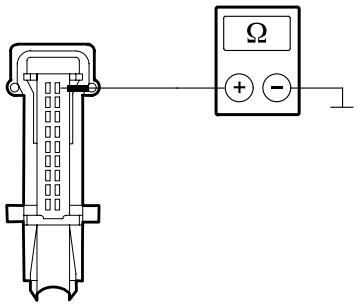
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between the instrument cluster, connector CMC01, pin 9, circuit SBP74C (RD/BK), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to K19. → **No** GO to K18.
K18: CHECK FOR OPEN CIRCUIT BETWEEN THE CJB AND THE INSTRUMENT CLUSTER	
	1 Disconnect Connector CBP02E from the CJB.
 E69605	2 Measure the resistance between the CJB, connector CBP02E, pin 27, circuit SBP74A (YE/RD), wiring harness side and the instrument cluster, connector CMC01, pin 9, circuit SBP74C (YE/RD), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the CJB using the Wiring Diagrams. CHECK the operation of the system.
K19: CHECK THE VOLTAGE AT THE INSTRUMENT CLUSTER	
	1 Ignition switch in position I.
	2 Measure the voltage between the instrument cluster, connector CMC01, pin 2, circuit SBP82C (YE/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to K21. → **No** GO to K20.
K20: CHECK FOR OPEN CIRCUIT BETWEEN THE CJB AND THE INSTRUMENT CLUSTER	
	1 Ignition switch in position 0.

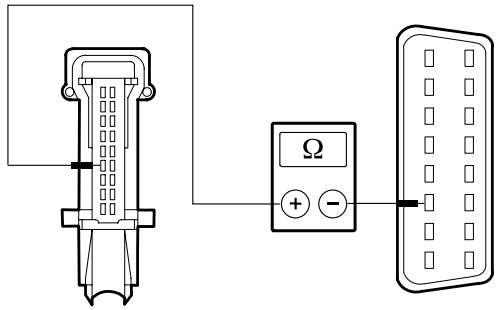
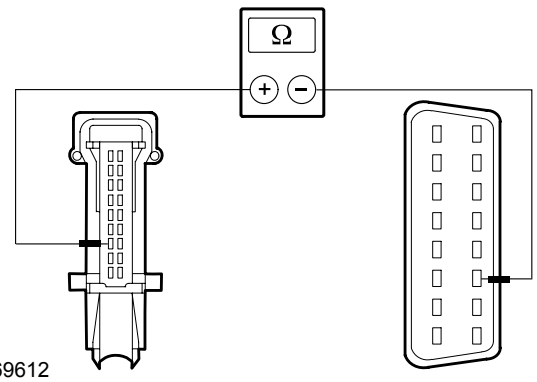
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Connector CBP02E from the CJB.
 E69607	3 Measure the resistance between the CJB, connector CBP02E, pin 11, circuit SBP82A (YE/RD), wiring harness side and the instrument cluster, connector CMC01, pin 2, circuit SBP82C (YE/RD), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the CJB using the Wiring Diagrams. CHECK the operation of the system.
K21: CHECK THE VOLTAGE AT THE INSTRUMENT CLUSTER	
	1 Ignition switch in position II.
	2 Measure the voltage between the instrument cluster, connector CMC01, pin 1, circuit SBP66C (YE/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to K23. → **No** GO to K22.
K22: CHECK FOR OPEN CIRCUIT BETWEEN THE CJB AND THE INSTRUMENT CLUSTER	
	1 Ignition switch in position 0.
	2 Disconnect Connector CBP02E from the CJB.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69609	3 Measure the resistance between the CJB, connector CBP02E, pin 25, circuit SBP66A (YE/RD), wiring harness side and the instrument cluster, connector CMC01, pin 1, circuit SBP66C (YE/RD), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the CJB using the Wiring Diagrams. CHECK the operation of the system.
K23: CHECK THE GROUND CONNECTION OF THE INSTRUMENT CLUSTER	
	1 Ignition switch in position 0.
	2 Measure the resistance between the instrument cluster, connector CMC01, pin 18, circuit GD116E (BK/VT), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to K24. → **No** LOCATE and REPAIR the open circuit between the instrument cluster and ground connection GP16 with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
K24: CHECK THE CIRCUIT BETWEEN THE INSTRUMENT CLUSTER AND THE DATA LINK CONNECTOR (DLC) FOR OPEN CIRCUIT	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.**	
 1	1 Measure the resistance between the instrument cluster, connector CMC01, pin 4, circuit VDB06F (GY/OG), wiring harness side and the DLC, connector CDB04, pin 3, circuit VDB06F (GY/OG), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to K25. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the DLC using the Wiring Diagrams. CHECK the operation of the system.
K25: CHECK THE CIRCUIT BETWEEN THE INSTRUMENT CLUSTER AND THE DLC FOR CONTINUITY	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.**	
 E69612	1 Measure the resistance between the instrument cluster, connector CMC01, pin 3, circuit VDB07F (VT/OG), wiring harness side and the DLC, connector CDB04, pin 11, circuit VDB07F (VT/OG), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary RENEW the instrument cluster. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the DLC using the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST L : POWERTRAIN CONTROL MODULE (PCM) NOT COMMUNICATING WITH THE DIAGNOSTIC TESTER

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L1: CHECK THE COMMUNICATIONS WITH THE ELECTRONIC INSTRUMENT CLUSTER	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Select the electronic instrument cluster with the diagnostic tester. • Is it possible to establish communications with the electronic instrument cluster? → **Yes** GO to L2. → **No** GO to Pinpoint Test P.
L2: CHECK FUSE F26	
	1 CHECK Fuse F26 (EJB). • Is the fuse OK? → **Yes** GO to L3. → **No** RENEW fuse F26 (15 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
L3: CHECK THE VOLTAGE AT FUSE F26	
	1 Connect Fuse F26 (EJB).
	2 Measure the voltage between fuse F26 (15 A) and ground. • Does the meter display battery voltage? → **Yes** GO to L4. → **No** GO to L12.
L4: CHECK FUSE F37	
	1 CHECK Fuse F37 (EJB). • Is the fuse OK? → **Yes** GO to L5. → **No** RENEW fuse F37 (5 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
L5: CHECK THE VOLTAGE AT FUSE F37	
	1 Connect Fuse F37 (EJB).
	2 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between fuse F37 (5 A) and ground. • Does the meter display battery voltage? → **Yes** - Vehicles with diesel engines: GO to L32. - All except vehicles with diesel engines: GO to L26. → **No** GO to L6.
L6: CHECK THE CIRCUIT BETWEEN THE IGNITION RELAY AND THE EJB FOR OPEN CIRCUIT	
	1 Disconnect Ignition relay from socket R6.
	2 Measure the resistance between fuse F37 and the ignition relay, socket R6, pin 5, circuit CBB16A (BU/GN), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to L7. → **No** LOCATE and REPAIR the open circuit between fuse F37 and the ignition relay with the aid of the Wiring Diagrams. CHECK the operation of the system.
L7: CHECK THE VOLTAGE AT THE IGNITION RELAY	
	1 Measure the voltage between the ignition relay, socket R6, pin 3, circuit SBB16A (VT/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to L10. → **No** GO to L8.
L8: CHECK FUSE F16	
	1 CHECK Fuse F16 (EJB). • Is the fuse OK? → **Yes** GO to L9. → **No** RENEW fuse F16 (60 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L9: CHECK THE VOLTAGE AT FUSE F16	
	1 Connect Fuse F16 (EJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F16 (60 A) and ground. • Does the meter display battery voltage? → **Yes** LOCATE and REPAIR the break in circuit SBB16A (VT/RD) between the ignition relay and fuse F16 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** CHECK and if necessary RENEW the EJB. CHECK the operation of the system.
L10: CHECK THE VOLTAGE AT THE IGNITION RELAY	
	1 Ignition switch in position II.
	2 Measure the voltage between the ignition relay, socket R6, pin 1, circuit CDC32H (BN/YE), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to L11. → **No** LOCATE and RECTIFY the break in circuit CDC32E (BN/YE) between the ignition relay, pin 1 and soldered connection S2DC32 with the aid of the Wiring Diagrams. CHECK the operation of the system.
L11: CHECK GROUND CONNECTION AT IGNITION RELAY	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the ignition relay, socket R6, pin 2, circuit GD122H (BK), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** RENEW the ignition relay. CHECK the operation of the system. → **No** LOCATE and REPAIR the open circuit between the ignition relay and ground connection GP22 with the aid of the Wiring Diagrams. CHECK the operation of the system.
L12: CHECK FUSE F22	
	1 CHECK Fuse F22 (EJB). • Is the fuse OK? → **Yes** GO to L13. → **No** RENEW fuse F22 (20 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
L13: CHECK THE VOLTAGE AT FUSE F22	
	1 Connect Fuse F22 (EJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F22 (20 A) and ground. • Does the meter display battery voltage? → **Yes** GO to L16. → **No** GO to L14.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L14: CHECK FUSE F1	
	1 CHECK fuse F1 (BJB). • Is the fuse OK? → **Yes** GO to L15. → **No** RENEW fuse F1 (100 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
L15: CHECK THE VOLTAGE AT FUSE F1	
	1 Connect fuse F1 (BJB).
	2 Measure the voltage between fuse F1 (100 A) and ground. • Does the meter display battery voltage? → **Yes** LOCATE and REPAIR the break in circuit SBF01A (RD) between the EJB and fuse F1 with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** REPAIR the voltage supply to fuse F1 with the aid of the Wiring Diagrams. CHECK the operation of the system.
L16: CHECK FUSE F25	
	1 Ignition switch in position 0.
	2 CHECK Fuse F25 (EJB). • Is the fuse OK? → **Yes** GO to L17. → **No** RENEW fuse F25 (5 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
L17: CHECK THE VOLTAGE AT FUSE F25	
	1 Connect Fuse F25 (EJB).
	2 Ignition switch in position II.

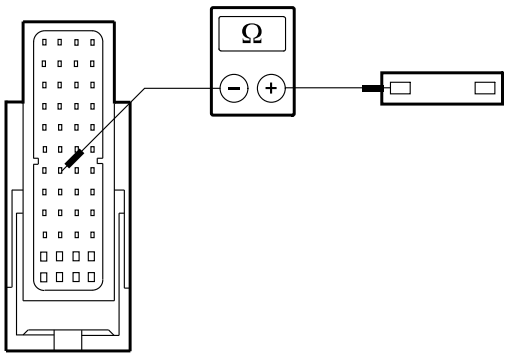
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between fuse F25 (5 A) and ground. • Does the meter display battery voltage? → **Yes** GO to L18. → **No** CHECK and if necessary RENEW the EJB. CHECK the operation of the system.
L18: CHECK THE VOLTAGE AT THE POWER SUPPLY RELAY	
	1 Ignition switch in position 0.
	2 Disconnect Power supply relay R8.
	3 Measure the voltage between the power supply relay, socket R8, pin 3, circuit SBB22A (BN/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to L19. → **No** LOCATE and REPAIR the break in circuit SBB22A (BN/RD) between the power supply relay and fuse F22 with the aid of the Wiring Diagrams. CHECK the operation of the system.
L19: CHECK THE VOLTAGE AT THE POWER SUPPLY RELAY	
	1 Measure the voltage between the power supply relay, socket R8, pin 1, circuit SBB25A (RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to L20. → **No** LOCATE and REPAIR the break in circuit SBB25A (RD) between the power supply relay, pin 1 and fuse F25 with the aid of the Wiring Diagrams. CHECK the operation of the system.

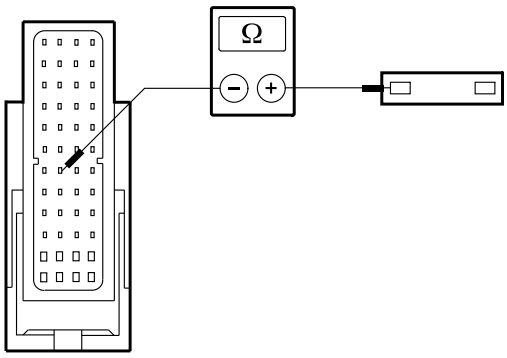
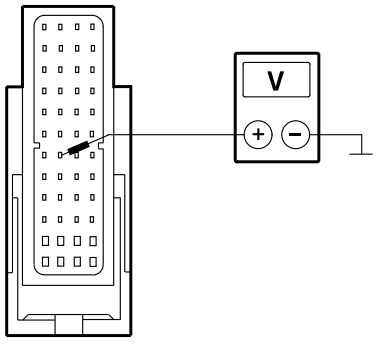
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L20: CHECK FOR OPEN CIRCUIT BETWEEN THE POWER SUPPLY RELAY AND FUSE F26	
	1 Measure the resistance between the power supply relay, socket R8, pin 5, circuit CBB22A (GN/OG), wiring harness side and fuse F26, wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** - Vehicles with diesel engines: GO to L21. - All except vehicles with diesel engines: GO to L23. → **No** LOCATE and REPAIR the break in circuit CBB22A (GN/OG) between the power supply relay and fuse F26 with the aid of the Wiring Diagrams. CHECK the operation of the system.
L21: CHECK THE CIRCUIT BETWEEN THE VOLTAGE SUPPLY RELAY AND THE PCM FOR OPEN CIRCUIT - VEHICLES WITH A DIESEL ENGINE	
	1 Disconnect Connector CE104B from the PCM.
	2 Measure the resistance between the power supply relay, socket R8, pin 2, circuit CE612A (GY/VT), wiring harness side and the PCM, connector CE104B, pin G1, circuit CE612A (GY/VT), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to L22. → **No** LOCATE and REPAIR the break in circuit CE612A (GY/VT) between the power supply relay and the PCM with the aid of the Wiring Diagrams. CHECK the operation of the system.

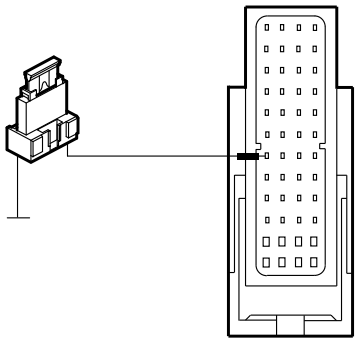
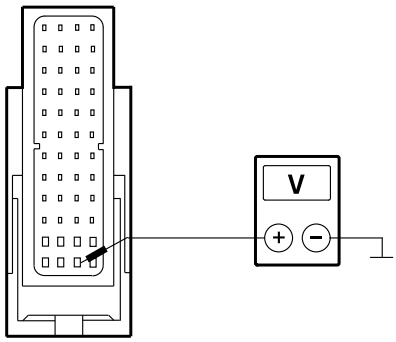
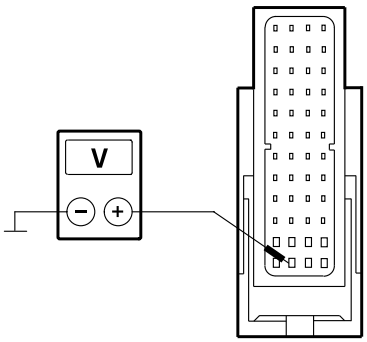
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L22: CHECK THE CIRCUIT BETWEEN THE PCM AND FUSE F37 FOR OPEN CIRCUIT - VEHICLES WITH A DIESEL ENGINE	
	1 Measure the resistance between the PCM, connector CE104B, pin G2, circuit CBB37A (WH), wiring harness side and fuse F37, wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to L25. → **No** LOCATE and REPAIR the break in circuit CBB37A (GN/BK) between the power supply relay and fuse F37 with the aid of the Wiring Diagrams. CHECK the operation of the system.
L23: CHECK THE CIRCUIT BETWEEN THE POWER SUPPLY RELAY AND THE PCM FOR OPEN CIRCUIT - ALL EXCEPT VEHICLES WITH A DIESEL ENGINE	
	1 Disconnect Connector CE512B from the PCM.
	2 Measure the resistance between the power supply relay, socket R8, pin 2, circuit CE612A (GY/VT), wiring harness side and the PCM, connector CE512B, pin G1, circuit CE612A (GY/VT), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to L24. → **No** LOCATE and REPAIR the break in circuit CE612A (GY/VT) between the power supply relay and the PCM with the aid of the Wiring Diagrams. CHECK the operation of the system.

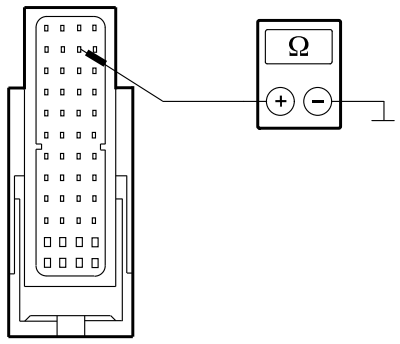
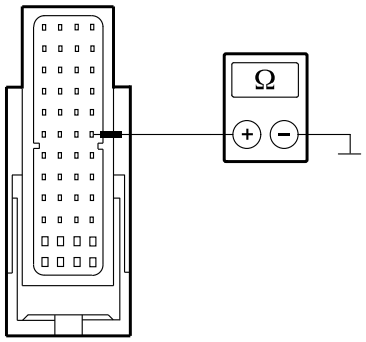
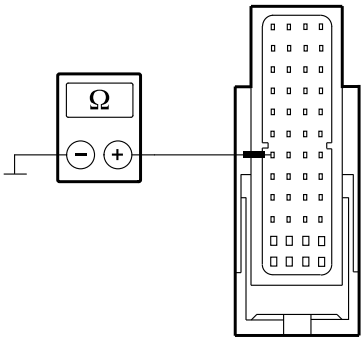
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L24: CHECK THE CIRCUIT BETWEEN THE PCM AND FUSE F37 FOR OPEN CIRCUIT - ALL EXCEPT VEHICLES WITH A DIESEL ENGINE	
	1 Measure the resistance between the PCM, connector CE512B, pin G2, circuit CBB37C (WH), wiring harness side and fuse F37, wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to L25. → **No** LOCATE and REPAIR the open circuit between the power supply relay and fuse F37 using the Wiring Diagrams. CHECK the operation of the system.
L25: CHECK THE POWER SUPPLY RELAY	
	1 Check the power supply relay according to the Component Checks at the end of this section. • Is the power supply relay OK? → **Yes** CHECK the PCM and RENEW if necessary. CHECK the operation of the system. → **No** RENEW the power supply relay. CHECK the operation of the system.
L26: CHECK THE VOLTAGE AT THE PCM	
	1 Disconnect Connector CE512B from the PCM.
	2 Ignition switch in position II.
	3 Measure the voltage between the PCM, connector CE512B, pin G2, circuit CBB37C (WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to L27. → **No** LOCATE and REPAIR the open circuit between the PCM and fuse F37 using the Wiring Diagrams. CHECK the operation of the system.
L27: CHECK THE VOLTAGE AT THE PCM (PIN F8)	
	1 Ignition switch in position 0.

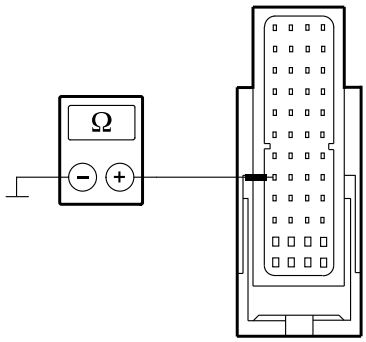
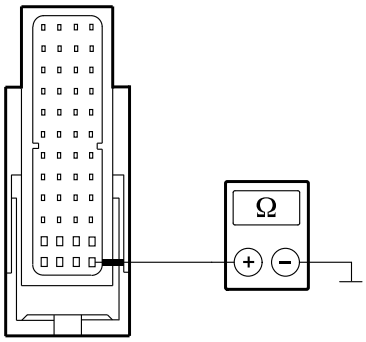
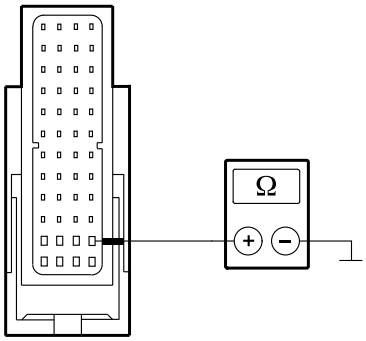
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E83646	2 Use a fused test lead (1 A) at the PCM, connector CE512B, pin G1 to short circuit CE612E (GY/VT), wiring harness side and ground.
 E73184	3 Measure the voltage between the PCM, connector CE512B, pin M3, circuit CBB26G (BU/WH), wiring harness side and ground.
	4 Measure the voltage between the PCM, connector CE512B, pin M2, circuit CBB26F (BU/WH), wiring harness side and ground. • Is battery voltage measured in both cases? → **Yes** GO to L28. → **No** - If battery voltage is not measured during both of the measurements: LOCATE and RECTIFY the break in the corresponding circuit between the PCM and soldered connection S1BB26 with the aid of the Wiring Diagrams. - If battery voltage is not measured during a measurement: LOCATE and REPAIR the open circuit between the PCM and fuse F26 using the Wiring Diagrams.

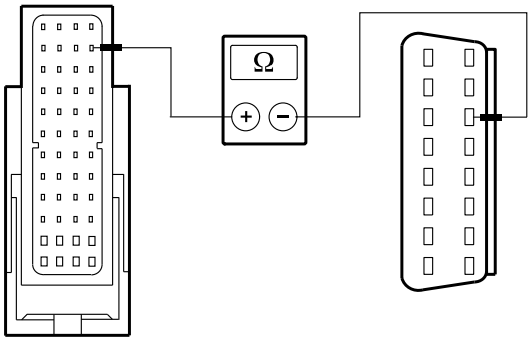
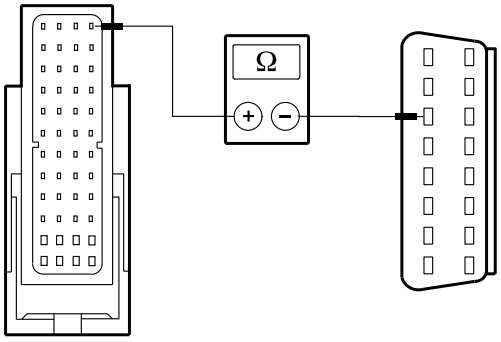
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L28: CHECK THE GROUND CONNECTION OF THE PCM	
 E73186	1 Measure the resistance between the PCM, connector CE512B, pin B3, circuit GD121F (BK/YE), wiring harness side and ground.
 E73187	2 Measure the resistance between the PCM, connector CE512B, pin F4, circuit GD121G (BK/YE), wiring harness side and ground.
 E73188	3 Measure the resistance between the PCM, connector CE512B, pin G1, circuit GD121D (BK/YE), wiring harness side and ground.

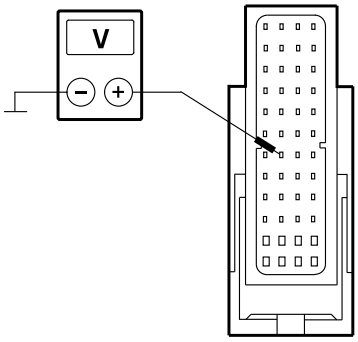
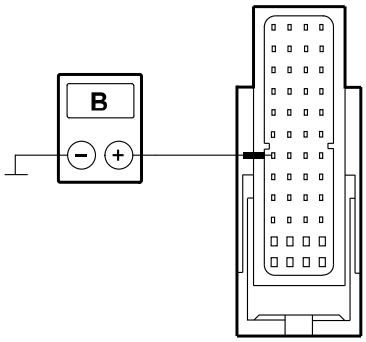
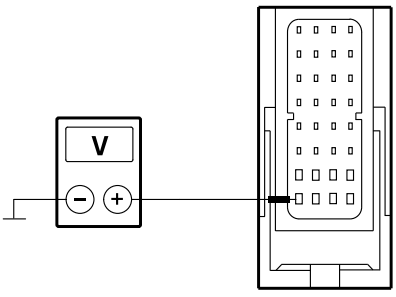
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73189	4 Measure the resistance between the PCM, connector CE512B, pin H1, circuit GD121E (BK/YE), wiring harness side and ground.
	5 Measure the resistance between the PCM, connector CE512B, pin M4, circuit GD121H (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm measured in all of the cases? → **Yes** GO to L29. → **No** - If a resistance of more than 2 Ohm is measured in one of the measurements: LOCATE and RECTIFY the break in the corresponding circuit between the PCM and soldered connection S1D121B with the aid of the Wiring Diagrams. CHECK the operation of the system. - Is a resistance of more than 2 Ohm measured in all of the measurements? LOCATE and REPAIR the break in circuit GD121A (BK/YE) between soldered connection S1D121B and ground connection GP21 with the aid of the Wiring Diagrams. CHECK the operation of the system.
L29: CHECK THE GROUND CONNECTION OF THE PCM	
	1 Measure the resistance between the PCM, connector CE512B, pin L4, circuit GD121D (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to L30. → **No** LOCATE and REPAIR the break in circuit GD121A (BK/YE) between the PCM and ground connection GP21 with the aid of the Wiring Diagrams. CHECK the operation of the system.

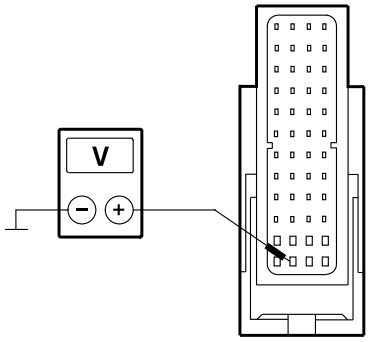
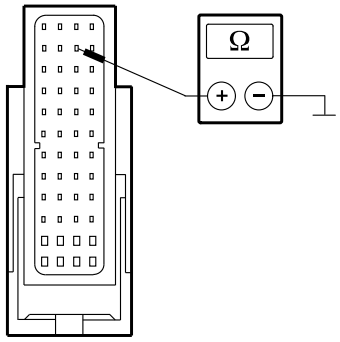
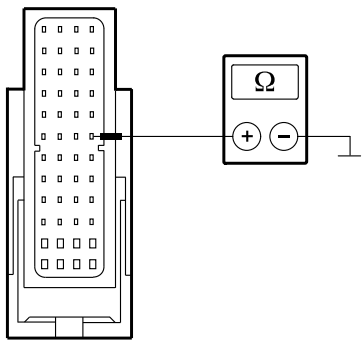
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L30: CHECK FOR OPEN CIRCUIT BETWEEN THE PCM AND THE DATA LINK CONNECTOR (DLC)	
CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.	
	1 Measure the resistance between the PCM, connector CE512B, pin B4, circuit VDB05F (WH), wiring harness side and the DLC, connector CDB04, pin 14, circuit VDB05B (WH), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to L31. → **No** LOCATE and REPAIR the open circuit between the PCM and the DLC using the Wiring Diagrams. CHECK the operation of the system.
L31: CHECK THE CIRCUIT BETWEEN THE PCM AND THE DLC FOR OPEN CIRCUIT	
CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.	
 E73193	1 Measure the resistance between the PCM, connector CE512B, pin A4, circuit VDB04F (WH/BU), wiring harness side and the DLC, connector CDB04, pin 6, circuit VDB04B (WH/BU), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the PCM and RENEW if necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the open circuit between the PCM and the DLC using the Wiring Diagrams. CHECK the operation of the system.
L32: CHECK THE VOLTAGE AT THE PCM	
	1 Disconnect Connector CE104B from the PCM.
	2 Ignition switch in position II.

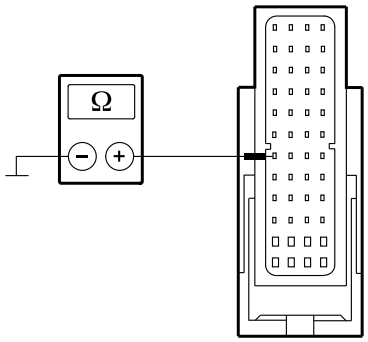
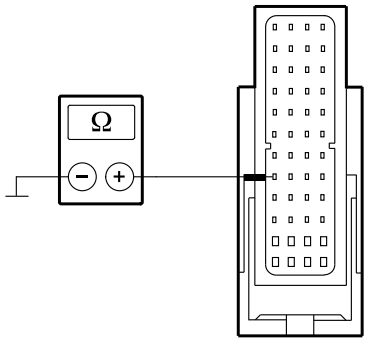
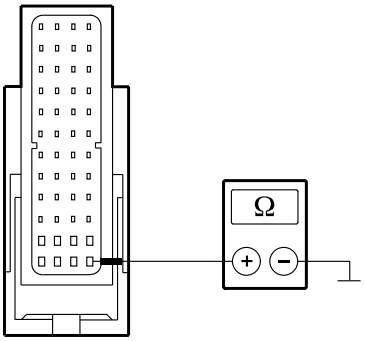
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the voltage between the PCM, connector CE104B, pin G2, circuit CBB37C (WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to L33. → **No** LOCATE and REPAIR the break in circuit CBB37A (GN/BK) between the PCM and fuse F37 with the aid of the Wiring Diagrams. CHECK the operation of the system.
L33: CHECK THE VOLTAGE AT THE PCM	
	1 Ignition switch in position 0.
	2 Disconnect Connector CE104A from the PCM.
	3 Disconnect Connector CE104C from the PCM.
 E73195	4 Use a fused test lead (1 A) at the PCM, connector CE104B, pin G1 to short circuit CE612A (GY/VT), wiring harness side and ground.
 E73196	5 Measure the voltage between the PCM, connector CE104A, pin H1, circuit CBB26D (BU/WH), wiring harness side and ground.

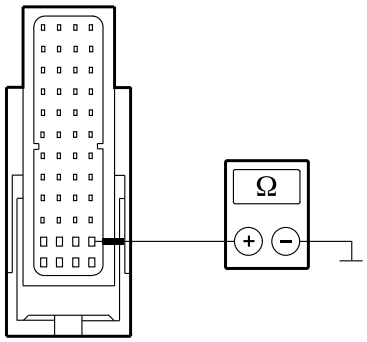
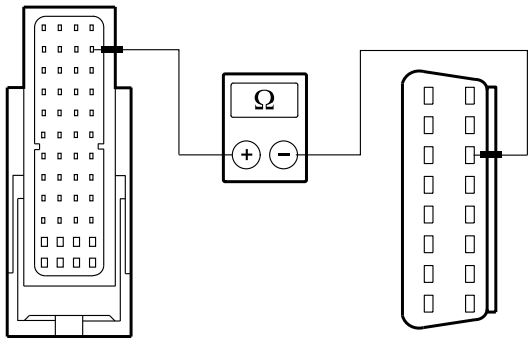
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	6 Measure the voltage between the PCM, connector CE104C, pin H2, circuit CBB26E (BU/WH), wiring harness side and ground. • Is battery voltage measured in both cases? → **Yes** GO to L34. → **No** - If battery voltage is not measured during both of the measurements: LOCATE and REPAIR the break in the relevant circuit using the Wiring Diagrams. - If battery voltage is not measured during a measurement: LOCATE and REPAIR the break in circuit CBB26A (BU/WH) between fuse F26 and soldered connection S1BB22 with the aid of the Wiring Diagrams.
L34: CHECK THE GROUND CONNECTION OF THE PCM	
 E73198	1 Measure the resistance between the PCM, connector CE104B, pin B3, circuit GD121F (BK/YE), wiring harness side and ground.
 E73199	2 Measure the resistance between the PCM, connector CE104B, pin F4, circuit GD121F (BK/YE), wiring harness side and ground.

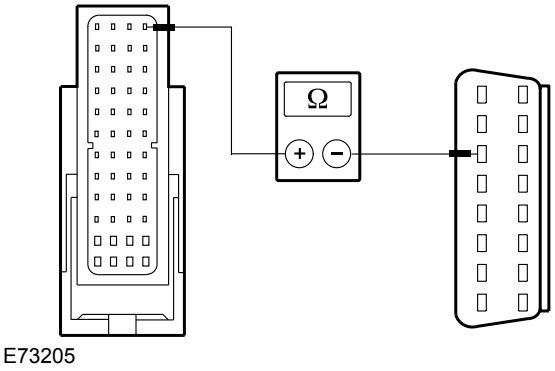
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E73200	3 Measure the resistance between the PCM, connector CE104B, pin G1, circuit GD121D (BK/YE), wiring harness side and ground.
 E73201	4 Measure the resistance between the PCM, connector CE104B, pin H1, circuit GD121E (BK/YE), wiring harness side and ground.
	5 Measure the resistance between the PCM, connector CE104B, pin M4, circuit GD121H (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm measured in all of the cases? → **Yes** GO to L35. → **No** - If a resistance of more than 2 Ohm is measured in one of the measurements: LOCATE and RECTIFY the break in the corresponding circuit between the PCM and soldered connection S1D121B with the aid of the Wiring Diagrams. CHECK the operation of the system. - If a resistance of more than 2 Ohm is measured in all of the measurements: LOCATE and REPAIR the open circuit between soldered connection S1D121B and ground connection GP21 with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L35: CHECK THE GROUND CONNECTION OF THE PCM	
	1 Measure the resistance between the PCM, connector CE104B, pin L4, circuit GD121A (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to L36. → **No** LOCATE and REPAIR the break in circuit GD121A (BK/YE) between the PCM and ground connection GP21 with the aid of the Wiring Diagrams. CHECK the operation of the system.
L36: CHECK FOR OPEN CIRCUIT BETWEEN THE PCM AND THE DATA LINK CONNECTOR (DLC)	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.**	
	1 Measure the resistance between the PCM, connector CE104B, pin B4, circuit VDB05F (GN/BK), wiring harness side and the DLC, connector CDB04, pin 14, circuit VDB05B (WH), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to L37. → **No** LOCATE and REPAIR the open circuit between the PCM and the DLC using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
L37: CHECK THE CIRCUIT BETWEEN THE PCM AND THE DLC FOR OPEN CIRCUIT	
CAUTION:The following measurement may only be performed using the WDS digital multi-meter. Failure to observe this instruction can lead to damage.	
 E73205	1 Measure the resistance between the PCM, connector CE104B, pin A4, circuit VDB04F (BU/BK), wiring harness side and the DLC, connector CDB04, pin 6, circuit VDB04B (WH/BU), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the PCM and RENEW if necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the open circuit between the PCM and the DLC using the Wiring Diagrams. CHECK the operation of the system.

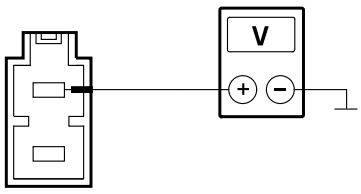
PINPOINT TEST M : GENERIC ELECTRONIC MODULE (GEM) NOT COMMUNICATING WITH THE DIAGNOSTIC TESTER

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: The generic electronic module (GEM) is an integral part of the central junction box (CJB).	
M1: CHECK THE COMMUNICATIONS WITH THE ELECTRONIC INSTRUMENT CLUSTER	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.
	3 Select the electronic instrument cluster with the diagnostic tester. • Is it possible to establish communications with the electronic instrument cluster? → **Yes** GO to M2. → **No** GO to Pinpoint Test N.
M2: CHECK FUSE F7	
	1 Ignition switch in position 0.

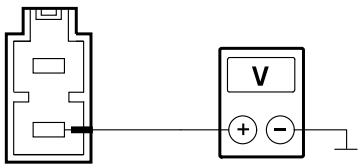
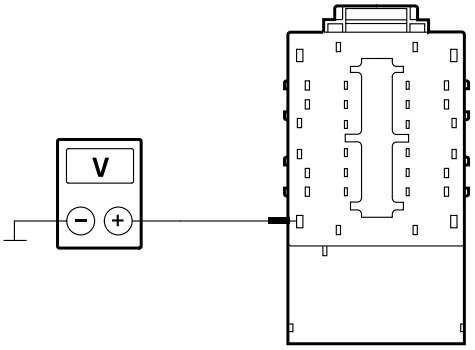
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK Fuse F7 (EJB). • Is the fuse OK? → **Yes** GO to M3. → **No** RENEW fuse F7 (60 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
M3: CHECK THE VOLTAGE AT FUSE F7	
	1 Connect Fuse F7 (EJB).
	2 Measure the voltage between fuse F7 (60 A) and ground. • Does the meter display battery voltage? → **Yes** GO to M4. → **No** REPAIR the voltage supply to fuse F7 with the aid of the Wiring Diagrams. CHECK the operation of the system.
M4: CHECK FUSE F2	
	1 CHECK Fuse F2 (EJB). • Is the fuse OK? → **Yes** GO to M5. → **No** RENEW fuse F2 (60 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
M5: CHECK THE VOLTAGE AT FUSE F2	
	1 Connect Fuse F2 (EJB).
	2 Measure the voltage between fuse F2 (60 A) and ground. • Does the meter display battery voltage? → **Yes** GO to M6. → **No** REPAIR the voltage supply to fuse F2 with the aid of the Wiring Diagrams. CHECK the operation of the system.

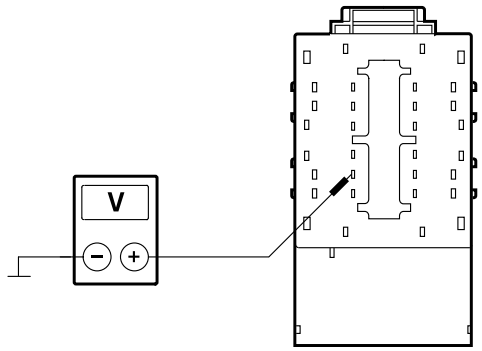
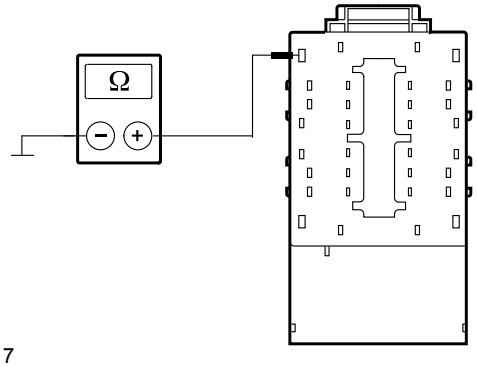
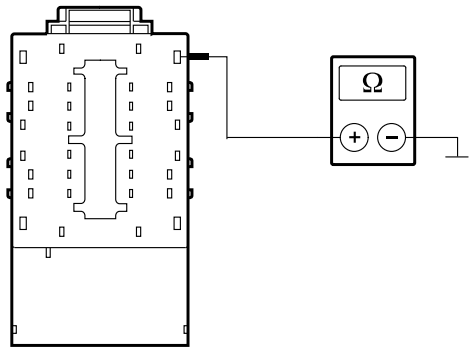
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
M6: CHECK FUSE F18	
	1 CHECK Fuse F18 (EJB). • Is the fuse OK? → **Yes** GO to M7. → **No** RENEW fuse F18 (40 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
M7: CHECK THE VOLTAGE AT FUSE F18	
	1 Connect Fuse F18 (EJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F18 (40 A) and ground. • Does the meter display battery voltage? → **Yes** GO to M8. → **No** REPAIR the voltage supply to fuse F18 with the aid of the Wiring Diagrams. CHECK the operation of the system.
M8: CHECK THE VOLTAGE AT THE GEM	
	1 Ignition switch in position 0.
	2 Disconnect Connector CBP02A from the GEM.
	3 Measure the voltage between the GEM, connector CBP02A, pin 1, circuit SBF07A (WH/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to M9. → **No** LOCATE and REPAIR the break in the circuit between the GEM and fuse F7 with the aid of the Wiring Diagrams. CHECK the operation of the system.

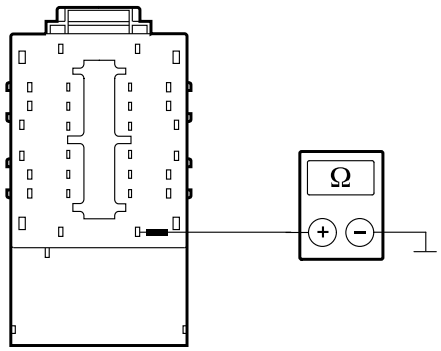
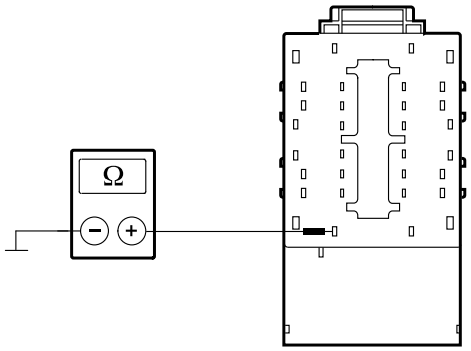
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
M9: CHECK THE VOLTAGE AT THE GEM	
	1 Measure the voltage between the GEM, connector CBP02A, pin 2, circuit SBF02A (YE/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to M10. → **No** LOCATE and REPAIR the break in the circuit between the GEM and fuse F2 with the aid of the Wiring Diagrams. CHECK the operation of the system.
M10: CHECK THE VOLTAGE AT THE GEM	
	1 Disconnect Connector CBP02B from the GEM.
	2 Ignition switch in position II.
	3 Measure the voltage between the GEM, connector CBP02B, pin 1, circuit CBB18B (GY/OG), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to M11. → **No** LOCATE and REPAIR the break in the circuit between the GEM and fuse F18 with the aid of the Wiring Diagrams. CHECK the operation of the system.
M11: CHECK THE VOLTAGE AT THE GEM	
	1 Ignition switch in position 0.
	2 Disconnect Connector C2BP02E from the GEM.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between the GEM, connector C2BP02E, pin 10, circuit CDC32B (BN/YE), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to M12. → **No** LOCATE and RECTIFY the break in the circuit between the GEM and the ignition switch with the aid of the Wiring Diagrams. CHECK the operation of the system.
M12: TEST THE GEM GROUND CONNECTION	
	1 Ignition switch in position 0.
 E69617	2 Measure the resistance between the GEM, connector C2BP02B, pin 29, circuit GD113C (BK/YE), wiring harness side and ground.
 E69618	3 Measure the resistance between the GEM, connector C2BP02B, pin 32, circuit GD113D (BK/YE), wiring harness side and ground.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the resistance between the GEM, connector C2BP02B, pin 3, circuit GD113B (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm measured in all of the cases? → **Yes** GO to M13. → **No** - If a resistance of more than 2 Ohm is measured in one of the measurements: LOCATE and RECTIFY the break in the corresponding circuit between the GEM and soldered connection S2D113B with the aid of the Wiring Diagrams. CHECK the operation of the system. - If a resistance of more than 2 Ohm is measured in all of the measurements: LOCATE and REPAIR the break in circuit GDD113A (BK/YE) between soldered connection S2D113B and ground connection GP13 with the aid of the Wiring Diagrams. CHECK the operation of the system.
M13: TEST THE GEM GROUND CONNECTION	
	1 Measure the resistance between the GEM, connector C2BP02B, pin 2, circuit GD113C (BK/YE), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to M14. → **No** LOCATE and REPAIR the break in the circuit between the GEM and ground point GP13 with the aid of the Wiring Diagrams. CHECK the operation of the system.
M14: CHECK FOR OPEN CIRCUIT BETWEEN THE GEM AND THE DLC	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.**	
	1 Disconnect Connector CBP02F from the GEM.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the GEM, connector CBP02F, pin 1, circuit VDB04A (WH/BU), wiring harness side and the DLC, connector CDB04, pin 6, circuit VDB04A (WH/BU), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to M15. → **No** LOCATE and REPAIR the break in the circuit between the GEM and the DLC using the Wiring Diagrams. CHECK the operation of the system.
M15: CHECK FOR OPEN CIRCUIT BETWEEN THE GEM AND THE DLC	
⚠ **CAUTION:The following measurement may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.**	
	1 Measure the resistance between the GEM, connector CBP02F, pin 11, circuit VDB05A (WH), wiring harness side and the DLC, connector CDB04, pin 14, circuit VDB05A (WH), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the GEM or CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the GEM and the DLC using the Wiring Diagrams. CHECK the operation of the system.

PINPOINT TEST N : FAULTY COMMUNICATIONS BETWEEN THE MODULES - MM CAN BUS.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
⚠ **CAUTION:The measurements below may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.**	
N1: CHECK THE COMMUNICATIONS WITH THE ELECTRONIC INSTRUMENT CLUSTER	
	1 Ignition switch in position 0.
	2 Connect the diagnostic tool.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Select the electronic instrument cluster with the diagnostic tester. • Is it possible to establish communications with the electronic instrument cluster? → **Yes** GO to N2. → **No** GO to Pinpoint Test K.
N2: CHECK THE MM CAN BUS FOR SHORT	
	1 Disconnect Ground cable from battery.
	2 Disconnect Connector CME03B from the audio module.
	3 Measure the resistance at the audio module, connector CME03B, between pin 10, circuit VDB14B (VT/GY), wiring harness side and pin 9, circuit VDB13B (BU/GY), wiring harness side. • Is a resistance of between 55 and 65 Ohm measured? → **Yes** GO to N3. → **No** - If a resistance of between 115 and 125 Ohm is measured: GO to N7. - If a resistance of between 115 and 125 Ohm is not measured: GO to N11.
N3: PERFORM NETWORK TEST	
NOTE: The number of modules connected to the CAN bus depends on the equipment levels of the vehicle. Therefore, not every vehicle will have all the modules mentioned below.	
	1 Disconnect Ground cable from battery.
	2 Select the vehicle with the diagnostic unit. • Is it possible to establish communications with the control module for mobile electronic auxiliary equipment? → **Yes** CHECK and if necessary RENEW the audio module. CHECK the operation of the system. → **No** GO to N4.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
N4: PERFORM NETWORK TEST	
NOTE: The number of modules connected to the CAN bus depends on the equipment levels of the vehicle. Therefore not every vehicle will have all the modules mentioned below.	
	1 Ignition switch in position 0.
	2 Disconnect Connector CMM01A from the control module for mobile electronic auxiliary equipment.
	3 Connect Connector CME03B from the audio module.
	4 Select the vehicle with the diagnostic unit. • Is it possible to establish communications with the audio module? → **Yes** CHECK and if necessary RENEW the control module for mobile electronic auxiliary equipment. CHECK the operation of the system. → **No** GO to N5.
N5: CHECK THE MM CAN BUS FOR A SHORT TO VOLTAGE SUPPLY	
	1 Disconnect Connector CMC01 from the instrument cluster.
	2 Ignition switch in position II.
	3 Measure the voltage between the audio module, connector CME03B, pin 9, circuit VDB13B (BU/GY), wiring harness side and ground.
	4 Measure the voltage between the audio module, connector CME03B, pin 10, circuit VDB14B (VT/GY), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and REPAIR the short to voltage in the affected circuit using using the Wiring Diagrams. CHECK the operation of the system. → **No** GO to N6.
N6: CHECK THE MM CAN BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the audio module, connector CME03B, pin 10, circuit VDB14B (VT/GY), wiring harness side and ground.
	3 Measure the resistance between the audio module, connector CME03B, pin 9, circuit VDB13B (BU/GY), wiring harness side and ground. • Is a resistance greater than 10,000 Ohm measured in both cases? → **Yes** CHECK and if necessary RENEW the instrument cluster. CHECK the operation of the system. → **No** LOCATE and REPAIR the short to ground in the relevant circuit using the Wiring Diagrams. CHECK the operation of the system.
N7: CHECK THE CIRCUIT BETWEEN THE INSTRUMENT CLUSTER AND THE AUDIO MODULE FOR OPEN CIRCUIT	
	1 Disconnect Connector CMC01 from the instrument cluster.
	2 Measure the resistance between the instrument cluster, connector CMC01, pin 8, circuit VDB13D (BU/GY), wiring harness side and the audio module, connector CME03B, pin 9, circuit VDB13B (BU/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to N8. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the audio module using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
N8: CHECK THE CIRCUIT BETWEEN THE INSTRUMENT CLUSTER AND THE AUDIO MODULE FOR OPEN CIRCUIT	
	1 Measure the resistance between the instrument cluster, connector CMC01, pin 7, circuit VDB14D (VT/GY), wiring harness side and the audio module, connector CME03B, pin 10, circuit VDB14B (VT/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to N9. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the audio module using the Wiring Diagrams. CHECK the operation of the system.
N9: CHECK THE CIRCUIT BETWEEN THE INSTRUMENT CLUSTER AND THE AUDIO MODULE FOR OPEN CIRCUIT	
	1 Measure the resistance between the instrument cluster, connector CMC01, pin 6, circuit VDB13C (BU/GY), wiring harness side and the audio module, connector CME03B, pin 9, circuit VDB13B (BU/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to N10. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the audio module using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
N10: CHECK THE CIRCUIT BETWEEN THE INSTRUMENT CLUSTER AND THE AUDIO MODULE FOR OPEN CIRCUIT	
	1 Measure the resistance between the instrument cluster, connector CMC01, pin 5, circuit VDB14C (VT/GY), wiring harness side and the audio module, connector CME03B, pin 10, circuit VDB14B (VT/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary RENEW the instrument cluster. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the audio module using the Wiring Diagrams. CHECK the operation of the system.
N11: PERFORM NETWORK TEST	
NOTE: The number of modules connected to the CAN bus depends on the equipment levels of the vehicle. Therefore, not every vehicle will have all the modules mentioned below.	
	1 Connect ground cable to battery.
	2 Select the vehicle with the diagnostic unit. • Is it possible to establish communications with the control module for mobile electronic auxiliary equipment? → **Yes** CHECK and if necessary RENEW the audio module. CHECK the operation of the system. → **No** GO to N12.
N12: PERFORM NETWORK TEST	
NOTE: The number of modules connected to the CAN bus depends on the equipment levels of the vehicle. Therefore, not every vehicle will have all the modules mentioned below.	
	1 Ignition switch in position 0.
	2 Disconnect Connector CMM01A from the control module for mobile electronic auxiliary equipment.
	3 Connect Connector CME03B from the audio module.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Select the vehicle with the diagnostic unit. • Is it possible to establish communications with the audio module? → **Yes** CHECK and if necessary RENEW the control module for mobile electronic auxiliary equipment. CHECK the operation of the system. → **No** GO to N13.
N13: CHECK THE CIRCUIT BETWEEN THE INSTRUMENT CLUSTER AND THE AUDIO MODULE FOR OPEN CIRCUIT	
	1 Disconnect Connector CMC01 from the instrument cluster.
	2 Measure the resistance between the instrument cluster, connector CMC01, pin 8, circuit VDB13D (BU/GY), wiring harness side and the audio module, connector CME03B, pin 9, circuit VDB13B (BU/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to N14. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the audio module using the Wiring Diagrams. CHECK the operation of the system.
N14: CHECK THE CIRCUIT BETWEEN THE INSTRUMENT CLUSTER AND THE AUDIO MODULE FOR OPEN CIRCUIT	
	1 Measure the resistance between the instrument cluster, connector CMC01, pin 7, circuit VDB14D (VT/GY), wiring harness side and the audio module, connector CME03B, pin 10, circuit VDB14C (VT/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to N15. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the audio module using the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
N15: CHECK THE CIRCUIT BETWEEN THE INSTRUMENT CLUSTER AND THE AUDIO MODULE FOR OPEN CIRCUIT	
	1 Measure the resistance between the instrument cluster, connector CMC01, pin 6, circuit VDB13C (BU/GY), wiring harness side and the audio module, connector CME03B, pin 9, circuit VDB13B (BU/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to N16. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the audio module using the Wiring Diagrams. CHECK the operation of the system.
N16: CHECK THE CIRCUIT BETWEEN THE INSTRUMENT CLUSTER AND THE AUDIO MODULE FOR OPEN CIRCUIT	
	1 Measure the resistance between the instrument cluster, connector CMC01, pin 5, circuit VDB14C (VT/GY), wiring harness side and the audio module, connector CME03B, pin 10, circuit VDB14B (VT/GY), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to N17. → **No** LOCATE and REPAIR the break in the circuit between the instrument cluster and the audio module using the Wiring Diagrams. CHECK the operation of the system.
N17: CHECK THE MM CAN BUS FOR A SHORT TO VOLTAGE SUPPLY	
	1 Disconnect Connector CMC01 from the instrument cluster.
	2 Ignition switch in position II.
	3 Measure the voltage between the audio module, connector CME03B, pin 9, circuit VDB13B (BU/GY), wiring harness side and ground.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between the audio module, connector CME03B, pin 10, circuit VDB14B (VT/GY), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and REPAIR the short to voltage in the affected circuit using using the Wiring Diagrams. CHECK the operation of the system. → **No** GO to N18.
N18: CHECK THE MM CAN BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Measure the resistance between the audio module, connector CME03B, pin 9, circuit VDB13B (BU/GY), wiring harness side and ground.
	3 Measure the resistance between the audio module, connector CME03B, pin 10, circuit VDB14B (VT/GY), wiring harness side and ground. • Is a resistance greater than 10,000 Ohm measured in both cases? → **Yes** GO to N19. → **No** LOCATE and REPAIR the short to ground in the relevant circuit using the Wiring Diagrams. CHECK the operation of the system.

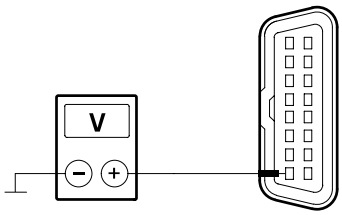
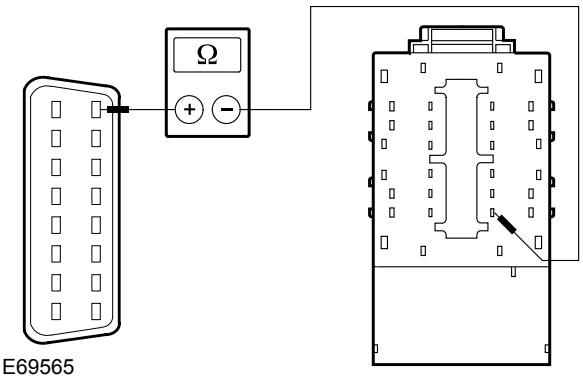
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
N19: CHECK THE MM CAN BUS FOR SHORT	
	1 Measure the resistance at the audio module, connector CME03B, between pin 9, circuit VDB13B (BU/GY), wiring harness side and pin 10, circuit VDB14B (VT/GY), wiring harness side. • Is a resistance greater than 10,000 Ohm measured in both cases? → **Yes** CHECK and if necessary RENEW the instrument cluster. CHECK the operation of the system. → **No** LOCATE and REPAIR the short in the MM CAN bus with the aid of the Wiring Diagrams. CHECK the operation of the system.

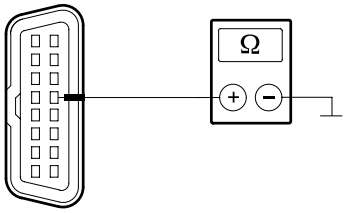
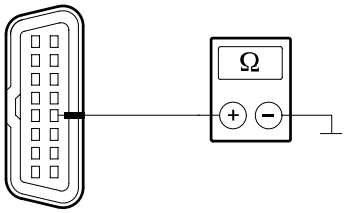
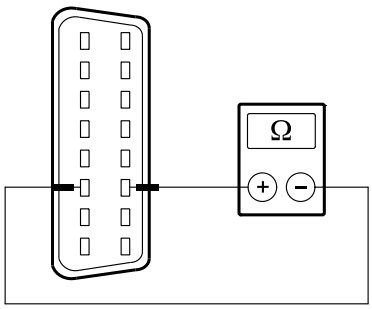
PINPOINT TEST O : FAULTY COMMUNICATIONS BETWEEN THE MODULES - MS CAN BUS.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
⚠ **CAUTION:The measurements below may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.**	
O1: CHECK FUSE F72	
	1 Ignition switch in position 0.
	2 CHECK Fuse F72 (CJB). • Is the fuse OK? → **Yes** GO to O2. → **No** RENEW fuse F72 (10 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
O2: CHECK THE VOLTAGE AT FUSE F72	
	1 Connect Fuse F72 (CJB).

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the voltage between fuse F72 (10 A) and ground. • Does the meter display battery voltage? → **Yes** GO to O3. → **No** REPAIR the voltage supply to fuse F72 with the aid of the Wiring Diagrams. CHECK the operation of the system.
O3: CHECK THE VOLTAGE AT THE DATA LINK CONNECTOR (DLC)	
 VFE0028957	1 Measure the voltage between the DLC, connector CDB04, pin 16, circuit VDB03A (GY/BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to O5. → **No** GO to O4.
O4: CHECK FOR OPEN CIRCUIT BETWEEN THE DLC AND THE CENTRAL JUNCTION BOX (CJB)	
	1 Disconnect Connector C2BP02E from the CJB.
 E69565	2 Measure the resistance between the DLC, connector CDB04, pin 16, circuit VDB03A (GY/BN), wiring harness side and the CJB, connector C2BP02E, pin 7, circuit VDB03A (GY/BN), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit VDB03A (GY/BN) between the DLC and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
O5: CHECK THE GROUND CONNECTION OF THE DLC	
	1 Ignition switch in position 0.

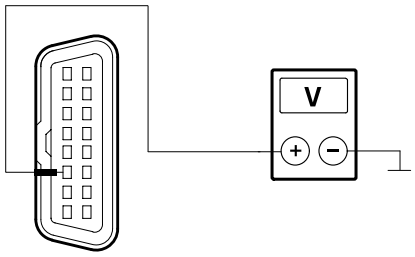
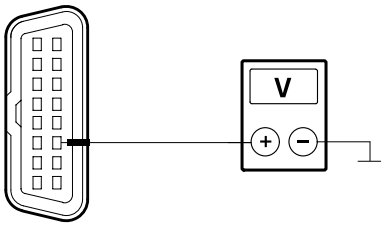
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0028965	2 Measure the resistance between the DLC, connector CDB04, pin 4, circuit GD115B (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to O6. → **No** LOCATE and REPAIR the open circuit between the DLC and ground connection GP15 with the aid of the Wiring Diagrams. CHECK the operation of the system.
O6: CHECK THE GROUND CONNECTION OF THE DLC	
 VFE0028964	1 Measure the resistance between the DLC, connector CDB04, pin 5, circuit GD116B (BK/VT), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to O7. → **No** LOCATE and REPAIR the break in circuit D116B (BK/VT) between the DLC and ground connection GP16 with the aid of the Wiring Diagrams. CHECK the operation of the system.
O7: CHECK THE MS CAN BUS FOR SHORT	
	1 Disconnect Ground cable from battery.
	2 Measure the resistance at the DLC, connector CDB04, between pin 3, circuit VDB06J (GY/OG), wiring harness side and pin 11, circuit VDB07Y (VT/OG), wiring harness side. • Is a resistance of between 55 and 65 Ohm measured? → **Yes** GO to O8. → **No** - If a resistance of between 115 and 125 Ohm is measured: GO to O12. - If a resistance of between 115 and 125 Ohm is not measured: GO to O17.

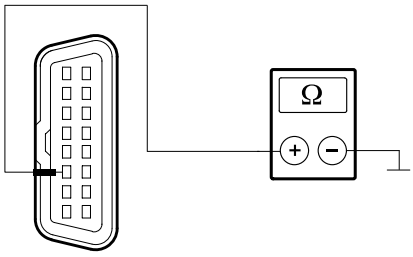
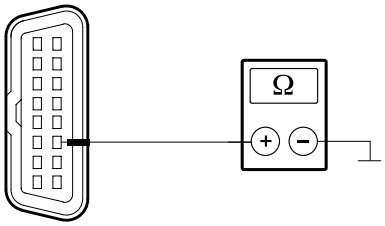
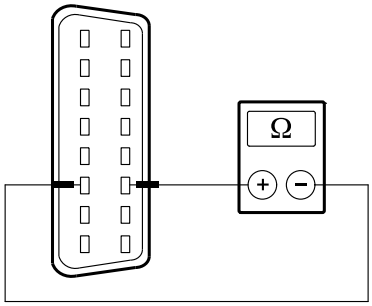
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
O8: PERFORM NETWORK TEST (RESTRAINTS CONTROL MODULE (RCM))	
WARNINGS: **The backup voltage must be discharged in order to prevent unintentional deployment of the airbag/belt pretensioner. After disconnecting the battery, wait at least 1 minute before starting work on the supplemental restraint system (SRS). Failure to observe this instruction can lead to injury.**	
In order to prevent the risk of accidental deployment, do not program any keycodes while working on the supplemental restraint system. Failure to observe this instruction can lead to injury.	
Never use terminal probes to test any connectors of the airbag systems or of any other supplemental restraint systems. Failure to observe this instruction can lead to injury.	
	1 Disconnect Connector CR114A from the restraints control module.
	2 Connect ground cable to battery.
	3 Connect the diagnostic tool.
	4 Select the vehicle with the diagnostic unit. • Is it possible to establish communication with the GEM? → **Yes** CHECK and if necessary RENEW the restraint control module. CHECK the operation of the system. → **No** GO to O9.
O9: PERFORM NETWORK TEST	
NOTE: The number of modules connected to the CAN bus depends on the equipment levels of the vehicle. Therefore, not every vehicle will have all the modules mentioned below.	
	1 Ignition switch in position 0.
	2 Disconnect a listed component, then proceed with the following test step: – Parking aid module CMP01A – Electronic instrument cluster CMC01

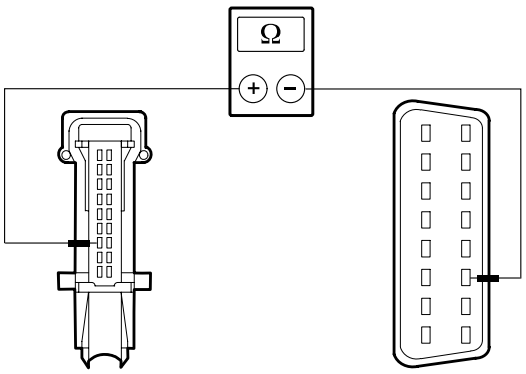
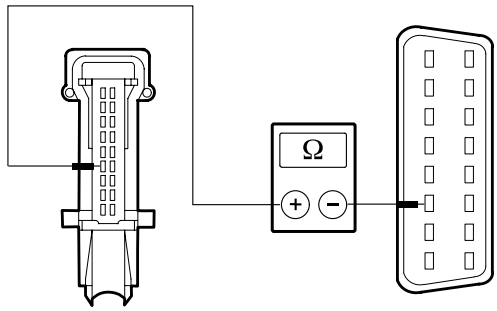
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Select the vehicle with the diagnostic unit. • Is it possible to establish communication with the GEM? → **Yes** The component last disconnected is the cause of the concern; CHECK and if necessary RENEW the component. CHECK the operation of the system. → **No** - If not all the listed components are disconnected: DISCONNECT the next component (go to test step 1). - If all the listed components are disconnected: GO to O10.
O10: CHECK THE MS CAN BUS FOR A SHORT TO VOLTAGE SUPPLY	
	1 Ignition switch in position 0.
	2 Disconnect Connector CBP02F from the GEM.
	3 Ignition switch in position II.
 E65386	4 Measure the voltage between the DLC, connector CDB04, pin 3 (GY/OG), wiring harness side and ground.
 E65387	5 Measure the voltage between the DLC, connector CDB04, pin 11 (VT/OG), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and REPAIR the short to voltage in the affected circuit using using the Wiring Diagrams. CHECK the operation of the system. → **No** GO to O11.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
O11: CHECK THE MS CAN BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
 E65388	2 Measure the resistance between the DLC, connector CDB04, pin 3 (GY/OG), wiring harness side and ground.
 E65389	3 Measure the resistance between the DLC, connector CDB04, pin 11 (VT/OG), wiring harness side and ground. • Is a resistance greater than 10,000 Ohm measured in both cases? → **Yes** CHECK the GEM, if necessary INSTALL a new one. CHECK the operation of the system. → **No** LOCATE and REPAIR the short to ground in the relevant circuit using the Wiring Diagrams. CHECK the operation of the system.
O12: CHECK THE MS CAN BUS FOR SHORT	
	1 Disconnect Connector CMC01 from the electronic instrument cluster.
	2 Measure the resistance at the DLC, connector CDB04, between pin 3, circuit VDB06J (GY/OG), wiring harness side and pin 11, circuit VDB07J (VT/OG), wiring harness side. • Is a resistance of between 115 and 120 Ohm measured? → **Yes** GO to O13. → **No** GO to O15.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
O13: CHECK FOR OPEN CIRCUIT BETWEEN THE ELECTRONIC INSTRUMENT CLUSTER AND THE DATA LINK CONNECTOR (DLC)	
	1 Measure the resistance between the electronic instrument cluster, connector CMC01, pin 3, circuit VDB07F (VT/OG), wiring harness side and the DLC, connector CDB04, pin 11, circuit VDB07J (VT/OG), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to O14. → **No** LOCATE and RECTIFY the break in the circuit between the electronic instrument cluster and the DLC with the aid of the Wiring Diagrams. CHECK the operation of the system.
O14: CHECK FOR OPEN CIRCUIT BETWEEN THE ELECTRONIC INSTRUMENT CLUSTER AND THE DLC	
 E69611	1 Measure the resistance between the electronic instrument cluster, connector CMC01, pin 4, circuit VDB06F (GY/OG), wiring harness side and the DLC, connector CDB04, pin 3, circuit VDB06J (GY/OG), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK and if necessary RENEW the electronic instrument cluster. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in the circuit between the electronic instrument cluster and the DLC with the aid of the Wiring Diagrams. CHECK the operation of the system.
O15: CHECK FOR OPEN CIRCUIT BETWEEN THE GEM AND THE DLC	
	1 Disconnect Connector CBP02F from the GEM.

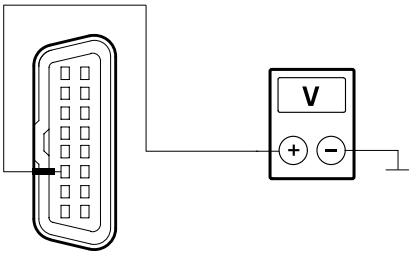
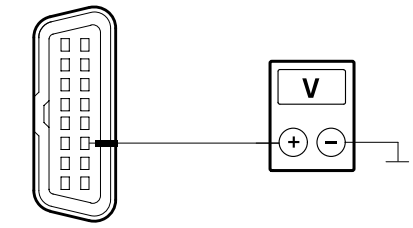
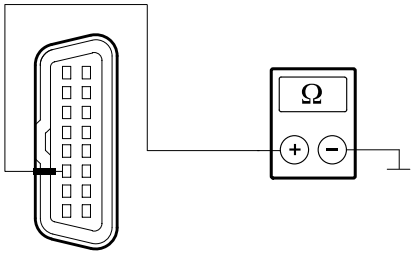
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the GEM, connector CBP02F, pin 21, circuit VDB06A (GY/OG), wiring harness side and the DLC, connector CDB04, pin 3, circuit VDB06J (GY/OG), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to O16. → **No** LOCATE and REPAIR the break in the circuit between the GEM and the DLC using the Wiring Diagrams. CHECK the operation of the system.
O16: CHECK FOR OPEN CIRCUIT BETWEEN THE GEM AND THE DLC	
	1 Measure the resistance between the GEM, connector CBP02F, pin 31, circuit VDB07A (VT/OG), wiring harness side and the DLC, connector CDB04, pin 11, circuit VDB07Y (VT/OG), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the GEM, if necessary INSTALL a new one. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the GEM and the DLC using the Wiring Diagrams. CHECK the operation of the system.
O17: PERFORM NETWORK TEST (RESTRAINTS CONTROL MODULE (RCM))	
WARNINGS: **The backup voltage must be discharged in order to prevent unintentional deployment of the airbag/belt pretensioner. After disconnecting the battery, wait at least 1 minute before starting work on the supplemental restraint system (SRS). Failure to observe this instruction can lead to injury.**	
In order to prevent the risk of accidental deployment, do not program any keycodes while working on the supplemental restraint system. Failure to observe this instruction can lead to injury.	
Never use terminal probes to test any connectors of the airbag systems or of any other supplemental restraint systems. Failure to observe this instruction can lead to injury.	
	1 Disconnect Ground cable from battery.
	2 Disconnect Connector CR114A from the restraints control module.

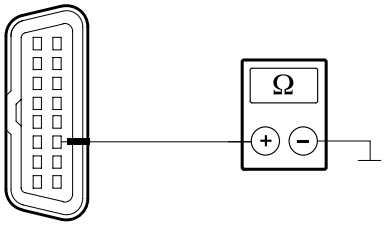
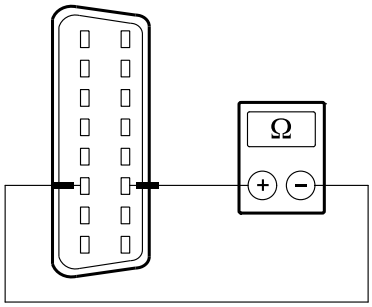
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Connect ground cable to battery.
	4 Connect the diagnostic tool.
	5 Select the vehicle with the diagnostic unit. • Is it possible to establish communication with the GEM? → **Yes** CHECK and if necessary RENEW the restraint control module. CHECK the operation of the system. → **No** GO to O18.
O18: PERFORM NETWORK TEST	
NOTE: The number of modules connected to the CAN bus depends on the equipment levels of the vehicle. Therefore, not every vehicle will have all the modules mentioned below.	
	1 Ignition switch in position 0.
	2 Disconnect a listed component, then proceed with the following test step: – Parking aid module CMP01A – Electronic instrument cluster CMC01
	3 Select the vehicle with the diagnostic unit. • Is it possible to establish communication with the GEM? → **Yes** The component last disconnected is the cause of the concern; CHECK and if necessary RENEW the component. CHECK the operation of the system. → **No** - If not all the listed components are disconnected: DISCONNECT the next component (go to test step 1). - If all the listed components are disconnected: GO to O19.
O19: CHECK THE MS CAN BUS FOR A SHORT TO VOLTAGE SUPPLY	
	1 Ignition switch in position 0.
	2 Disconnect Connector CBP02F from the GEM.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E65386	4 Measure the voltage between the DLC, connector CDB04, pin 3, circuit VDB06J (GY/OG), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and REPAIR the short to voltage in the affected circuit using using the Wiring Diagrams. CHECK the operation of the system. → **No** GO to O20.
O20: CHECK THE MS CAN BUS FOR A SHORT TO VOLTAGE SUPPLY	
 E65387	1 Measure the voltage between the DLC, connector CDB04, pin 11, circuit VDB07Y (VT/OG), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and REPAIR the short to voltage in the affected circuit using using the Wiring Diagrams. CHECK the operation of the system. → **No** GO to O21.
O21: CHECK THE MS CAN BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Measure the resistance between the DLC, connector CDB04, pin 3, circuit VDB06J (GY/OG), wiring harness side and ground. • Is a resistance greater than 10,000 Ohm measured in both cases? → **Yes** GO to O22. → **No** LOCATE and REPAIR the short to ground in the relevant circuit using the Wiring Diagrams. CHECK the operation of the system.
O22: CHECK THE MS CAN BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.

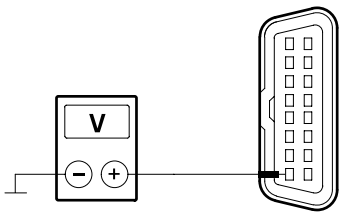
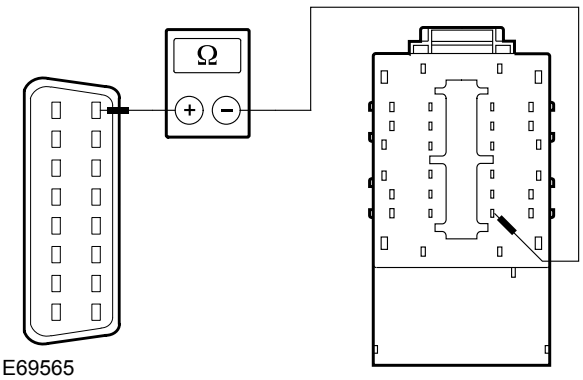
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the DLC, connector CDB04, pin 11, circuit VDB07Y (VT/OG), wiring harness side and ground. • Is a resistance greater than 10,000 Ohm measured in both cases? → **Yes** GO to O23. → **No** LOCATE and REPAIR the short to ground in the relevant circuit using the Wiring Diagrams. CHECK the operation of the system.
O23: CHECK THE MS CAN BUS FOR SHORT	
 E45952	1 Measure the resistance at the DLC, connector CDB04, between pin 3, circuit VDB06J (GY/OG), wiring harness side and pin 11, circuit VDB07Y (VT/OG), wiring harness side. • Is a resistance greater than 10,000 Ohm measured in both cases? → **Yes** CHECK the GEM, if necessary INSTALL a new one. CHECK the operation of the system. → **No** LOCATE and REPAIR the short in the CAN bus using the Wiring Diagrams. CHECK the operation of the system.

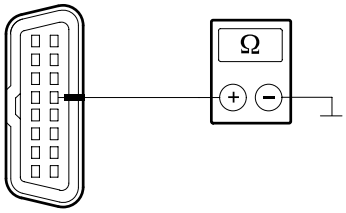
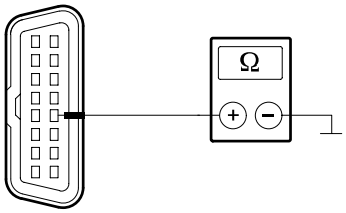
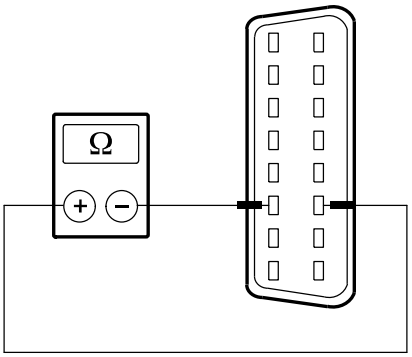
PINPOINT TEST P : FAULTY COMMUNICATIONS BETWEEN THE MODULES - HS CAN BUS.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
⚠ **CAUTION:The measurements below may only be performed using the WDS digital multimeter. Failure to observe this instruction can lead to damage.**	
P1: CHECK FUSE F72	
	1 Ignition switch in position 0.
	2 CHECK Fuse F72 (CJB). • Is the fuse OK? → **Yes** GO to P2. → **No** RENEW fuse F72 (10 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
P2: CHECK THE VOLTAGE AT FUSE F72	
	1 Connect Fuse F72 (CJB).
	2 Measure the voltage between fuse F72 (10 A) and ground. • Does the meter display battery voltage? → **Yes** GO to P3. → **No** REPAIR the voltage supply to fuse F72 with the aid of the Wiring Diagrams. CHECK the operation of the system.
P3: CHECK THE VOLTAGE AT THE DATA LINK CONNECTOR (DLC)	
 VFE0028957	1 Measure the voltage between the DLC, connector CDB04, pin 16, circuit VDB03A (GY/BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to P5. → **No** GO to P4.
P4: CHECK FOR OPEN CIRCUIT BETWEEN THE DLC AND THE CENTRAL JUNCTION BOX (CJB)	
	1 Disconnect Connector CBP02E from the CJB.
 E69565	2 Measure the resistance between the DLC, connector CDB04, pin 16, circuit VDB03A (GY/BN), wiring harness side and the CJB, connector CBP02E, pin 7, circuit VDB03A (GY/BN), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the CJB and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in circuit VDB03A (GY/BN) between the DLC and the CJB with the aid of the Wiring Diagrams. CHECK the operation of the system.
P5: CHECK THE GROUND CONNECTION OF THE DLC	
	1 Ignition switch in position 0.

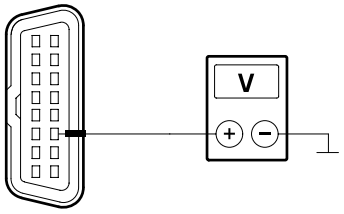
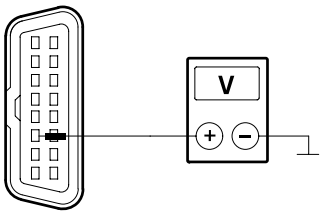
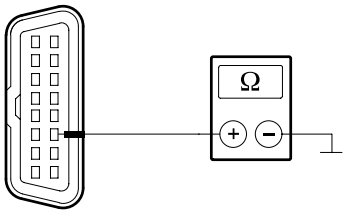
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0028965	2 Measure the resistance between the DLC, connector CDB04, pin 4, circuit GD115B (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to P5. → **No** LOCATE and REPAIR the open circuit between the DLC and ground connection GP15 with the aid of the Wiring Diagrams. CHECK the operation of the system.
P6: CHECK THE GROUND CONNECTION OF THE DLC	
 VFE0028964	1 Measure the resistance between the DLC, connector CDB04, pin 5, circuit GD116B (BK/VT), wiring harness side and ground. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to P7. → **No** LOCATE and REPAIR the break in circuit D116B (BK/VT) between the DLC and ground connection GP16 with the aid of the Wiring Diagrams. CHECK the operation of the system.
P7: CHECK THE HS CAN BUS FOR SHORT CIRCUIT	
	1 Disconnect Ground cable from battery.
 E45951	2 Measure the resistance between the DLC, connector CDB04, between pin 6, circuit VDB04B (WH/BU), wiring harness side and pin 14, circuit VDB05B (WH), wiring harness side. • Is a resistance of between 55 and 65 Ohm measured? → **Yes** GO to P8. → **No** - If a resistance of between 115 and 125 Ohm is measured: GO to P13. - If a resistance of between 115 and 125 Ohm is not measured: GO to P20.

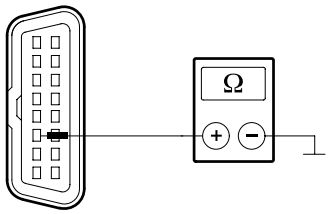
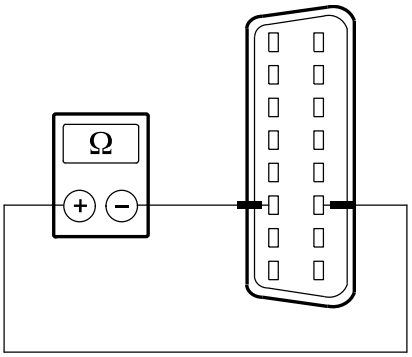
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
P8: PERFORM NETWORK TEST	
NOTE: The number of modules connected to the CAN bus depends on the equipment levels of the vehicle. Therefore, not every vehicle will have all the modules mentioned below.	
	1 Connect ground cable to battery.
	2 Disconnect Ground cable from battery.
	3 Connect the diagnostic tool.
	4 Disconnect a listed component, then proceed with the following test step: – Vehicles with ESP: ESP module CCA10 – Vehicles with ABS: ABS module CCA01 – Generic electronic module (GEM) CBP02F
	5 Select the vehicle with the diagnostic unit. • Is it possible to establish communication with the PCM? → **Yes** The component last disconnected is the cause of the concern; CHECK and if necessary RENEW the component. CHECK the operation of the system. → **No** - If not all the listed components are disconnected: Key in OFF position. DISCONNECT the next component (go to test step 3). - If all the listed components are disconnected: GO to P9.
P9: CHECK THE HS CAN BUS FOR A SHORT TO VOLTAGE SUPPLY	
	1 Ignition switch in position 0.
	2 Disconnect Vehicles with diesel engine Connector CE104B from the PCM.
	3 Disconnect All except vehicles with diesel engines: Connector CE512B from the PCM.
	4 Ignition switch in position II.

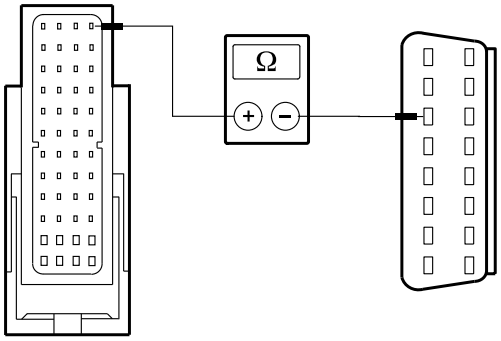
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0028970	5 Measure the voltage between the DLC, connector CDB04, pin 6, circuit VDB04B (WH/BU), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and REPAIR the short to voltage in the circuit between the PCM and the DLC with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to P10.
P10: CHECK THE HS CAN BUS FOR A SHORT TO VOLTAGE SUPPLY	
 VFE0028962	1 Measure the voltage between the DLC, connector CDB04, pin 14, circuit VDB05B (WH), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and REPAIR the short to voltage in the circuit between the PCM and the DLC with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to P11.
P11: CHECK THE HS CAN BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
 VFE0028967	2 Measure the resistance between the DLC, connector CDB04, pin 6, circuit VDB04B (WH/BU), wiring harness side and ground. • Is a resistance of more than 10,000 Ohm measured? → **Yes** GO to P12. → **No** LOCATE and REPAIR the short to ground in the circuit between the PCM and the DLC with the aid of the Wiring Diagrams. CHECK the operation of the system.

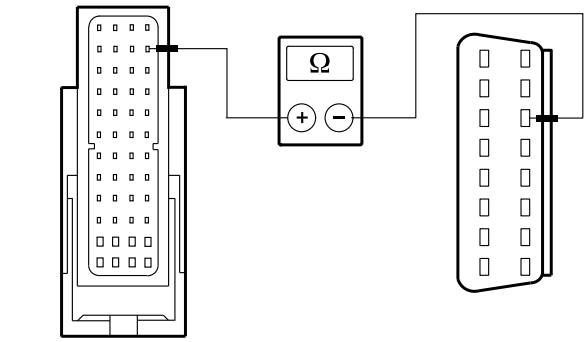
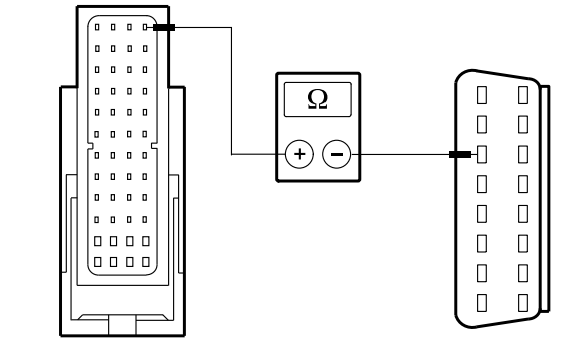
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
P12: CHECK THE HS CAN BUS FOR A SHORT TO GROUND	
 VFE0028959	1 Measure the resistance between the DLC, connector CDB04, pin 14, circuit VDB05B (WH), wiring harness side and ground. • Is a resistance of more than 10,000 Ohm measured? → **Yes** CHECK the PCM and RENEW if necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the short to ground in the circuit between the PCM and the DLC with the aid of the Wiring Diagrams. CHECK the operation of the system.
P13: CHECK THE GEM	
	1 Disconnect Connector CBP02F from the GEM.
 E45951	2 Measure the resistance between the DLC, connector CDB04, between pin 6, circuit VDB04B (WH/BU), wiring harness side and pin 14, circuit VDB05B (WH), wiring harness side. • Is a resistance of between 115 and 125 Ohm measured? → **Yes** GO to P14. → **No** - All except vehicles with diesel engines: GO to P16. - Vehicles with diesel engines: GO to P18.
P14: CHECK FOR OPEN CIRCUIT BETWEEN THE GEM AND THE DLC	
	1 Measure the resistance between the GEM, connector C2BP02F, pin 11, circuit VDB05A (WH), wiring harness side and the DLC, connector CDB04, pin 14, circuit VDB05A (WH), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to P15. → **No** LOCATE and RECTIFY the break in circuit VDB05A (WH) between the GEM and the DLC with the aid of the Wiring Diagrams. CHECK the operation of the system.

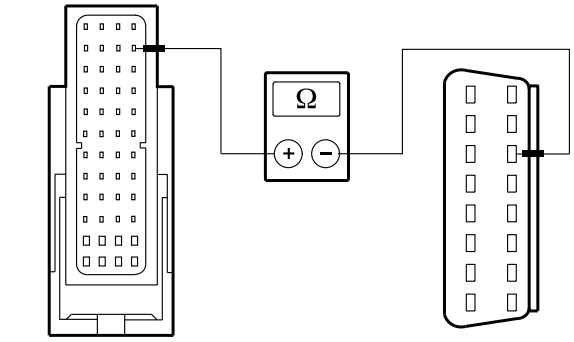
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
P15: CHECK FOR OPEN CIRCUIT BETWEEN THE GEM AND THE DLC	
	1 Measure the resistance between the GEM, connector C2BP02F, pin 1, circuit VDB04A (WH/BU), wiring harness side and the DLC, connector CDB04, pin 6, circuit VDB04A (WH/BU), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the GEM, if necessary INSTALL a new one. CHECK the operation of the system. → **No** LOCATE and RECTIFY the break in circuit VDB04A (WH/BU) between the GEM and the DLC with the aid of the Wiring Diagrams. CHECK the operation of the system.
P16: CHECK THE CIRCUIT BETWEEN THE PCM AND THE DLC FOR OPEN CIRCUIT	
	1 Disconnect Connector CE512B from the PCM.
	2 Measure the resistance between the PCM, connector CE512B, pin A4, circuit VDB04F (WH/BU), wiring harness side and the DLC, connector CDB04, pin 6, circuit VDB04B (BU/BK), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to P17. → **No** LOCATE and REPAIR the open circuit between the PCM and the DLC using the Wiring Diagrams. CHECK the operation of the system.

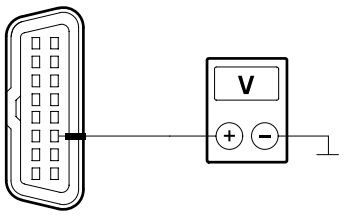
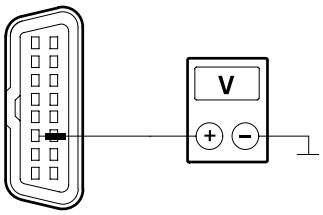
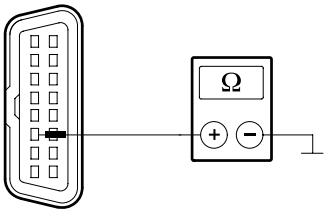
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
P17: CHECK THE CIRCUIT BETWEEN THE PCM AND THE DLC FOR OPEN CIRCUIT	
 E73192	1 Measure the resistance between the PCM, connector CE512B, pin B4, circuit VDB05F (GN/BK), wiring harness side and the DLC, connector CDB04, pin 14, circuit VDB05B (GN/BK), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the PCM and RENEW if necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the open circuit between the PCM and the DLC using the Wiring Diagrams. CHECK the operation of the system.
P18: CHECK THE CIRCUIT BETWEEN THE PCM AND THE DLC FOR OPEN CIRCUIT	
	1 Disconnect Connector CE104B from the PCM.
	2 Measure the resistance between the PCM, connector CE104B, pin A4, circuit VDB04F (BU/BK), wiring harness side and the DLC, connector CDB04, pin 6, circuit VDB04B (BU/BK), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** GO to P19. → **No** LOCATE and REPAIR the open circuit between the PCM and the DLC using the Wiring Diagrams. CHECK the operation of the system.

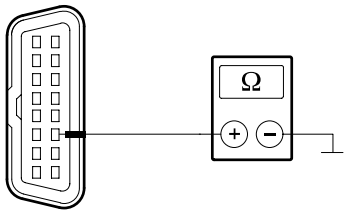
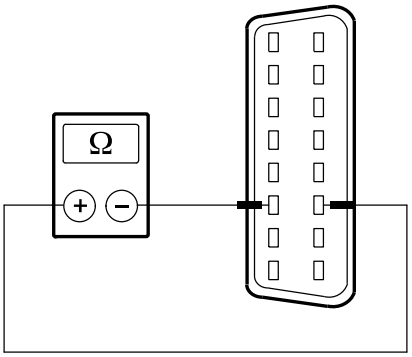
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
P19: CHECK THE CIRCUIT BETWEEN THE PCM AND THE DLC FOR OPEN CIRCUIT	
 E73204	1 Measure the resistance between the PCM, connector CE104B, pin B4, circuit VDB05F (GN/BK), wiring harness side and the DLC, connector CDB04, pin 14, circuit VDB05B (GN/BK), wiring harness side. • Is a resistance of less than 2 Ohm registered? → **Yes** CHECK the PCM and RENEW if necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the open circuit between the PCM and the DLC using the Wiring Diagrams. CHECK the operation of the system.
P20: PERFORM NETWORK TEST	
NOTE: The number of modules connected to the CAN bus depends on the equipment levels of the vehicle. Therefore, not every vehicle will have all the modules mentioned below.	
	1 Connect ground cable to battery.
	2 Disconnect Ground cable from battery.
	3 Connect the diagnostic tool.
	4 Disconnect a listed component, then proceed with the following test step: – Vehicles with ESP: ESP module CCA10 – Vehicles with ABS: ABS module CCA01 – Generic electronic module (GEM) CBP02F
	5 Select the vehicle with the diagnostic unit. • Is it possible to establish communications with the PCM? → **Yes** The component last disconnected is the cause of the concern; CHECK and if necessary RENEW the component. CHECK the operation of the system. → **No** - If not all the listed components are disconnected: Key in OFF position. DISCONNECT the next component (go to test step 3). - If all the listed components are disconnected: GO to P21.
P21: CHECK THE HS CAN BUS FOR A SHORT TO VOLTAGE SUPPLY	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Vehicles with diesel engine Connector CE104B from the PCM.
	3 Disconnect All except vehicles with diesel engines: Connector CE512B from the PCM.
	4 Ignition switch in position II.
 VFE0028970	5 Measure the voltage between the DLC, connector CDB04, pin 6, circuit VDB04B (WH/BU), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and REPAIR the short to voltage supply in the relevant circuit with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to P22.
P22: CHECK THE HS CAN BUS FOR A SHORT TO VOLTAGE SUPPLY	
 VFE0028962	1 Measure the voltage between the DLC, connector CDB04, pin 14, circuit VDB05B (WH), wiring harness side and ground. • Is a voltage measured? → **Yes** LOCATE and REPAIR the short to voltage supply in the relevant circuit with the aid of the Wiring Diagrams. CHECK the operation of the system. → **No** GO to P23.
P23: CHECK THE HS CAN BUS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
 VFE0028959	2 Measure the resistance between the DLC, connector CDB04, pin 14, circuit VDB05B (WH), wiring harness side and ground. • Is a resistance of more than 10,000 Ohm measured? → **Yes** GO to P24. → **No** LOCATE and REPAIR the short to ground in the relevant circuit with the aid of the Wiring Diagrams. CHECK the operation of the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
P24: CHECK THE HS CAN BUS FOR A SHORT TO GROUND	
 VFE0028967	1 Measure the resistance between the DLC, connector CDB04, pin 6, circuit VDB04B (WH/BU), wiring harness side and ground. • Is a resistance of more than 10,000 Ohm measured? → **Yes** GO to P25. → **No** LOCATE and REPAIR the short to ground in the relevant circuit with the aid of the Wiring Diagrams. CHECK the operation of the system.
P25: CHECK THE HS CAN BUS FOR SHORT CIRCUIT	
 E45951	1 Measure the resistance between the DLC, connector CDB04, between pin 6, circuit VDB04B (WH/BU), wiring harness side and pin 14, circuit VDB05B (WH), wiring harness side. • Is a resistance of more than 10,000 Ohm measured? → **Yes** CHECK the PCM and RENEW if necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the short circuit in the HS CAN Bus using the Wiring Diagrams. CHECK the operation of the system.

Component checks

Power supply relay

1. Check the normally open contact in the unswitched state:
   - Measure the resistance at the power supply relay, between pin 3 and pin 5, component side.
   - Is a resistance of more than 10,000 Ohm measured? If yes, go to 2. If no, RENEW the power supply relay.
2. Check the normally open contact in the switched state:
   - Using a fused test cable (1 A), connect pin 1 of the power supply relay, component side, with the battery positive terminal.
   - Using a test cable, connect pin 2 of the power supply relay, component side, to the battery negative terminal.
   - Measure the resistance at the power supply relay, between pin 3 and pin 5, component side.
   - Is a resistance of less than 2 Ohm registered? If yes, the power supply relay is OK. If no, RENEW the power supply relay.

SECTION 418-01 Module Configuration

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

GENERAL PROCEDURES

Module Configuration..... 418-01-2
Programmable Module Installation..... 418-01-3

GENERAL PROCEDURES

Module Configuration

1. **NOTE:Ensure that the most up-to-date software version is installed in WDS.**

   General

   - WDS now includes a new routine for replacing or subsequently changing the configuration data. This new routine is used to perform the central module configuration.
   - During the central module configuration, the required configuration parameters are transmitted from the GEM to the relevant module - WDS is only used to initiate and monitor the process.
   - For safety reasons all of the configuration data which are saved in the GEM are also backed up in the instrument cluster. This means that if the GEM is replaced then the required configuration data can read out from the instrument cluster with the aid of WDS and transmitted to the new GEM.
   - If the GEM and the instrument cluster are both replaced, or if it is not possible to read out the configuration data from the instrument cluster, then the vehicle-specific data will need to entered manually during programming of the GEM. This is done either by selecting the data from a selection list in WDS or by entering a code which can be obtained from the Technical Hotline.
   - The GEM checks the configuration data for consistency and stores a trouble code in the event of a fault - WDS (DTC). In the event of a fault the function of the GEM may be restricted.

2. **After replacement, use WDS to configure the GEM.**

GENERAL PROCEDURES

Programmable Module Installation

1. **NOTE:In order to minimize module variations, different equipment levels and functionalities are incorporated in the same module. For this reason, modules must be programmed following replacement.**

NOTE: All of the required data (software) are loaded by the WDS into the module. In the process it is for example also possible to replace older software versions with a more current version.

NOTE: If, before replacing a module, it was not possible to read out the vehicle-specific data using WDS (the module to be replaced does not respond) then, during programming of the new module, the vehicle-specific data must be entered manually via a selection list in WDS or via a code which can be obtained from the Technical Hotline.

NOTE: Ensure that the most up-to-date software version is installed in WDS.

In order to program, select the "Install programmable module" submenu in the "Module programming" menu tool box and then follow the instructions.

2. **NOTE:The number of modules installed in the vehicle can vary according to equipment level.**

   The following modules must be programmed after replacement:

   - Anti-lock braking system module (ABS)
   - Audio system module (ACM)
   - CD player (CDP)
   - Generic electronic module (GEM)
   - Instrument cluster (IC)
   - Navigation system (NAV) (vehicles with navigation system)
   - Parking aid module(PAM)
   - Powertrain control module (PCM)
   - Restraint control module (RCM)

3. **NOTE:If, before replacing a PCM, it was not possible to read out the vehicle-specific data using WDS (the PCM to be replaced does not respond), configuration of the PCM must be performed following programming. For this purpose, the vehicle-specific data must be entered manually.**

   In order to configure the PCM, select the "Programmable parameters" submenu in the "Module programming" menu tool box and then follow the instructions.

4. **Following configuration of the GEM, module-resetting of the GEM using WDS must be performed. For this purpose, select the "Programmable parameters" submenu in the "Module programming" menu tool box and then follow the instructions under the "GEM reset" menu item.**

5. **For vehicles with anti-lock braking system and electronic stability program, these must also be configured using WDS following replacement of the lateral acceleration sensor, yaw rate sensor or pressure sensor. Configuration is performed in the "Programmable parameters" menu tool box.**

SECTION 418-02 Wiring Harnesses

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

REMOVAL AND INSTALLATION

Engine Compartment Wiring Harness..... 418-02-2
Passenger Compartment Wiring Harness..... 418-02-5
Instrument Panel Wiring Harness..... 418-02-22

REMOVAL AND INSTALLATION

Engine Compartment Wiring Harness

Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Disconnect the battery negative lead.

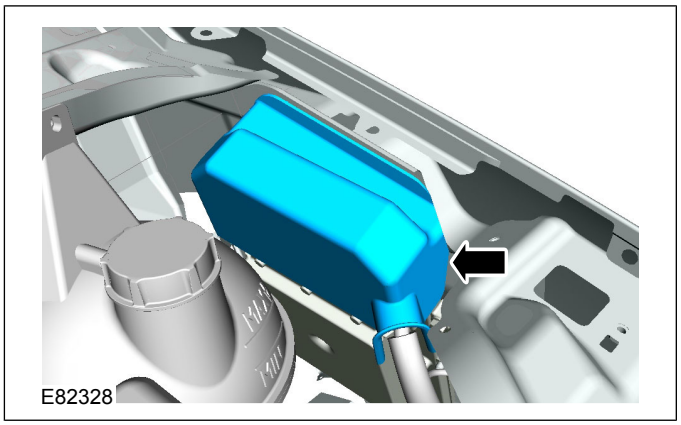
   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

2. Remove the left-hand headlamp.

   Refer to:Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).

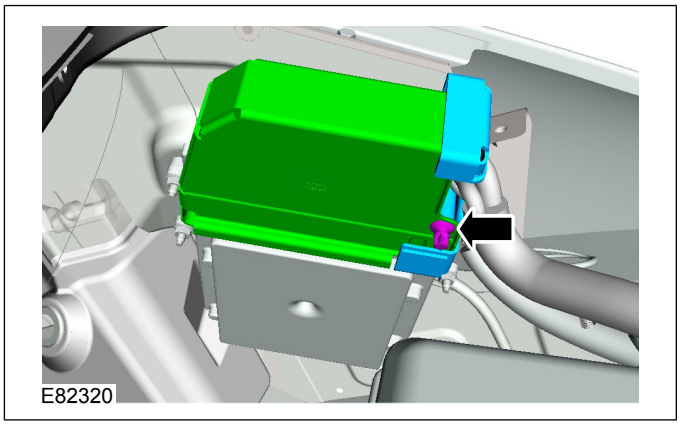
Left-hand drive vehicles

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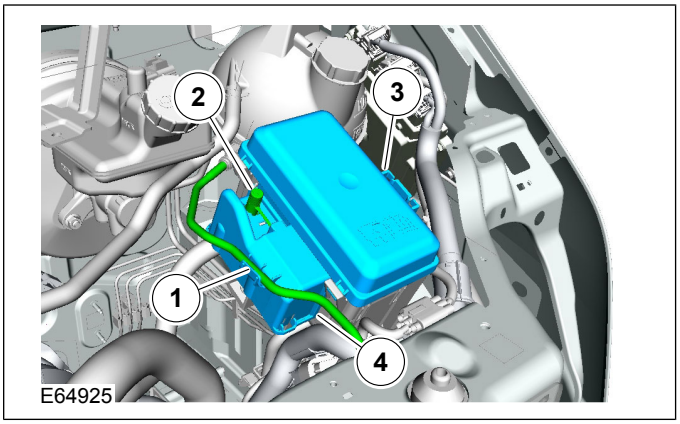
Right-hand drive vehicles

4.

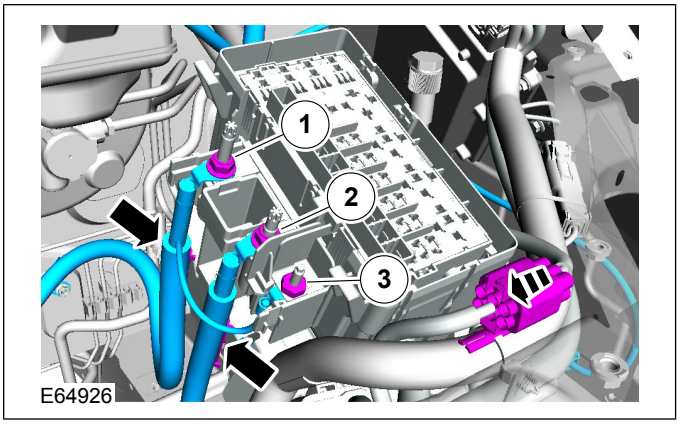


All vehicles

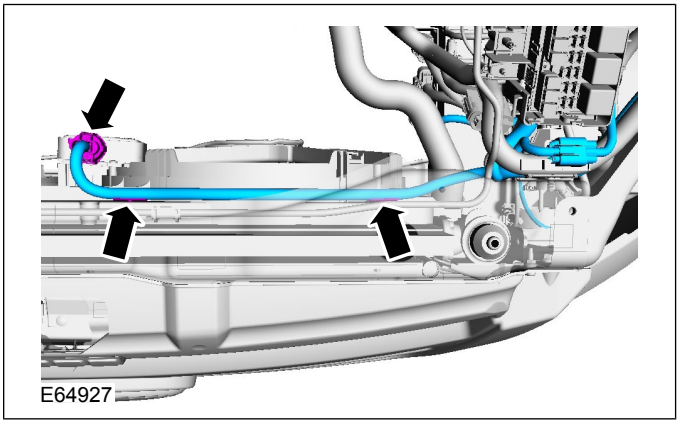
5.



6. 1. Torque: 12 Nm
2. Torque: 13 Nm
3. Torque: 7 Nm

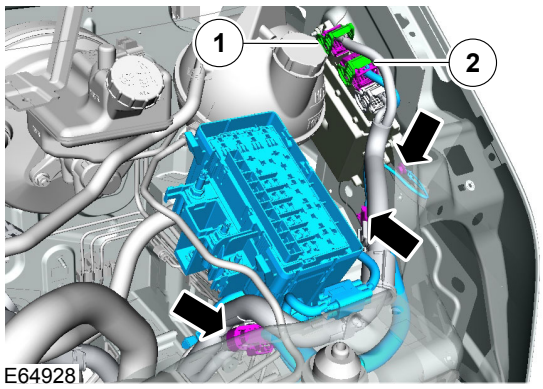


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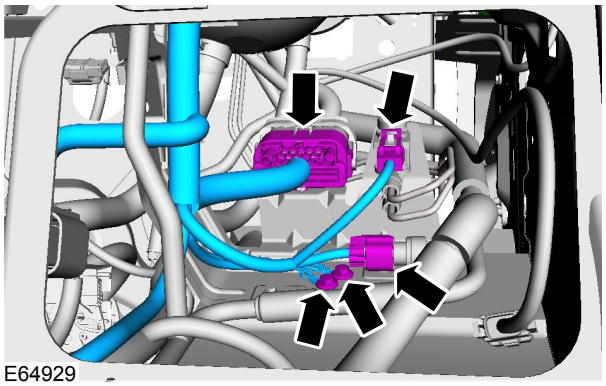


REMOVAL AND INSTALLATION

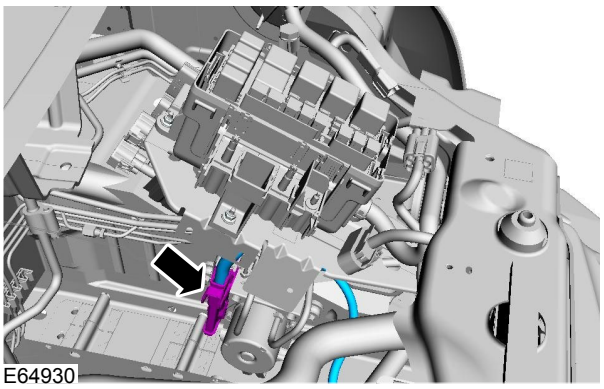
8. Torque: 8 Nm



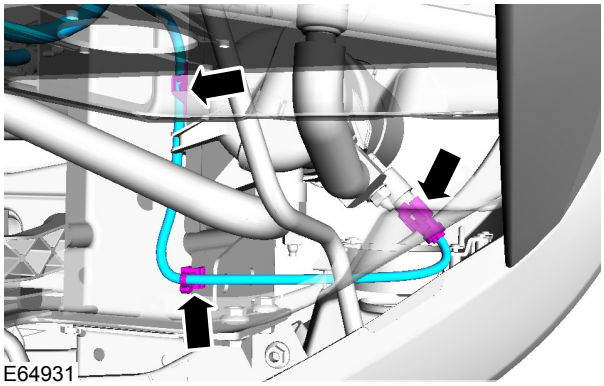
9. Torque: 8 Nm



10.

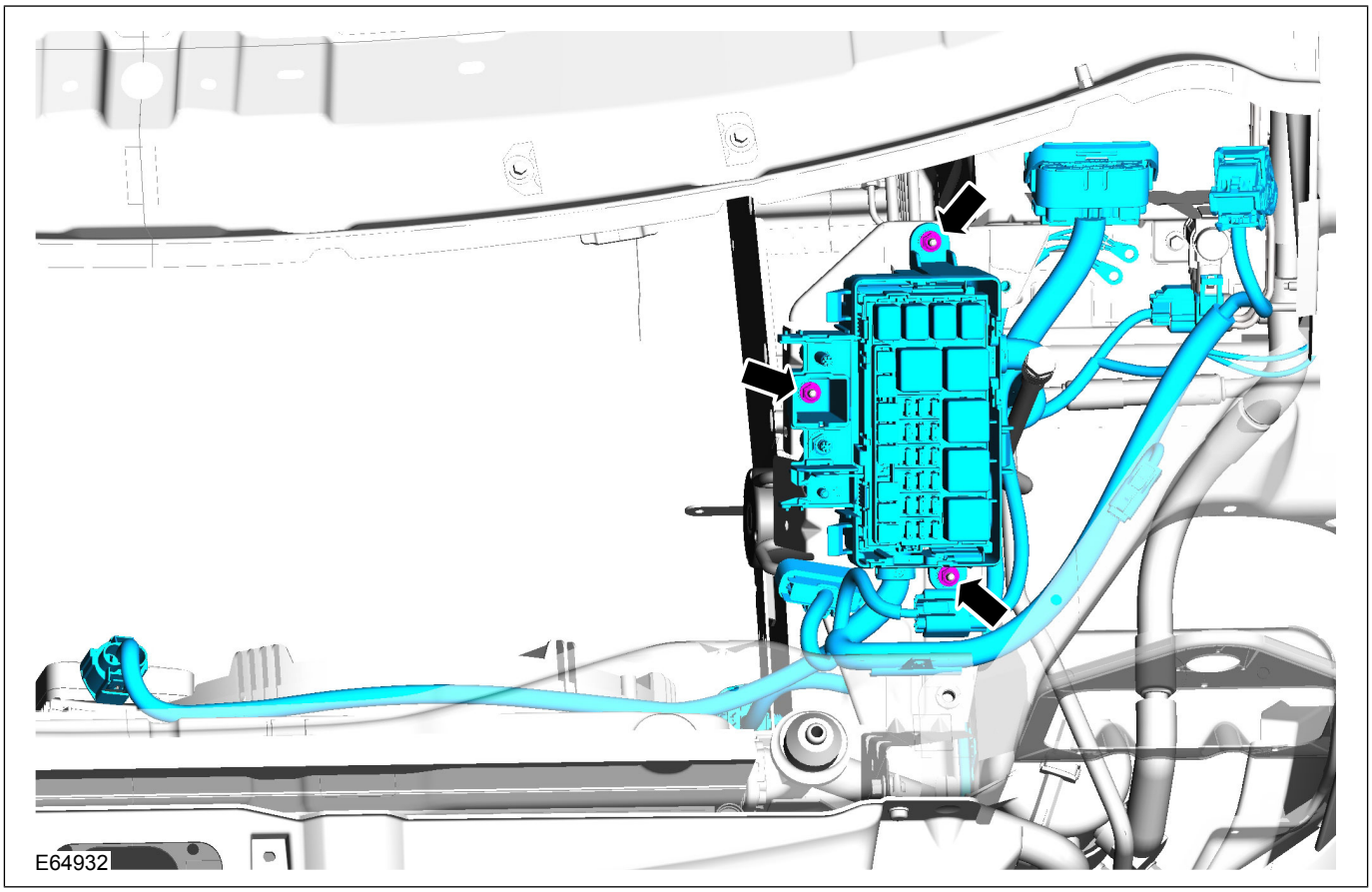


11.



12. Torque: 13 Nm

REMOVAL AND INSTALLATION



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Passenger Compartment Wiring Harness

Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Remove the batteries.

   Refer to:Battery (414-01 Battery, Mounting and Cables, Removal and Installation).

2. Remove the audio unit.

   Refer to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation).

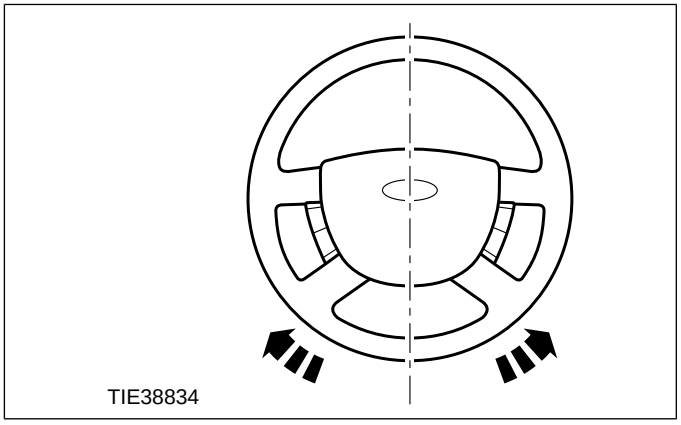
3. Remove the left and right-hand A-pillar trim.

   Refer to:A-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

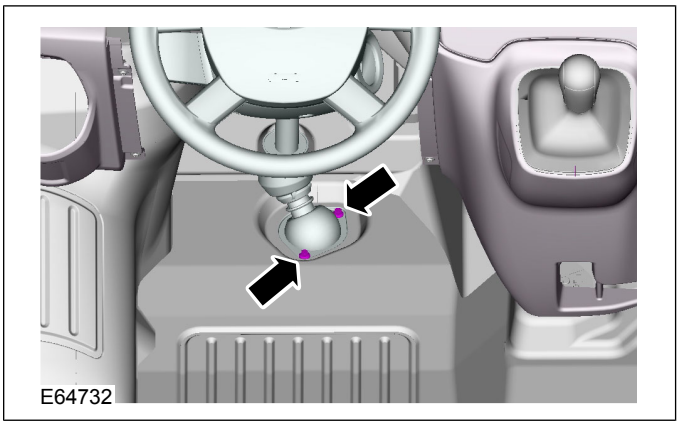
4. Remove the left and right-hand exterior mirrors.

   Refer to:Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation).

5. **NOTE:**Make sure that the road wheels are in the straight ahead position.



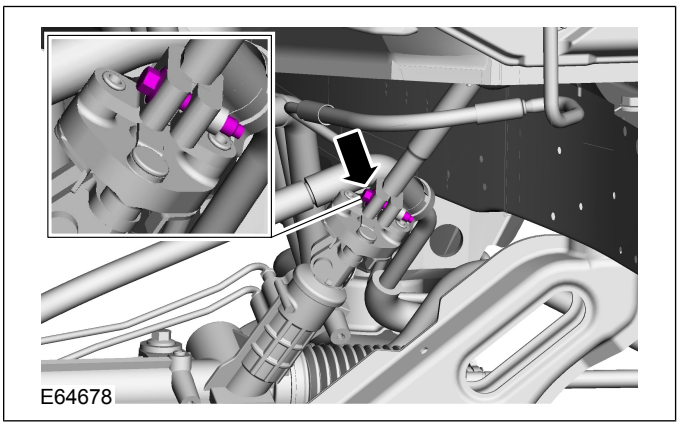
6. • Pull the footwell carpet to one side.
   • Torque: 12 Nm



7. Raise the vehicle.

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

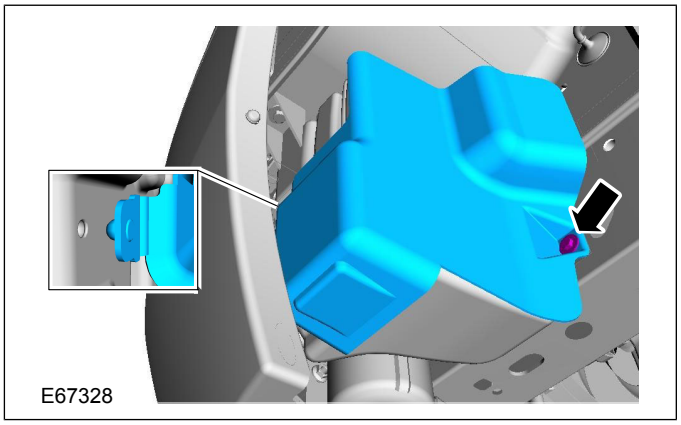
8. **CAUTION:Make sure that new bolts are installed.**
   • Detach the steering column shaft joint from the steering column shaft.
   • Torque: 28 Nm



REMOVAL AND INSTALLATION

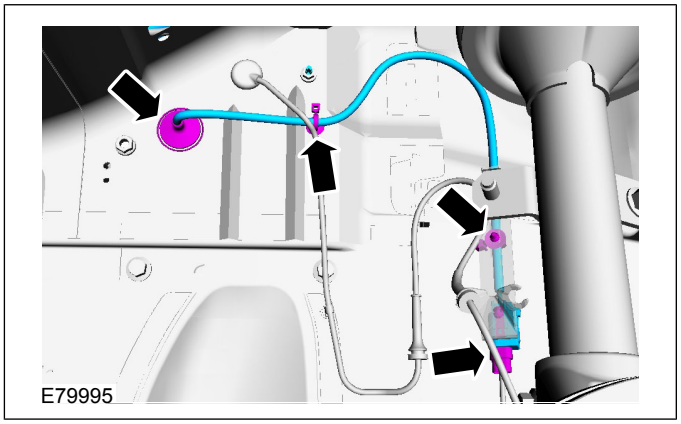
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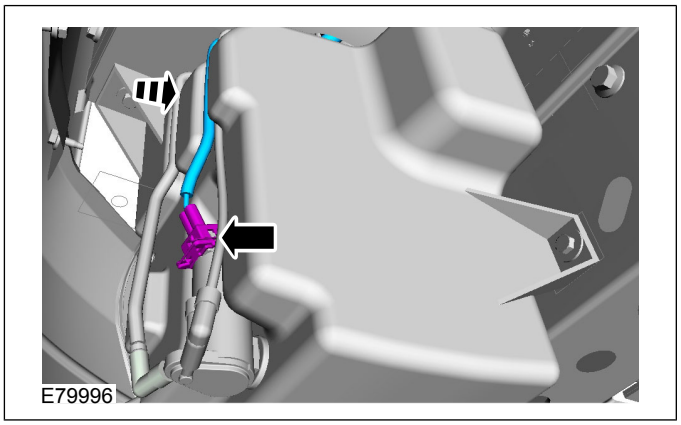


All Vehicles

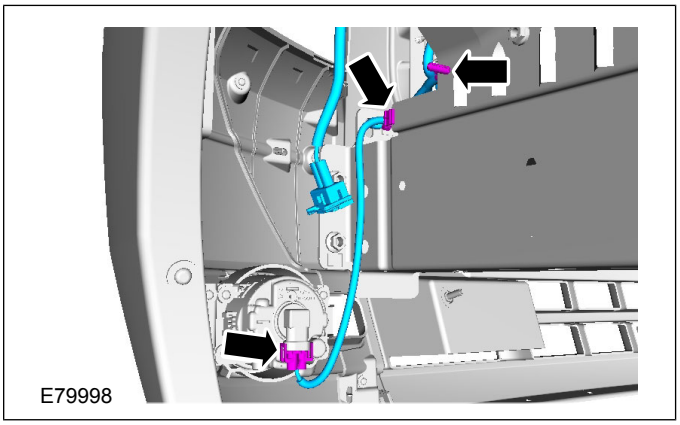
10. • On both sides.



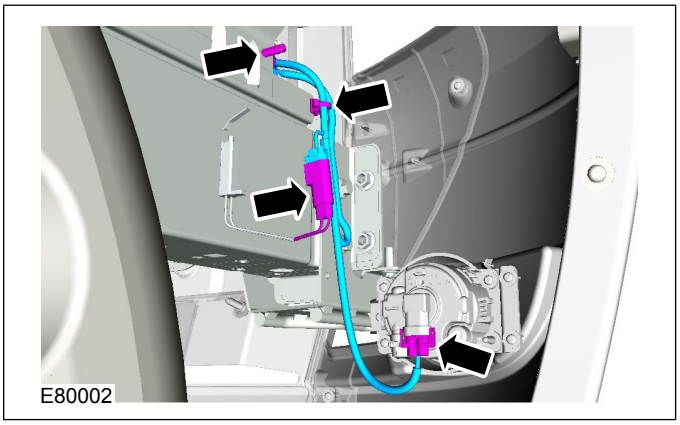
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12.



13.

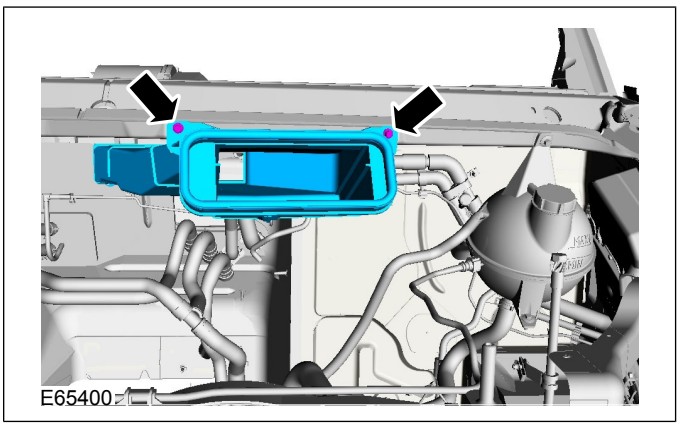


14. Lower the vehicle.

15. Remove the right- and left-hand headlamps.

Refer to:Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).

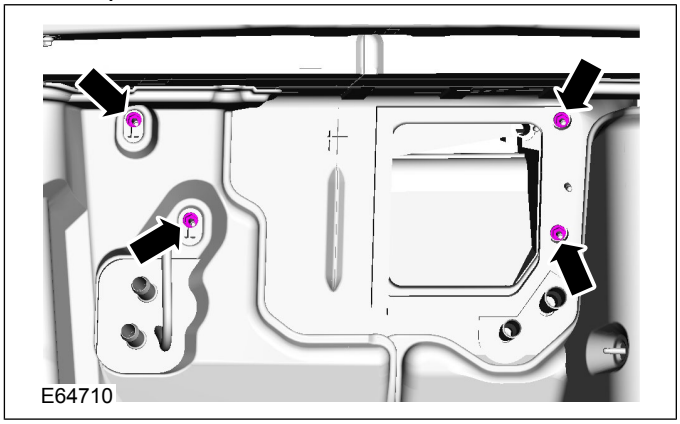
16.



REMOVAL AND INSTALLATION

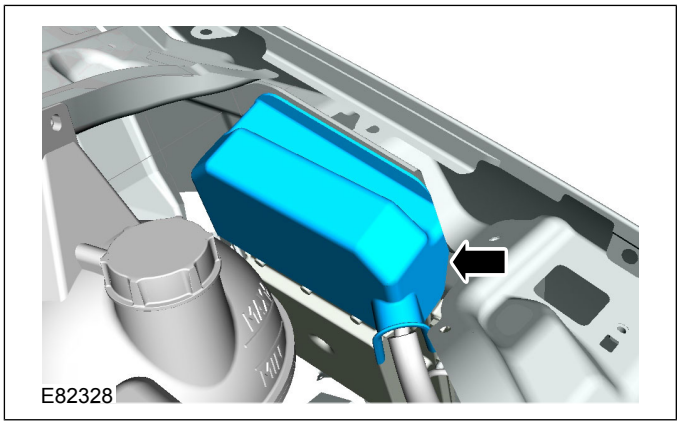
17. **NOTE:** Do not loosen the bolts more than 2 turns.

    Torque: 8 Nm



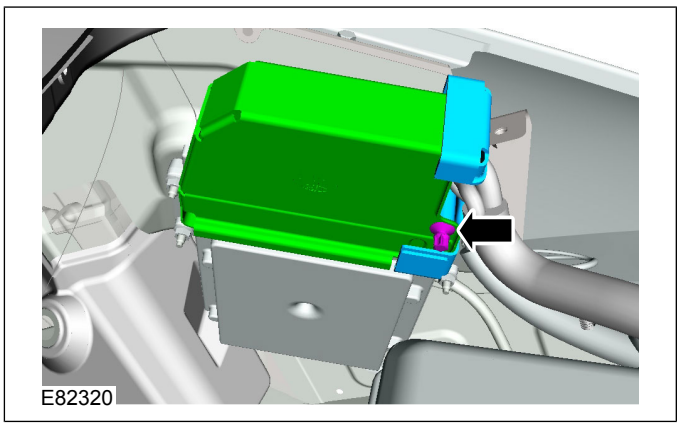
Left-hand drive vehicles

18.



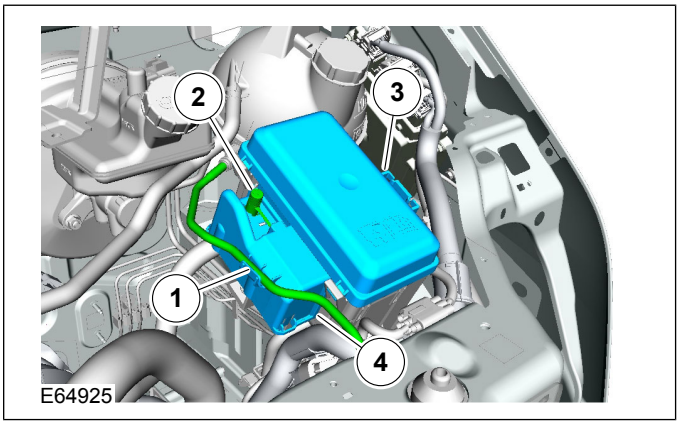
Right-hand drive vehicles

19.

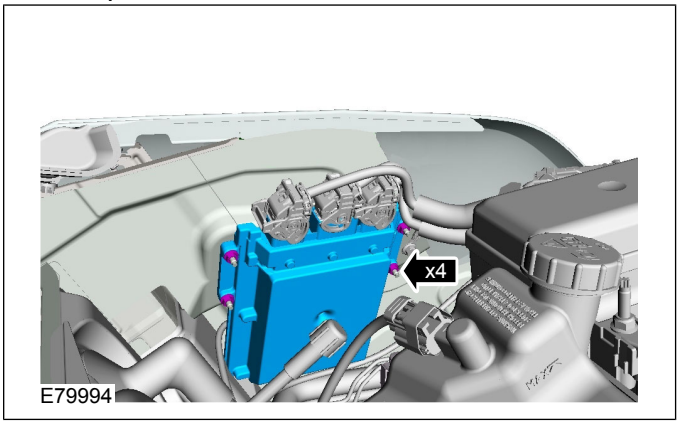


All Vehicles

20.

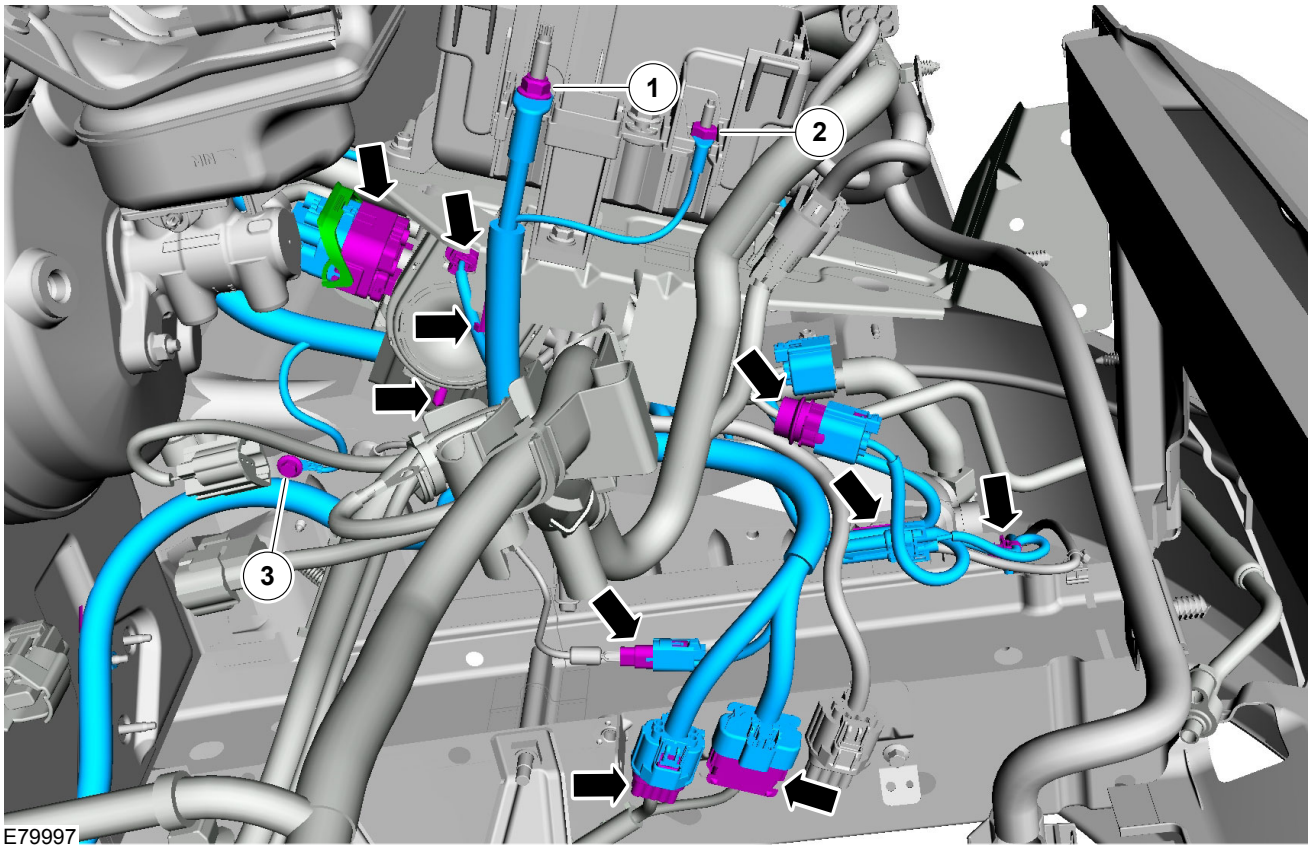


21. Torque: 10 Nm

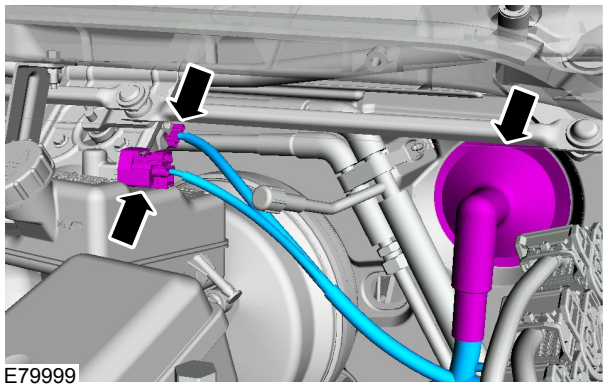


22. 1. Torque: 12 Nm
    2. Torque: 7 Nm
    3. Torque: 8 Nm

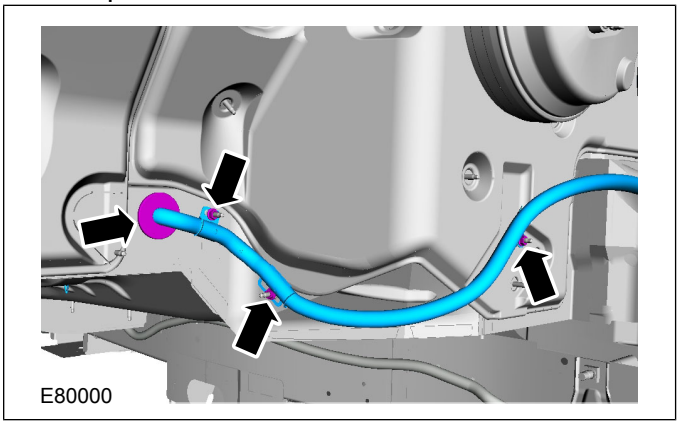
REMOVAL AND INSTALLATION



23.

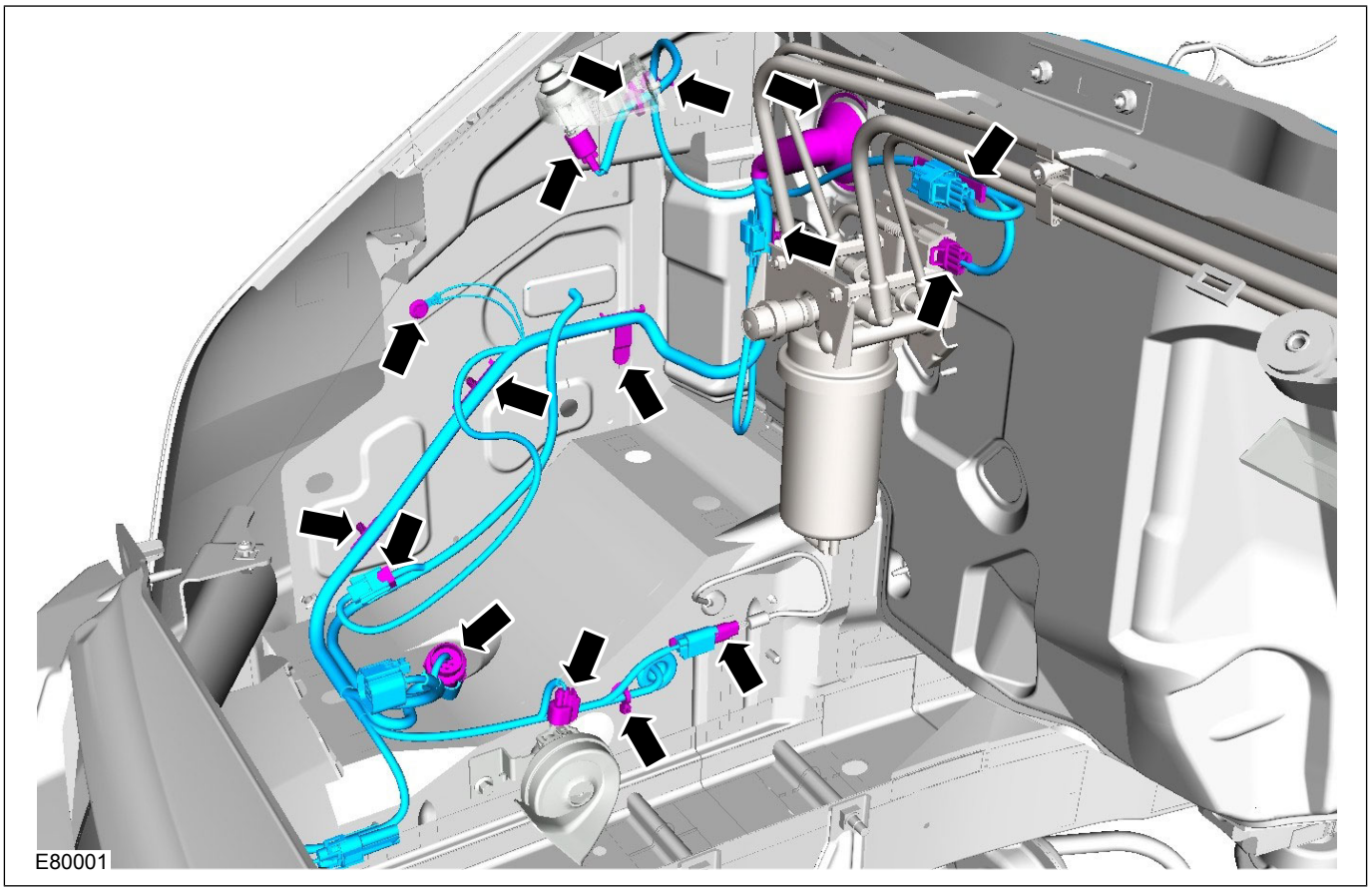


24. Torque: 8 Nm

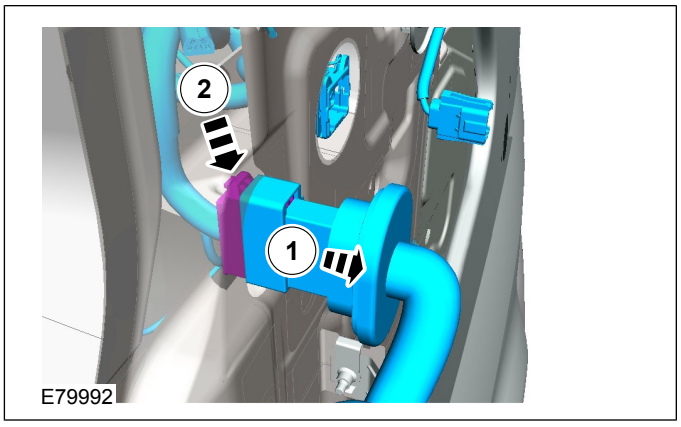


25. Torque: 8 Nm

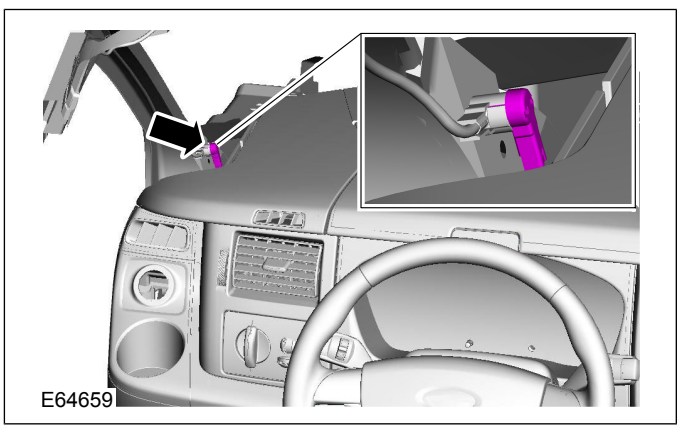
REMOVAL AND INSTALLATION



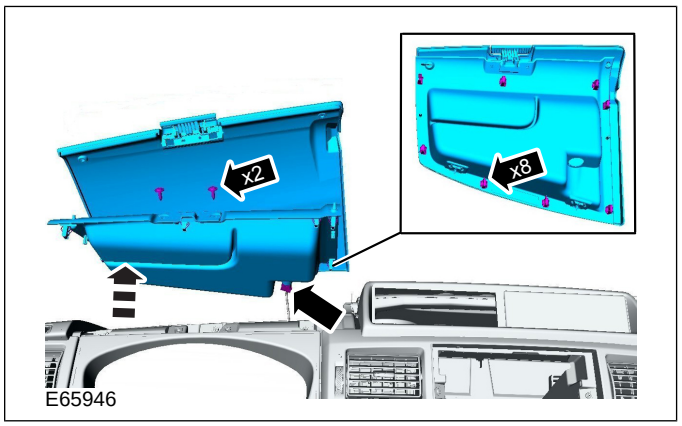
26. • On both sides.



27.

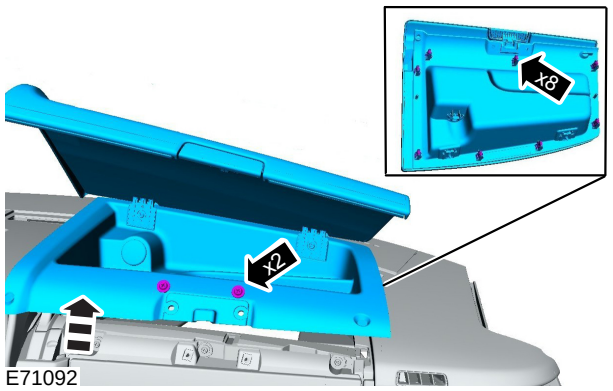


28.



REMOVAL AND INSTALLATION

29.

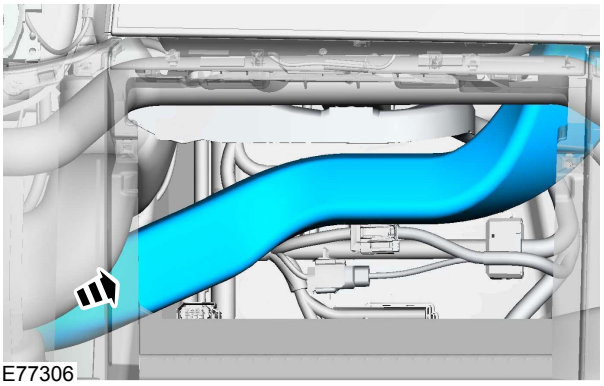


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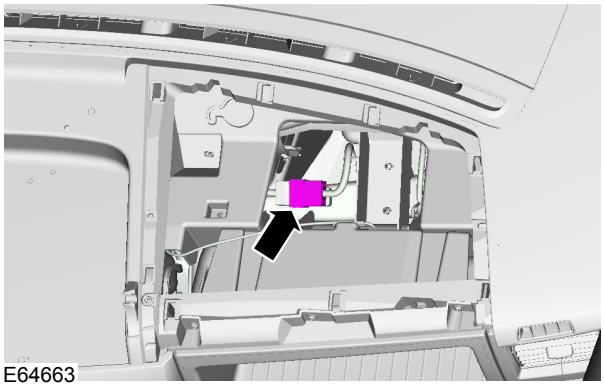
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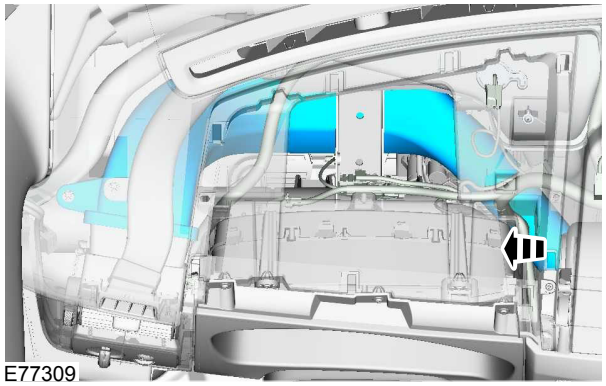

E77306

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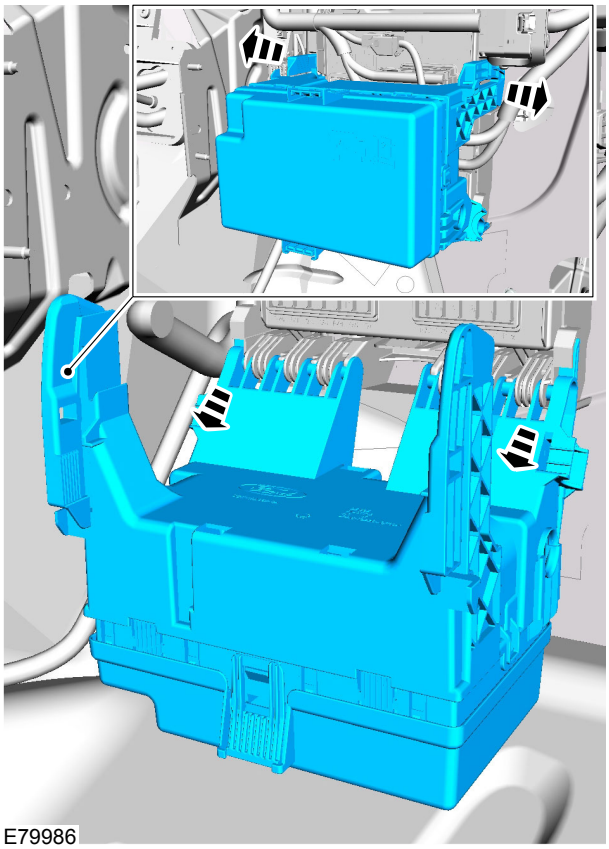

E64663

REMOVAL AND INSTALLATION

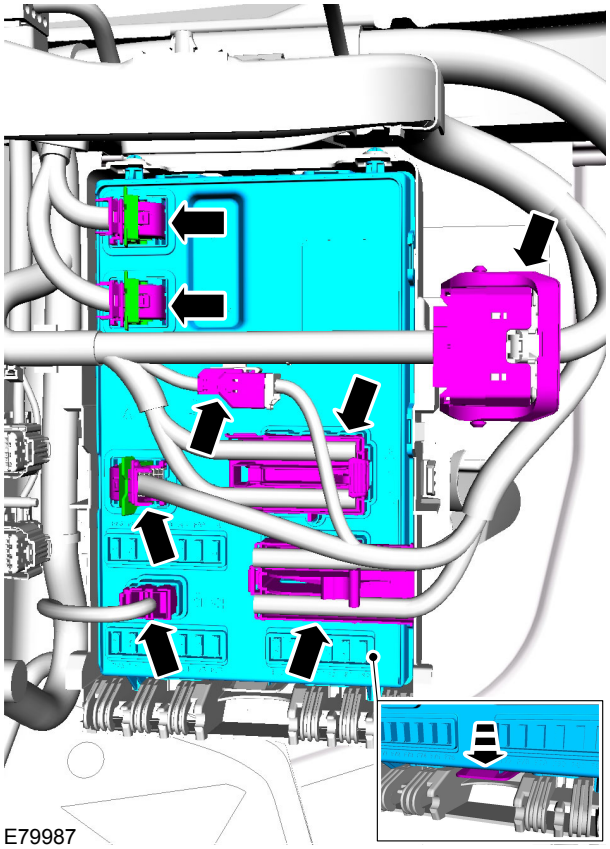
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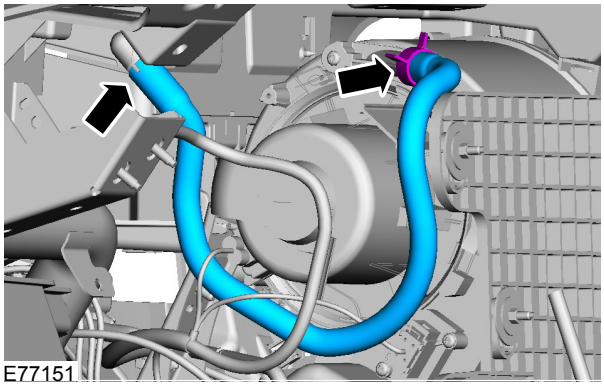
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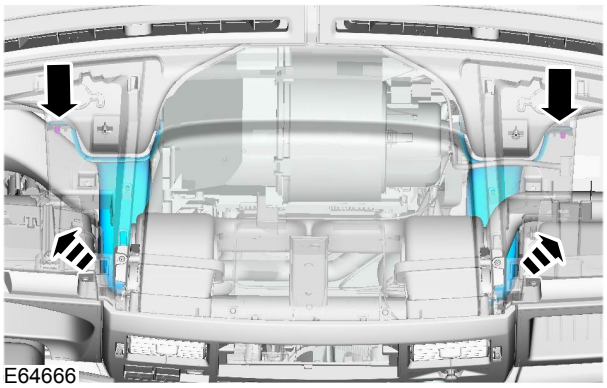


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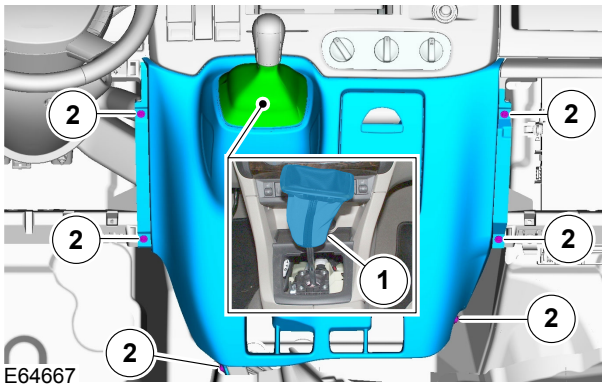


REMOVAL AND INSTALLATION

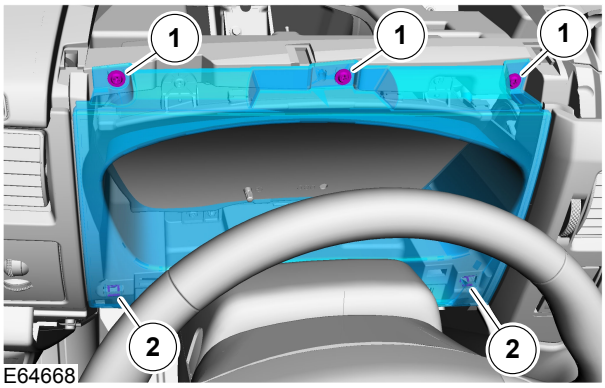
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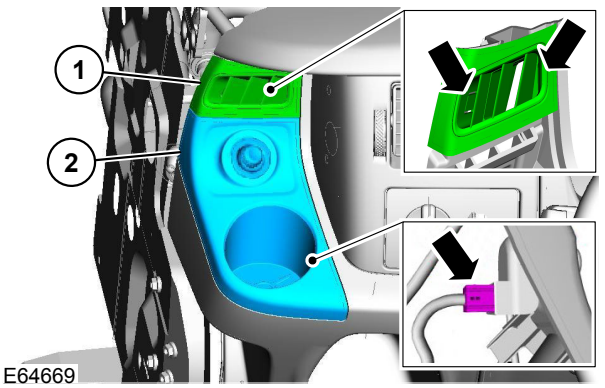
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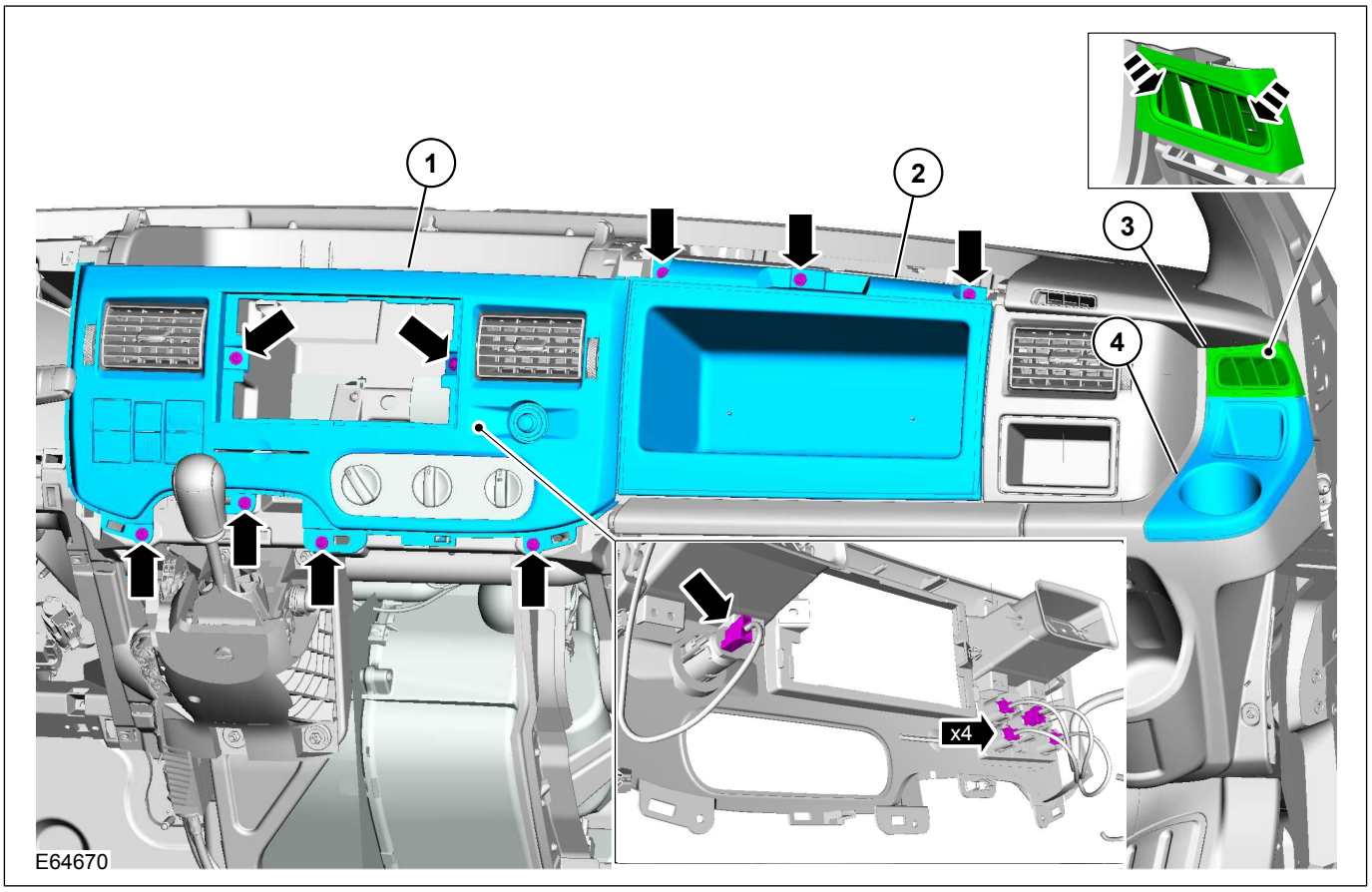


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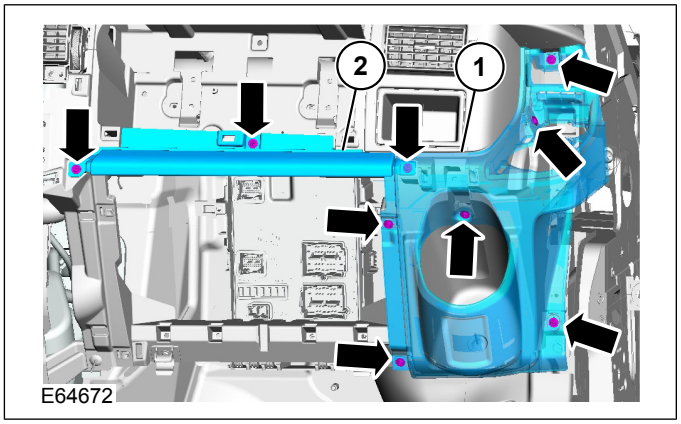


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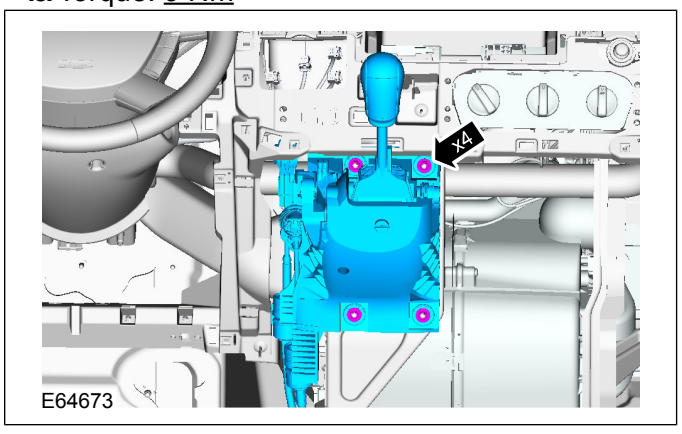
REMOVAL AND INSTALLATION



42.



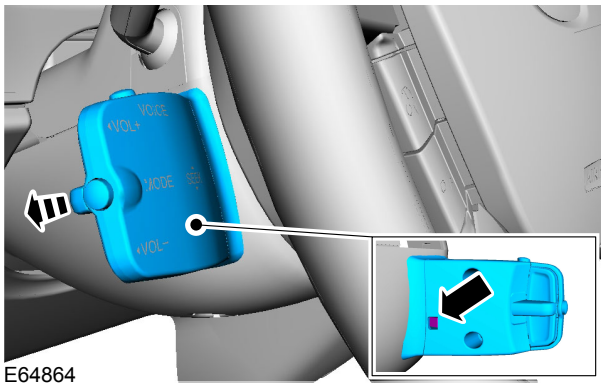
43. Torque: 9 Nm



REMOVAL AND INSTALLATION

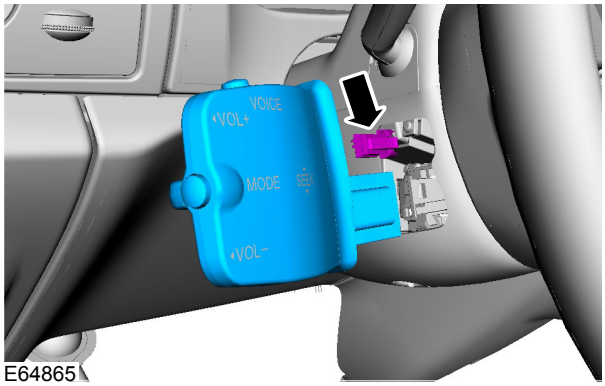
Vehicles with remote control for the audio unit

44.



E64864

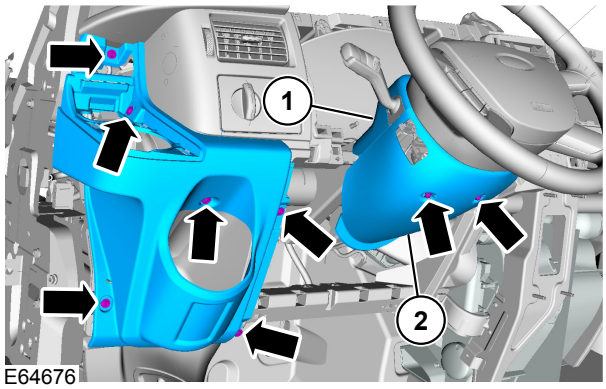
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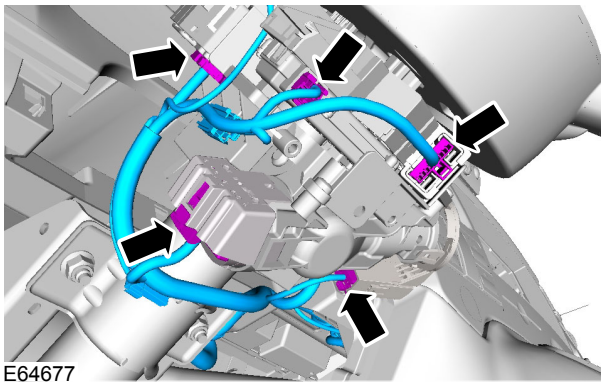
All Vehicles

46.

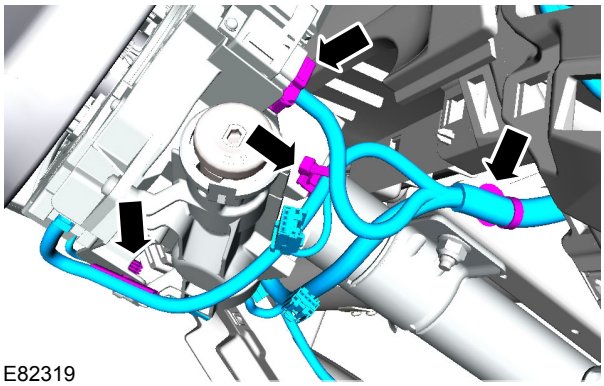


E64676

47.


E64677

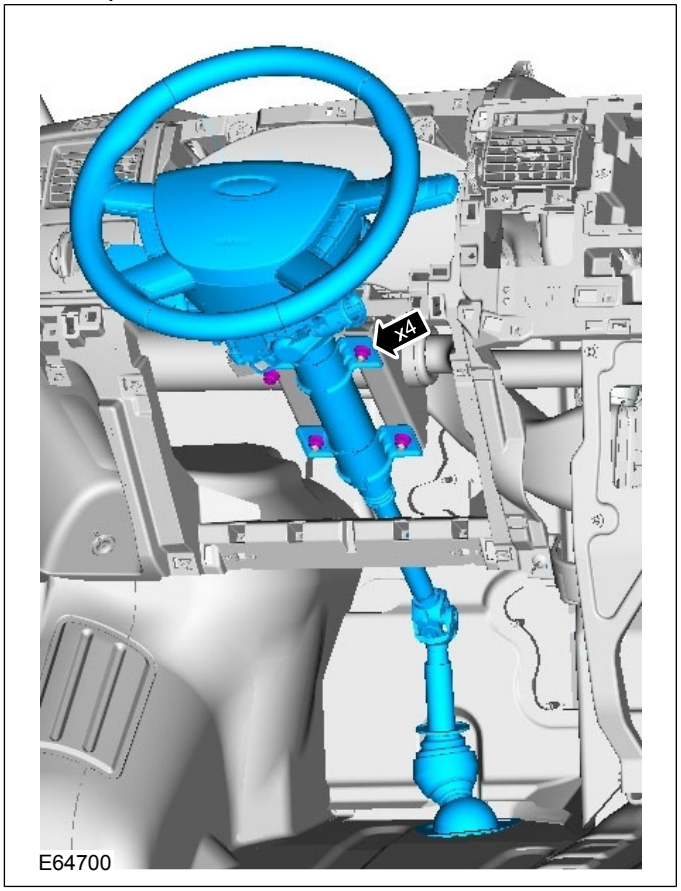
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E82319

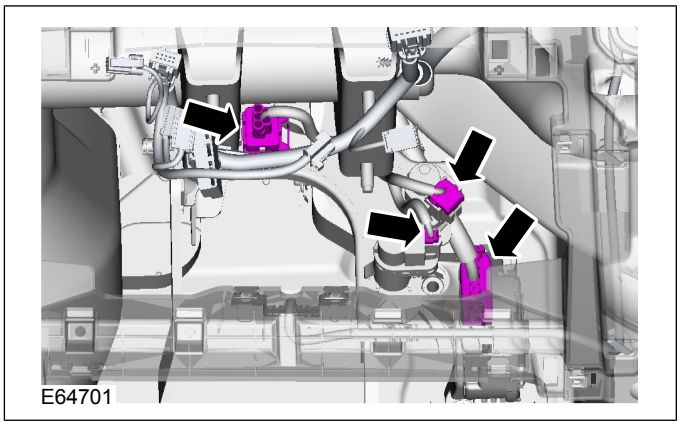
REMOVAL AND INSTALLATION

49. **WARNING:Make sure that new self-locking nuts are installed.**

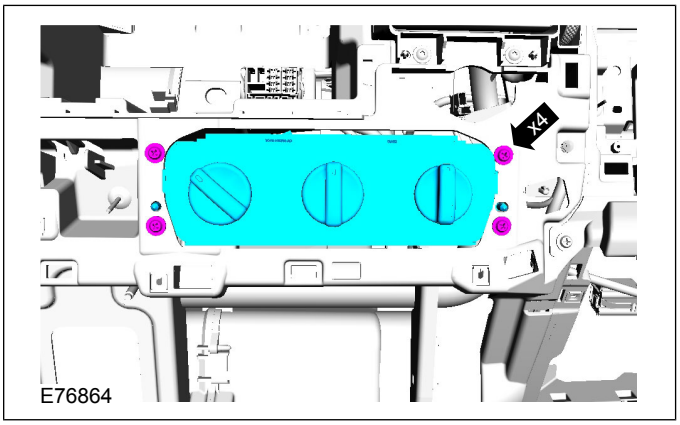
Torque: 20 Nm



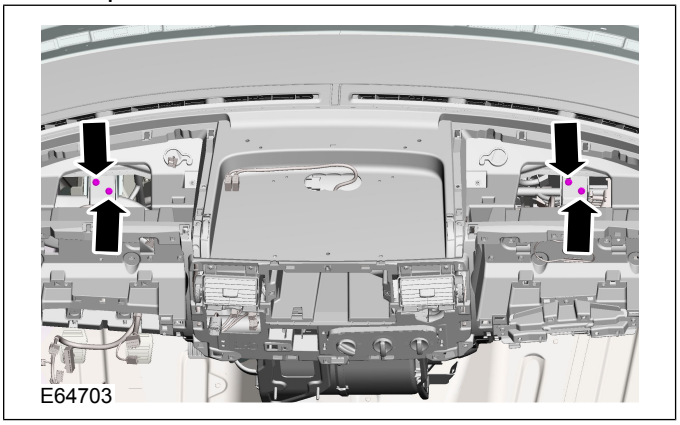
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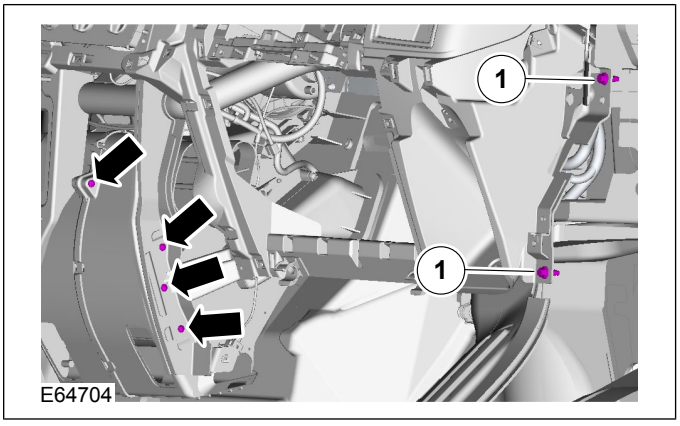
51.



52. Torque: 20 Nm

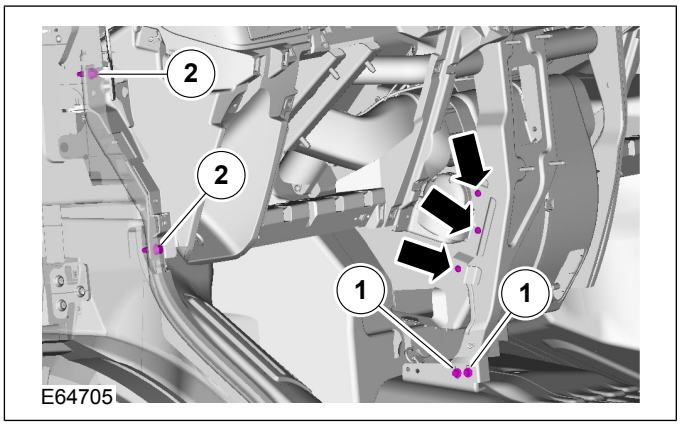


53. 1. Torque: 25 Nm

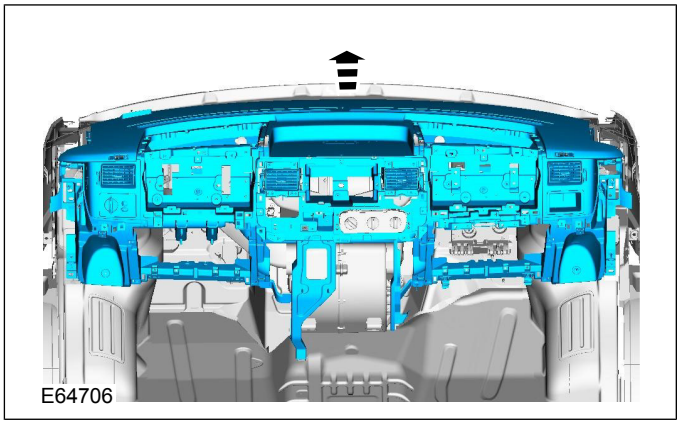


REMOVAL AND INSTALLATION

54. 1. Torque: 20 Nm
2. Torque: 25 Nm



55.



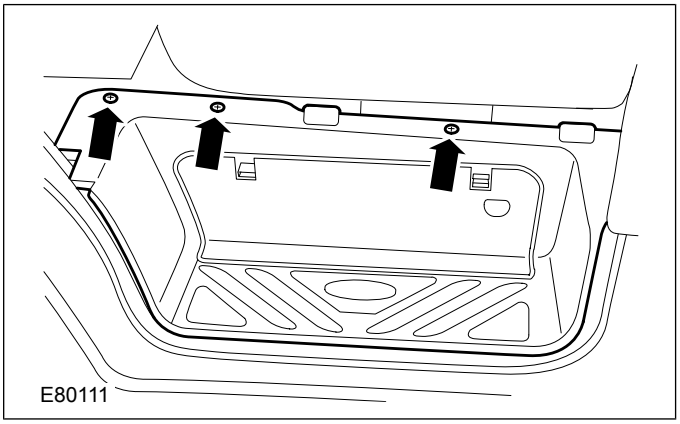
56. Remove front seat.

Refer to:Front Seat (501-10 Seating, Removal and Installation).

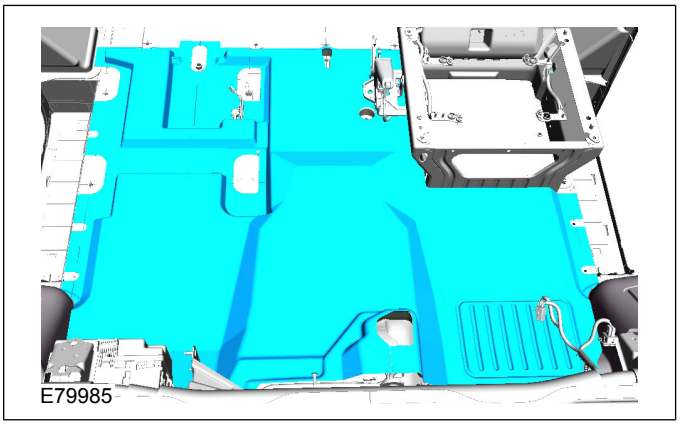
57. Remove the front bench seat.

Refer to:Double Passenger Seat (501-10 Seating, Removal and Installation).

58.

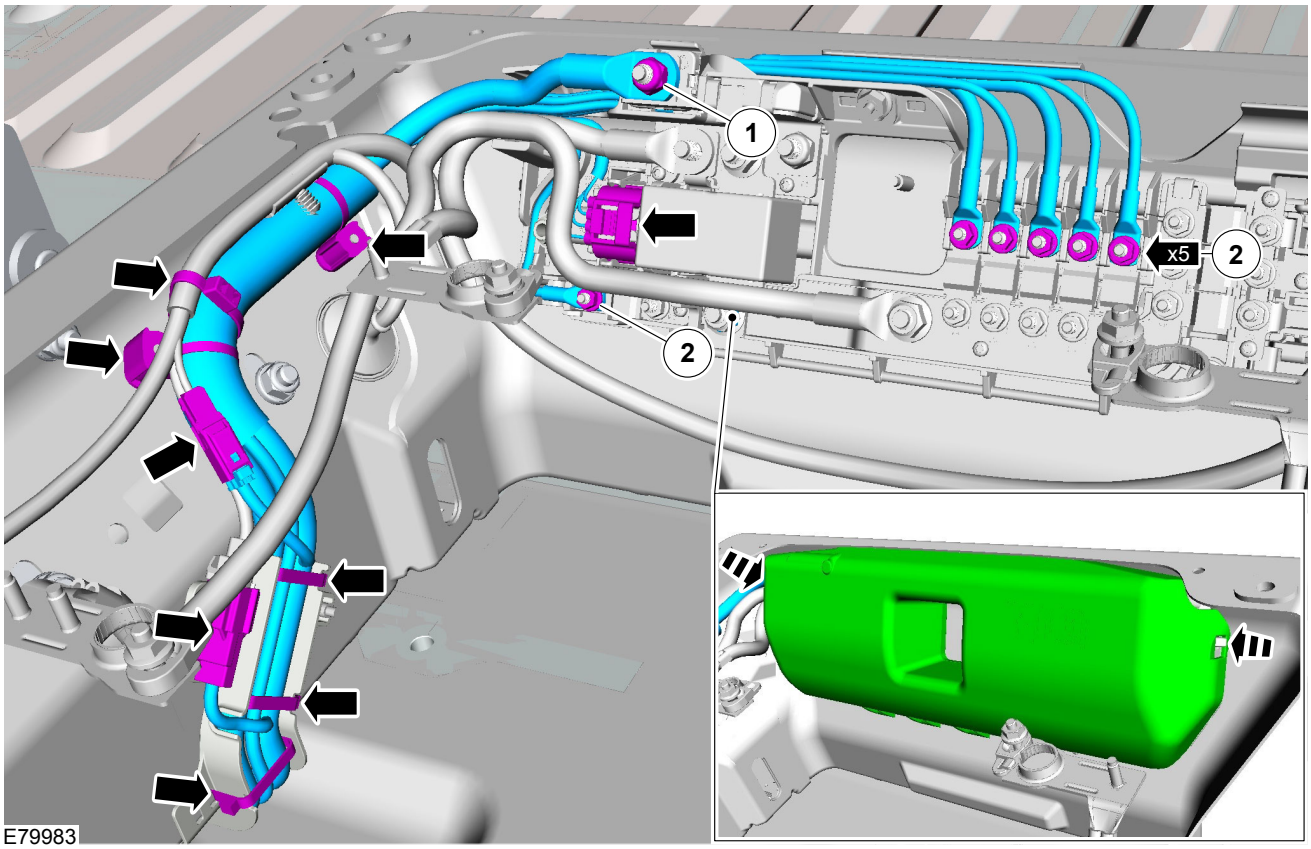


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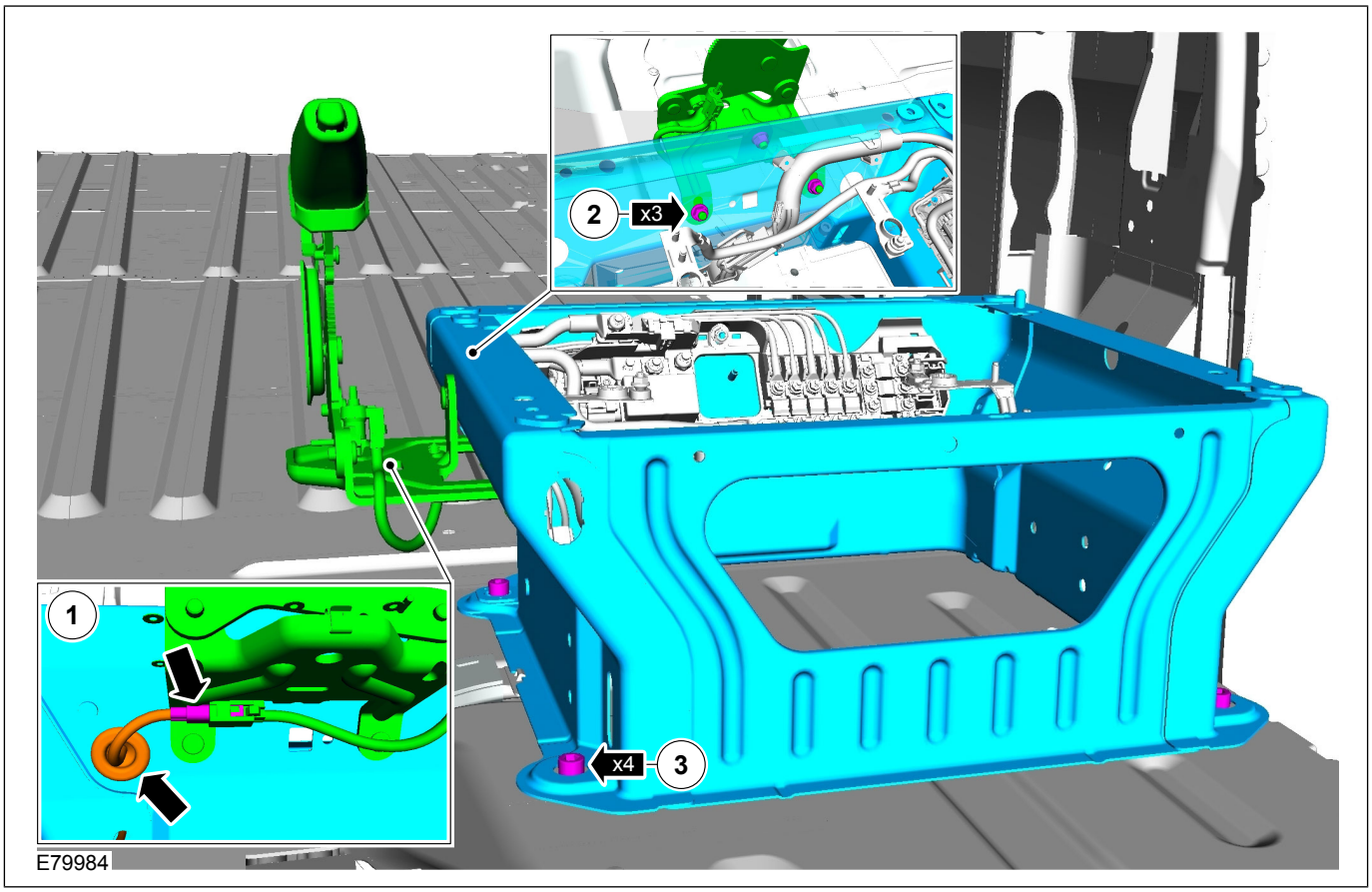
60. 1. Torque: 12 Nm
2. Torque: 7 Nm

REMOVAL AND INSTALLATION

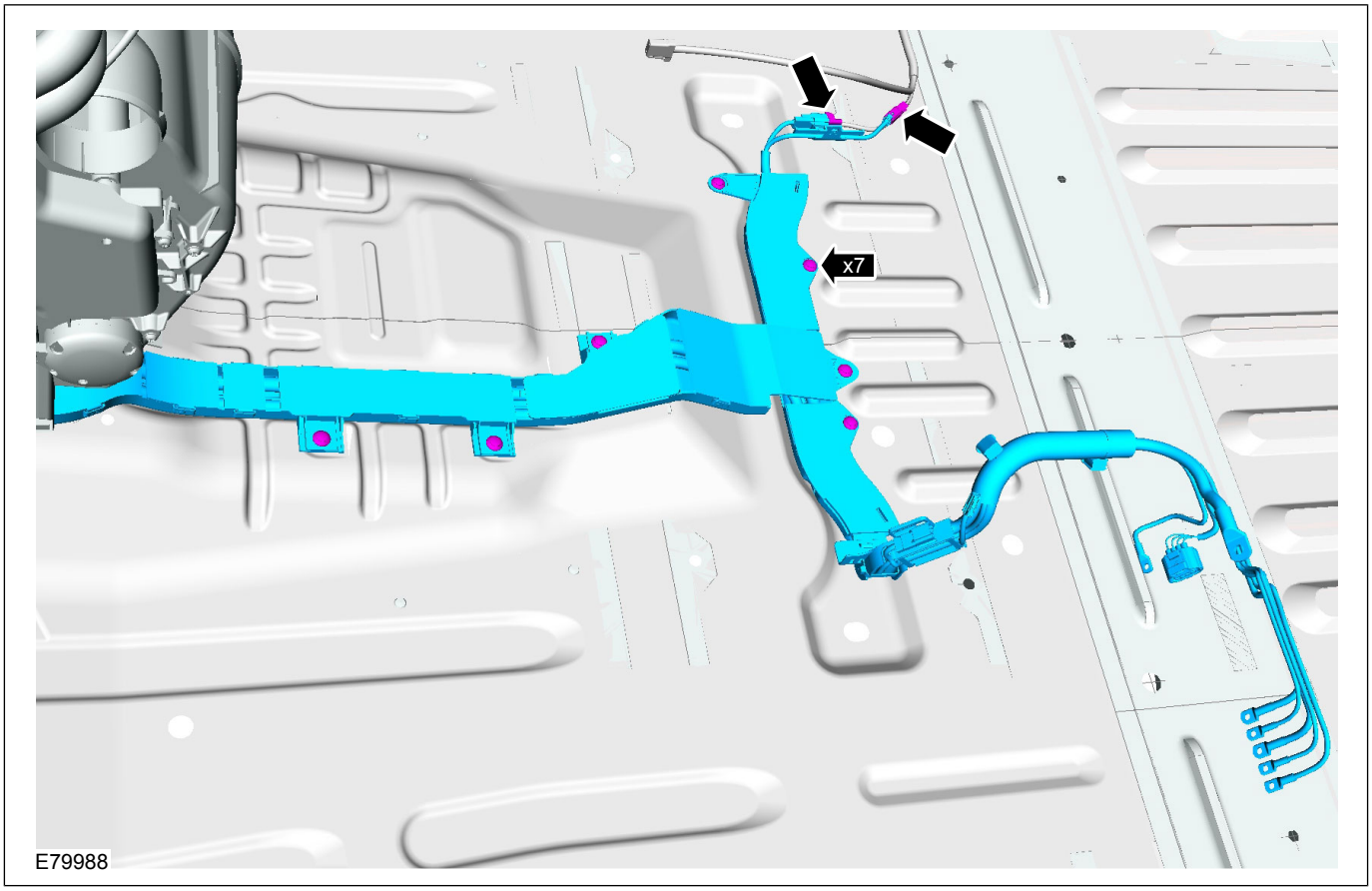


61. 2. Torque: 22 Nm
3. Torque: 55 Nm

REMOVAL AND INSTALLATION

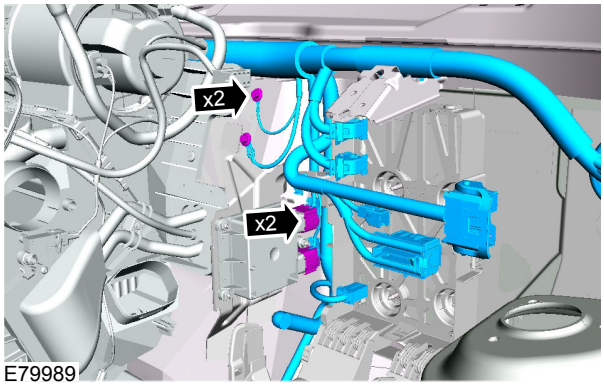


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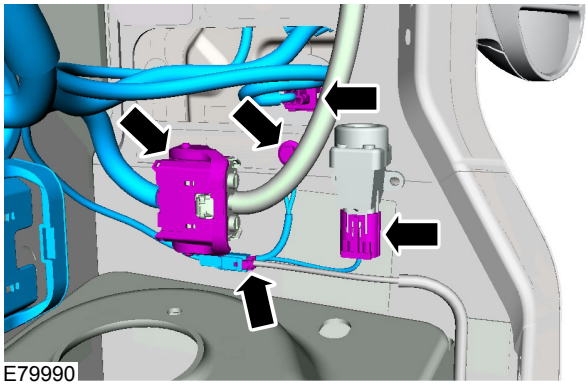


REMOVAL AND INSTALLATION

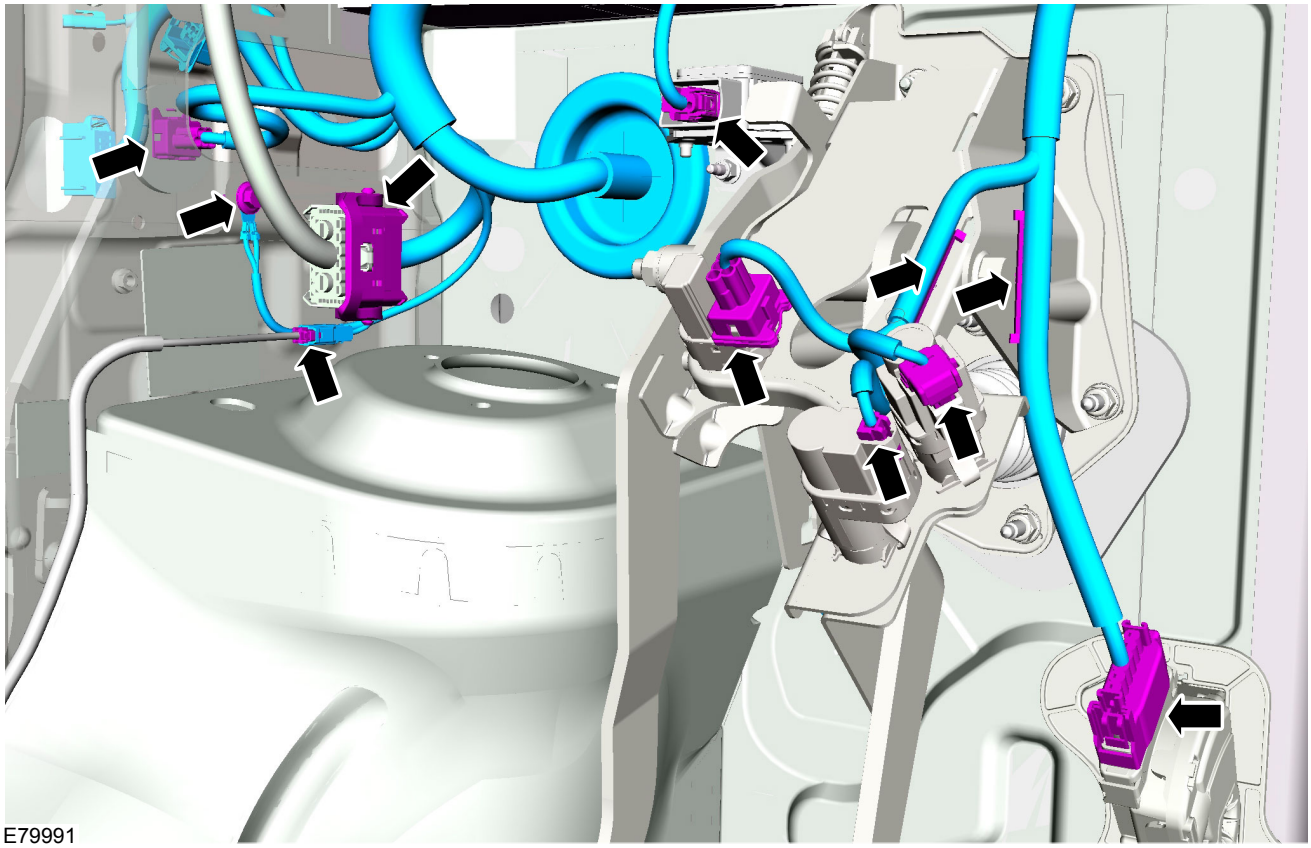
63. Torque: 8 Nm



64. Torque: 8 Nm

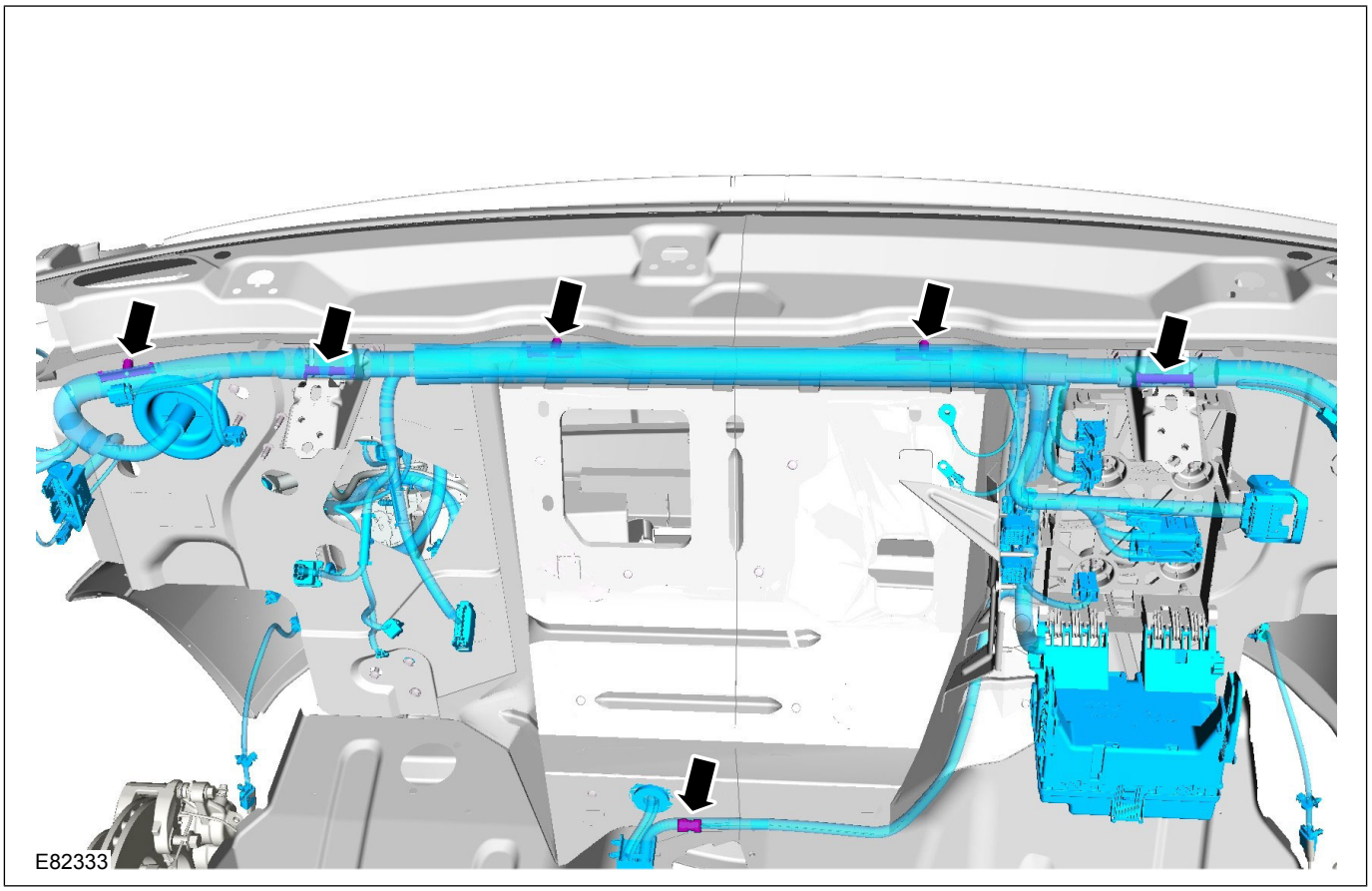


65. Torque: 8 Nm



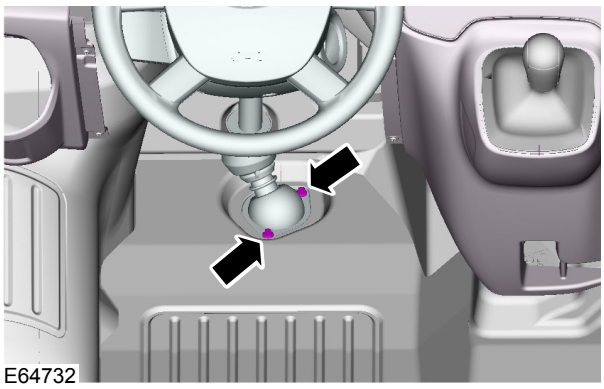
66.

REMOVAL AND INSTALLATION

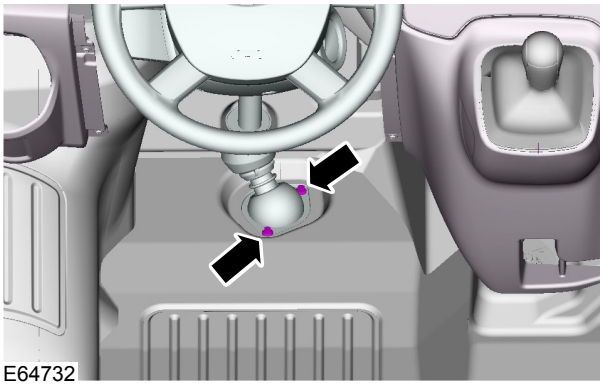


Installation

1. To install reverse the removal procedure.
2. Loosen the bolts four turns.



3. Start the engine, turn the steering wheel from lock to lock.
4. Torque: 12 Nm



REMOVAL AND INSTALLATION

5. Adjust the parking brake cable.

   Refer to:Parking Brake Cable Adjustment - Vehicles With: Rear Drum Brakes (206-05 Parking Brake and Actuation, General Procedures).
   Refer to:Parking Brake Cable Adjustment - Vehicles With: Rear Disc Brakes (206-05 Parking Brake and Actuation, General Procedures).
   Refer to:Parking Brake Cable Adjustment (206-05 Parking Brake and Actuation - Vehicles With: Parking Brake Assist, General Procedures).

REMOVAL AND INSTALLATION

Instrument Panel Wiring Harness

Removal

NOTE: Removal steps in this procedure may contain installation details.

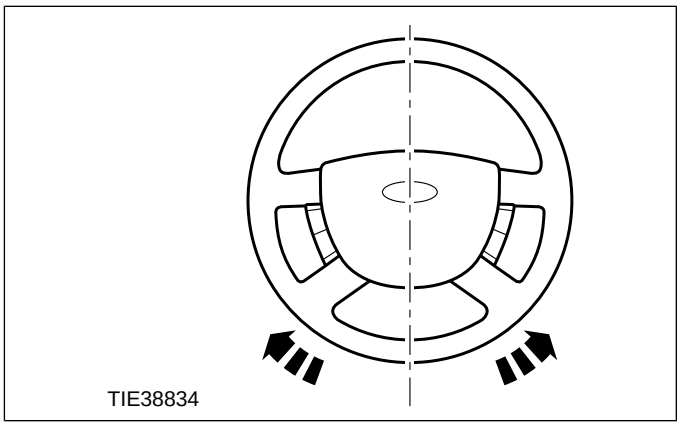
1. Refer to:Supplemental Restraint System (SRS) Health and Safety Precautions (100-00 General Information, Description and Operation).
2. Disconnect the battery ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).
3. Remove the audio unit.

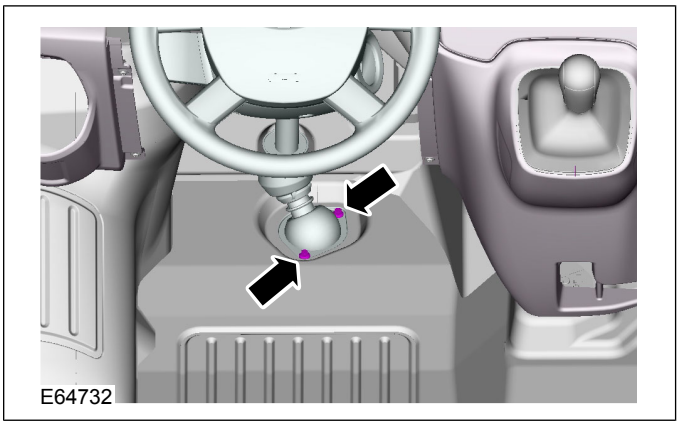
   Refer to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation).
4. Remove the left and right-hand A-pillar trim.

   Refer to:A-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
5. Remove the digital tachograph.

   Refer to:Digital Tachograph (413-17 Tachograph, Removal and Installation).
6. **NOTE:**Make sure that the road wheels are in the straight ahead position.

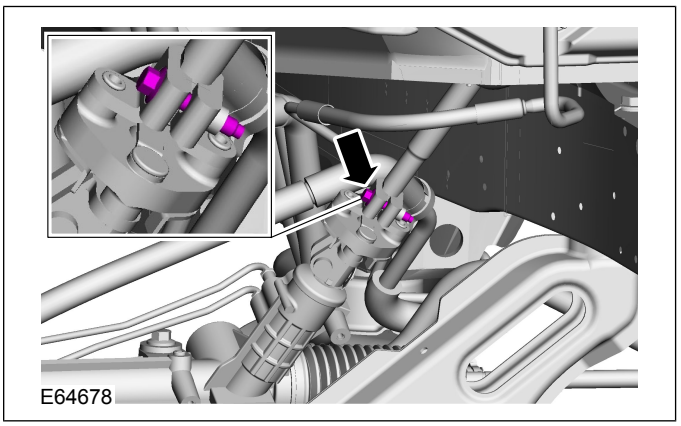


7. • Pull the footwell carpet to one side.
   • Torque: 12 Nm



8. Raise the vehicle.

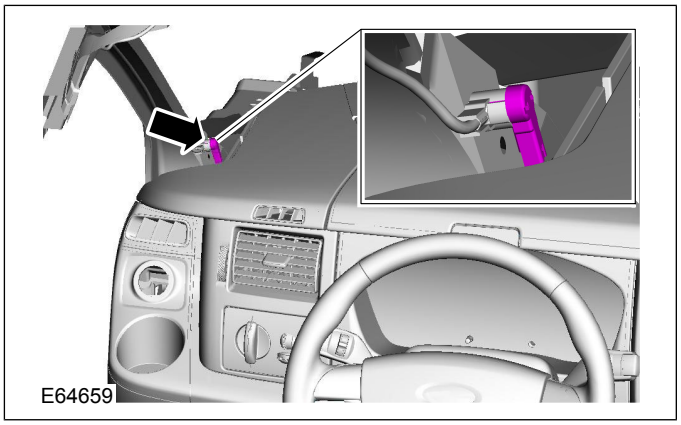
   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).
9. **CAUTION:Install a new bolt on the steering column shaft joint.**
   • Detach the steering column shaft joint from the steering column shaft.
   • Torque: 28 Nm



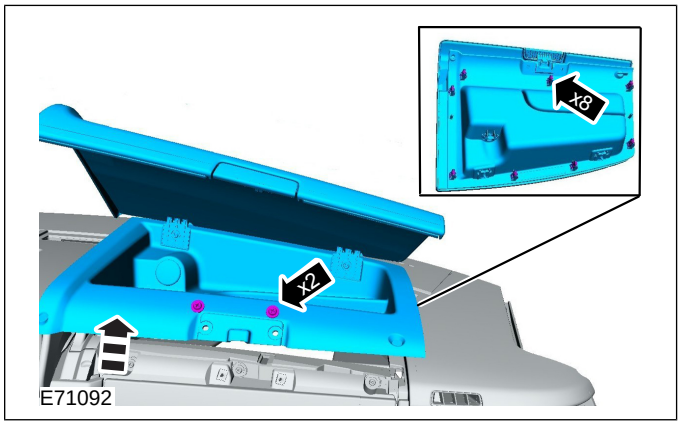
10. Lower the vehicle.

REMOVAL AND INSTALLATION

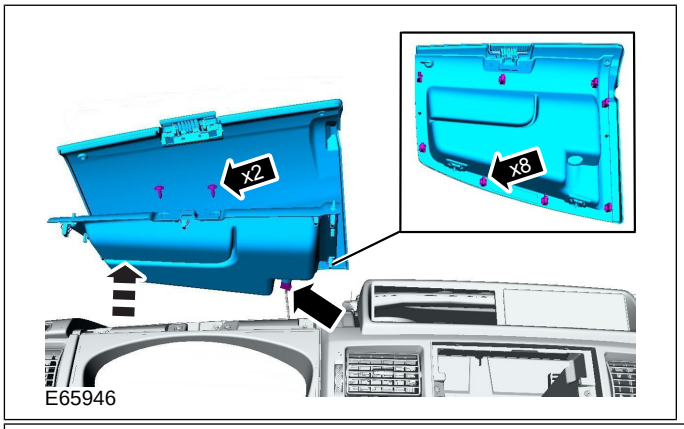
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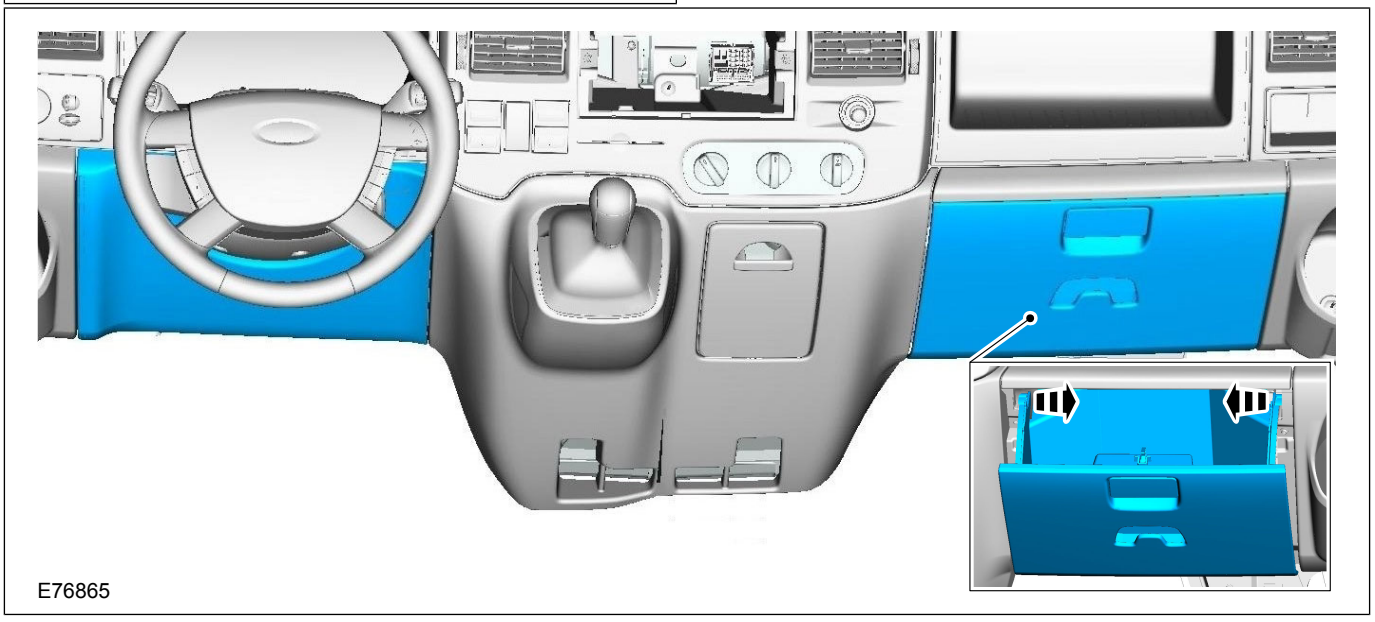
13.



12.

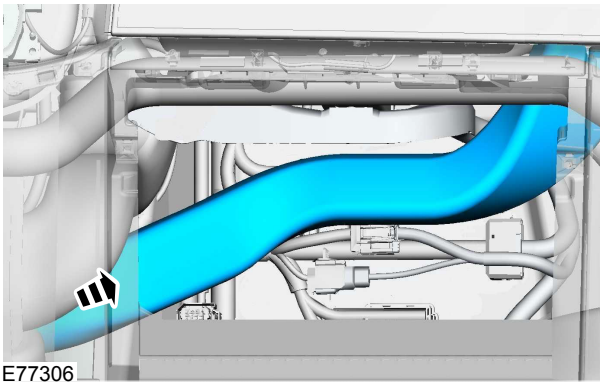


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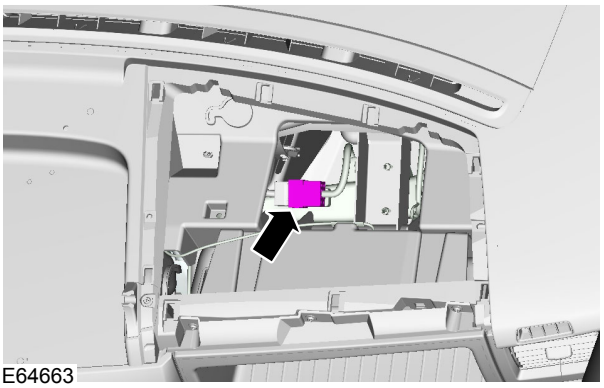


REMOVAL AND INSTALLATION

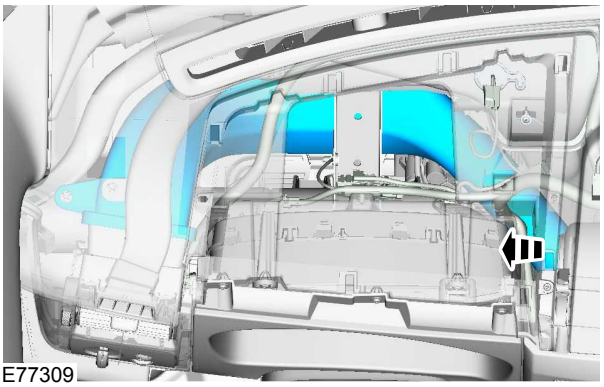
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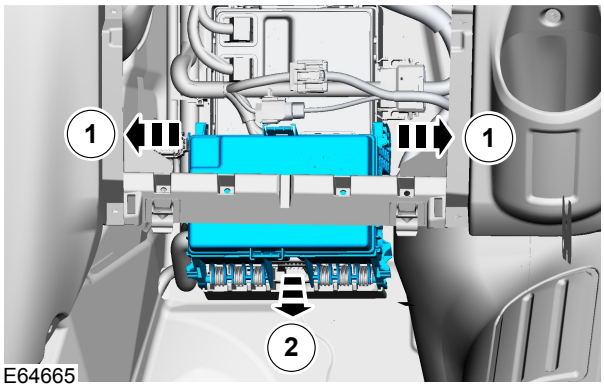
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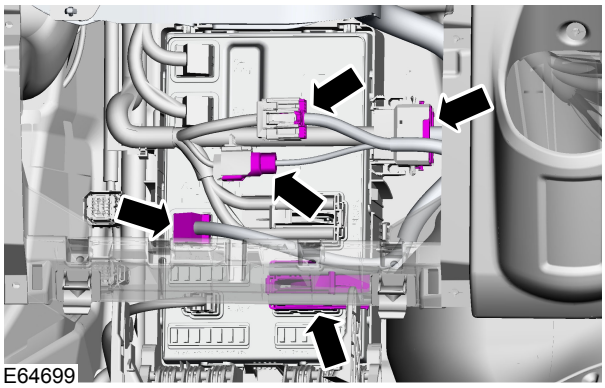
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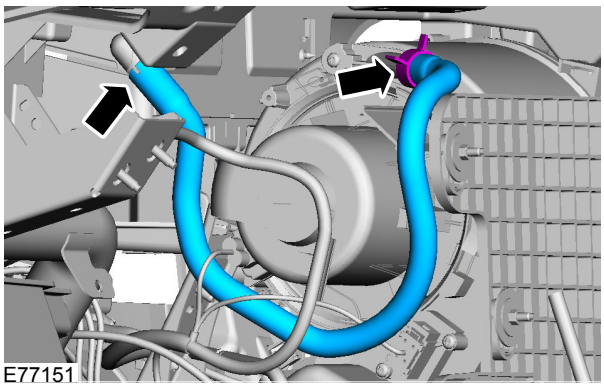
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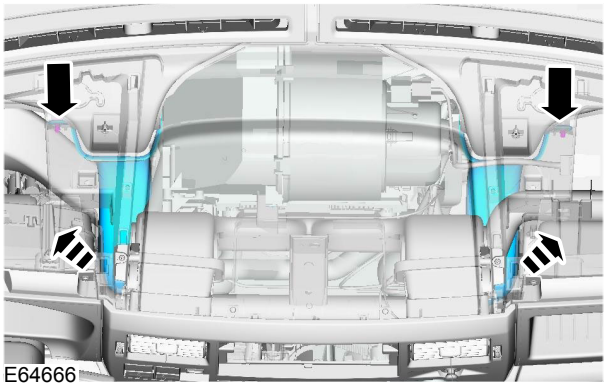


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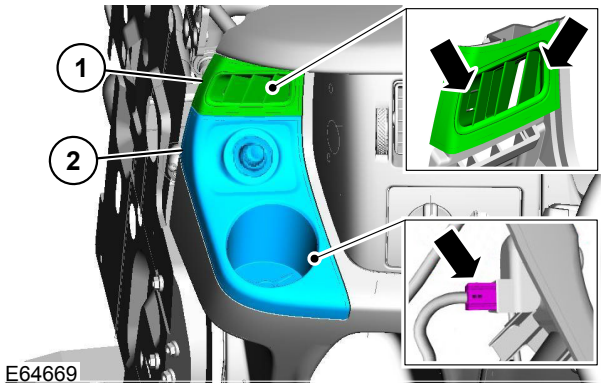


REMOVAL AND INSTALLATION

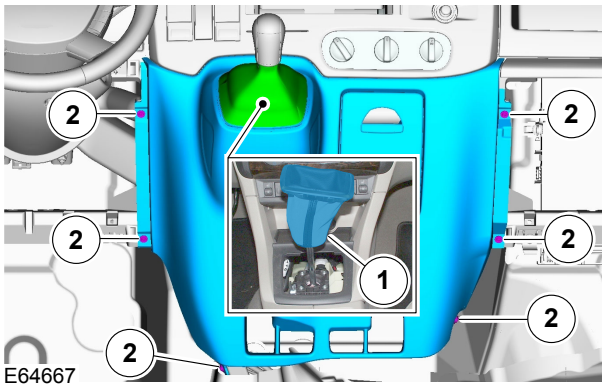
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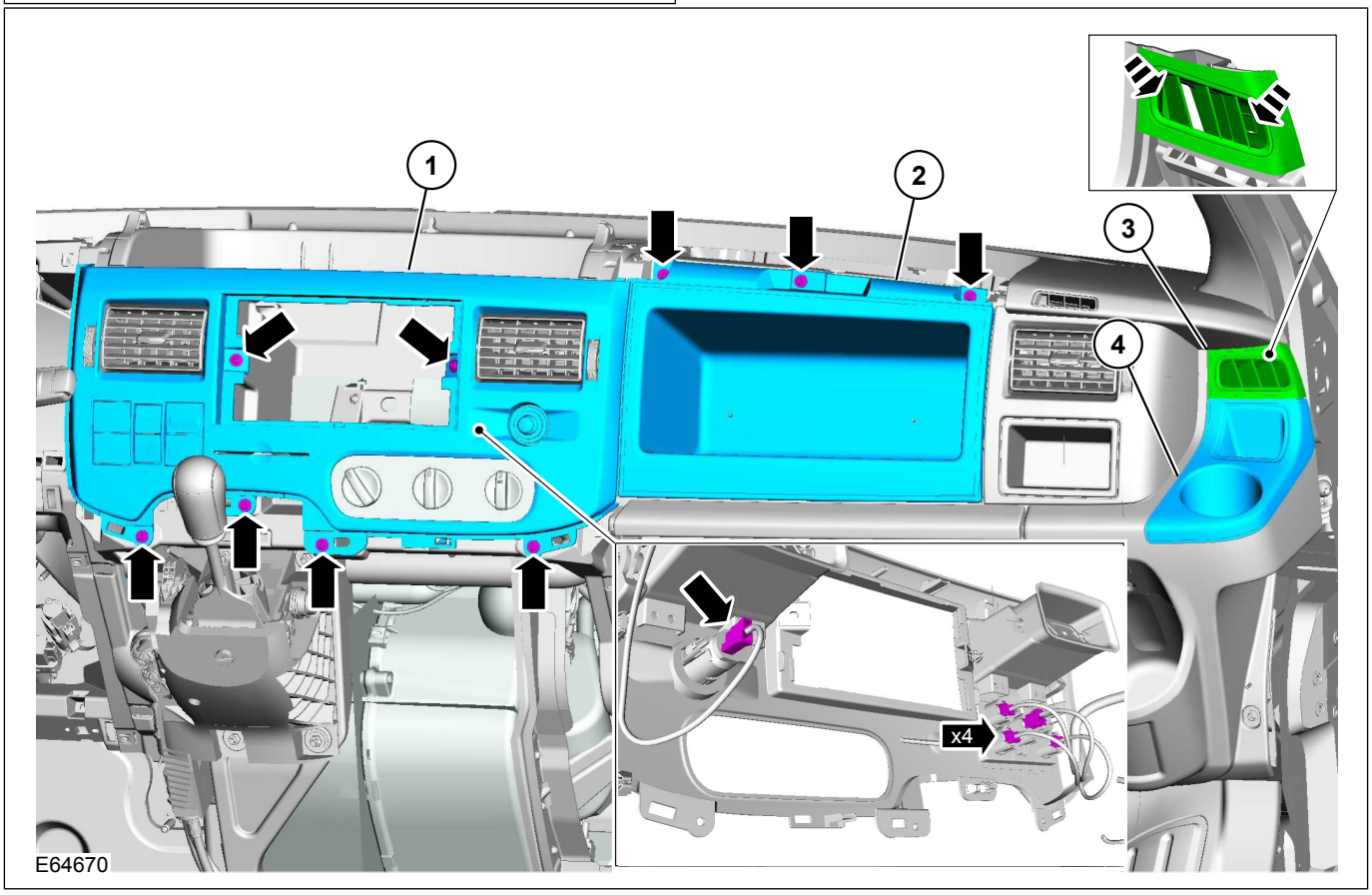
23.



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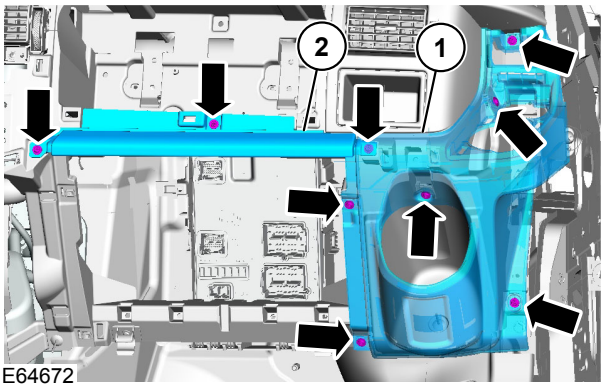


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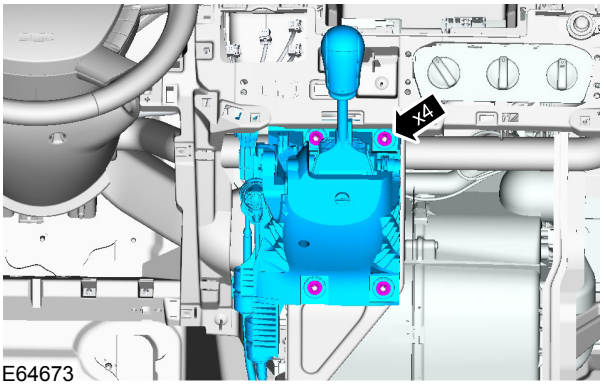


REMOVAL AND INSTALLATION

25.



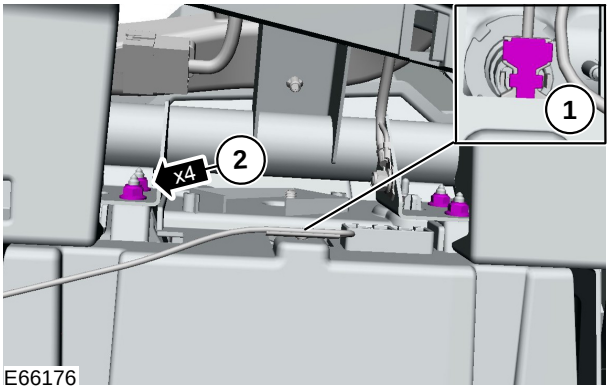
26. Torque: 9 Nm



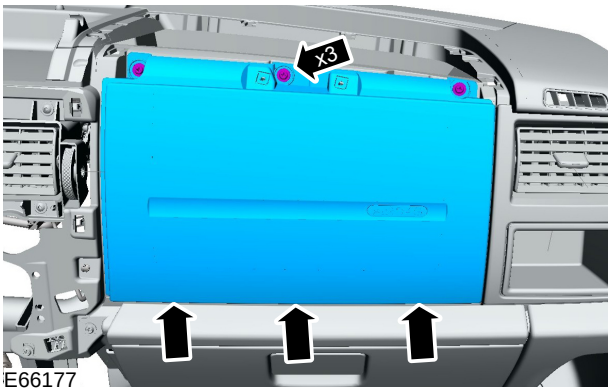
Vehicles with passenger air bag

27. **WARNING:The supplemental restraint system (SRS) is active for a certain length of time after the power supply has been disconnected. Wait for a minimum of 3 minutes before disconnecting or removing any SRS components.**

1. Torque: 8 Nm

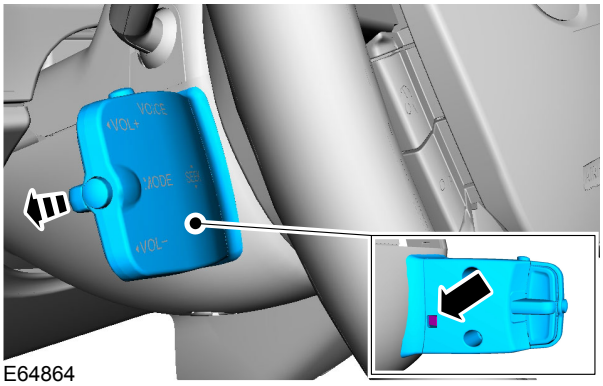


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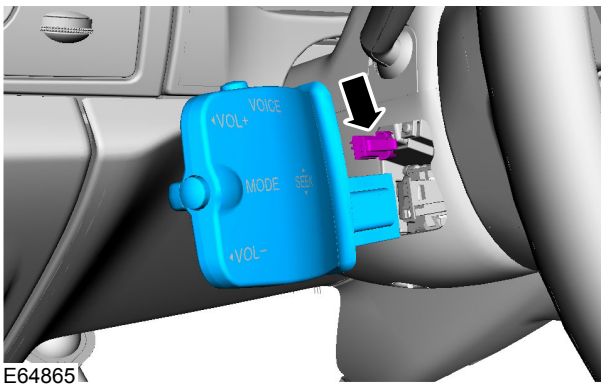


Vehicles with remote control for the audio unit

29.



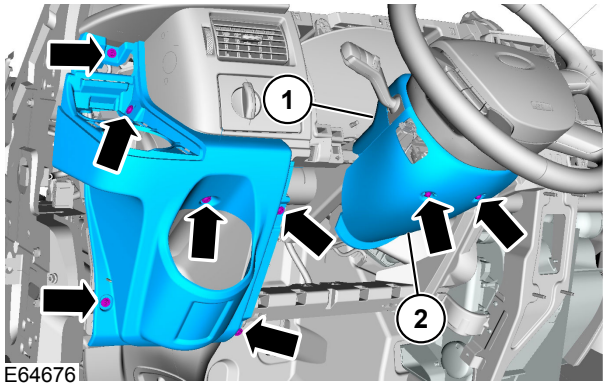
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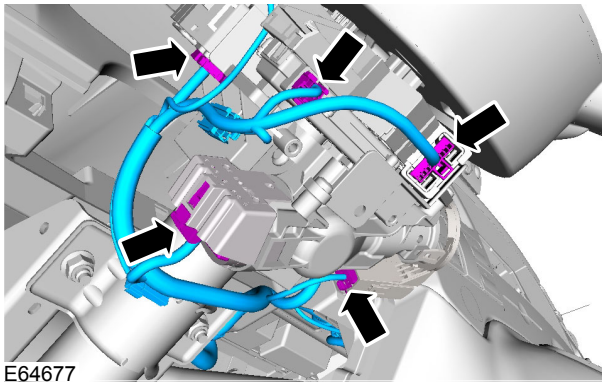
REMOVAL AND INSTALLATION

All Vehicles

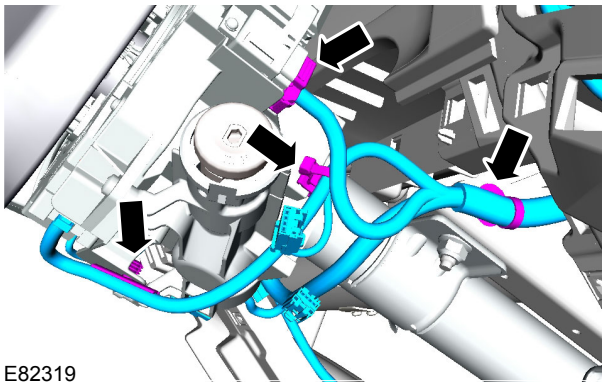
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32.

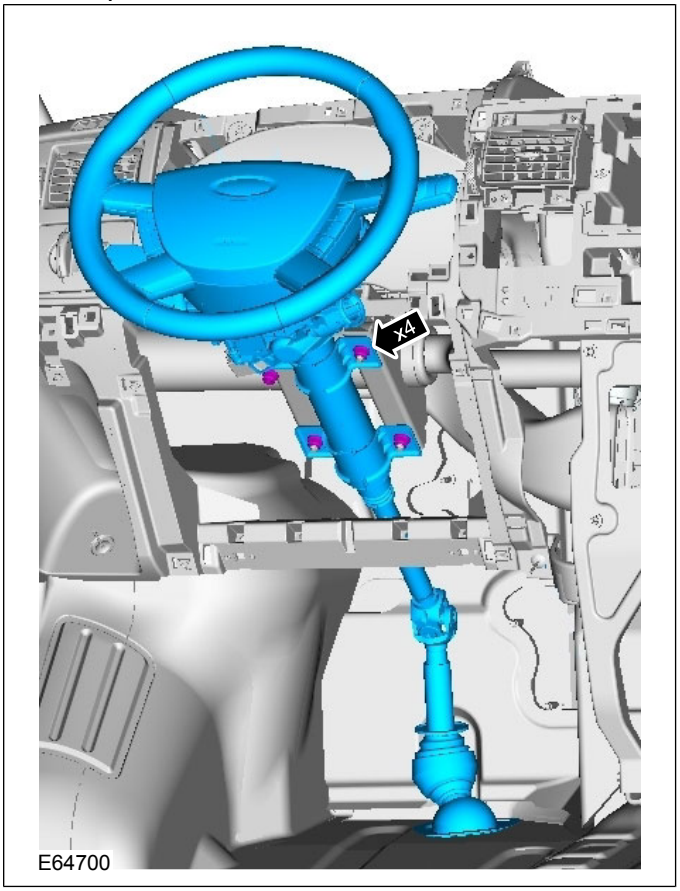


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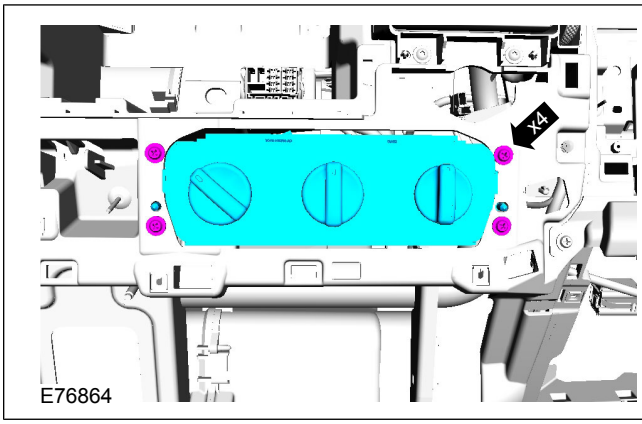


34. **WARNING:Make sure that new self-locking nuts are installed.**

Torque: 20 Nm

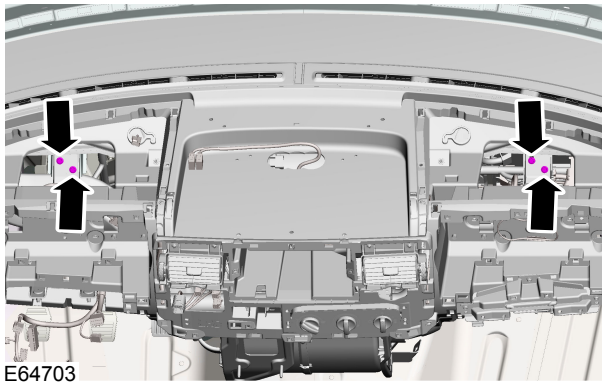


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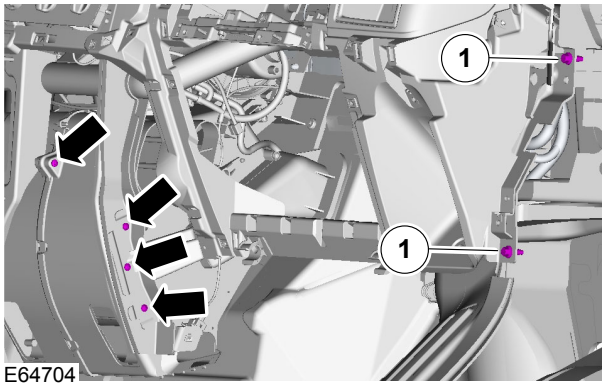


REMOVAL AND INSTALLATION

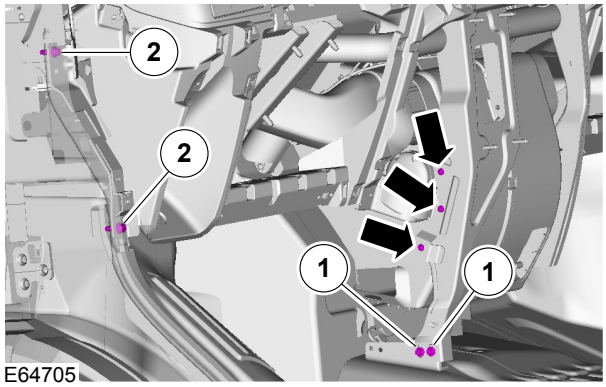
36. Torque: 20 Nm



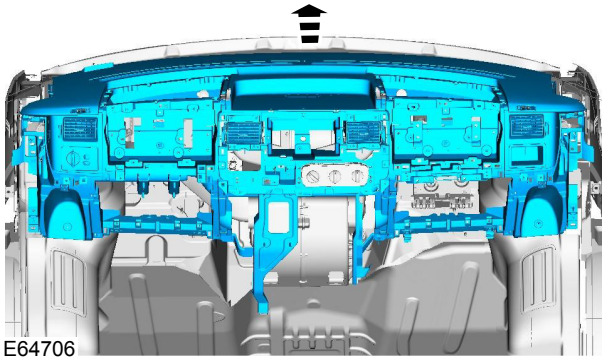
37. 1. Torque: 25 Nm



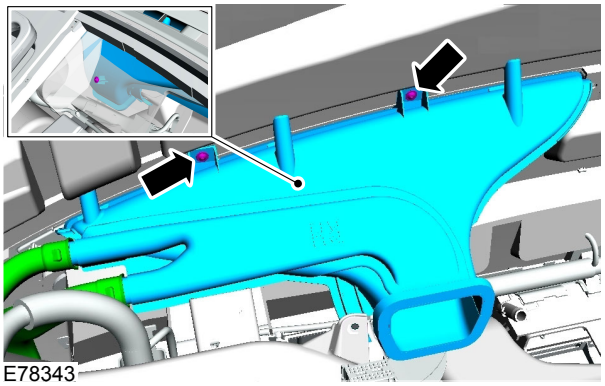
38. 1. Torque: 20 Nm
2. Torque: 25 Nm



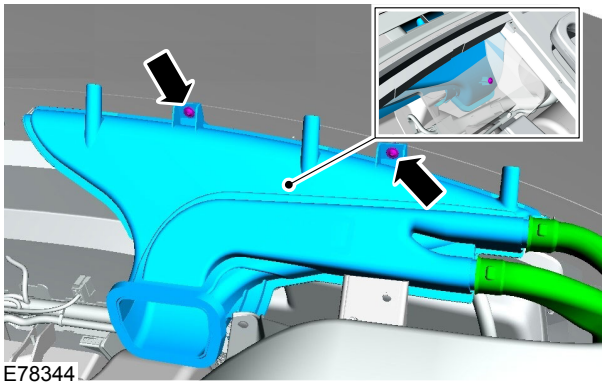
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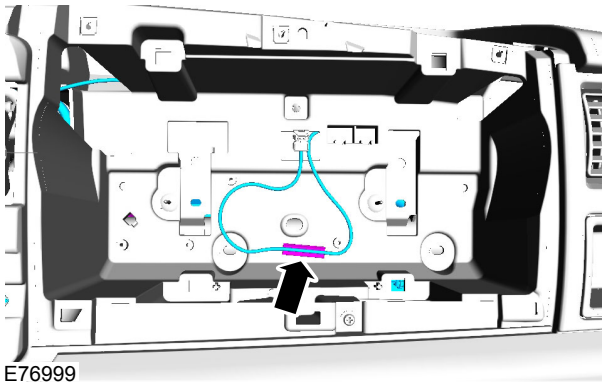


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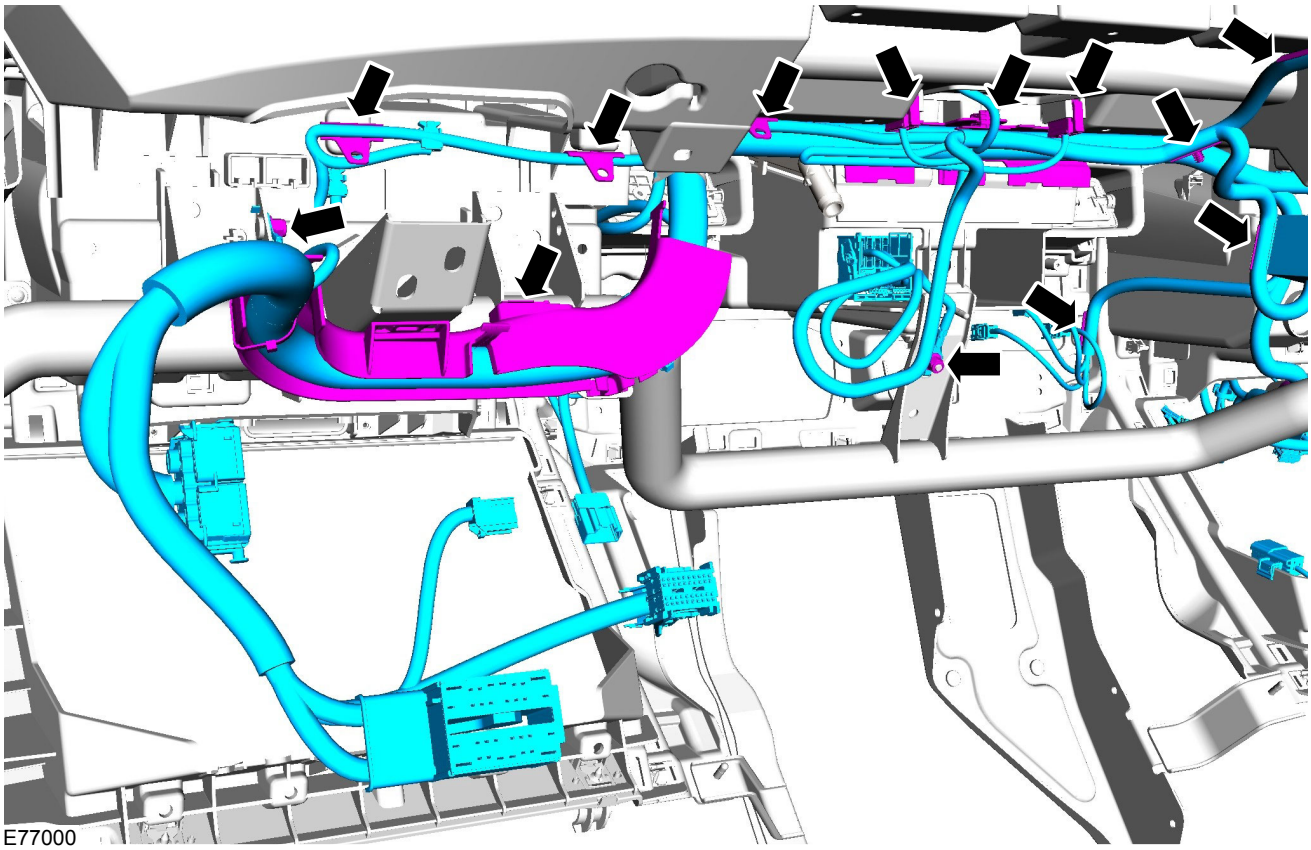


REMOVAL AND INSTALLATION

42.

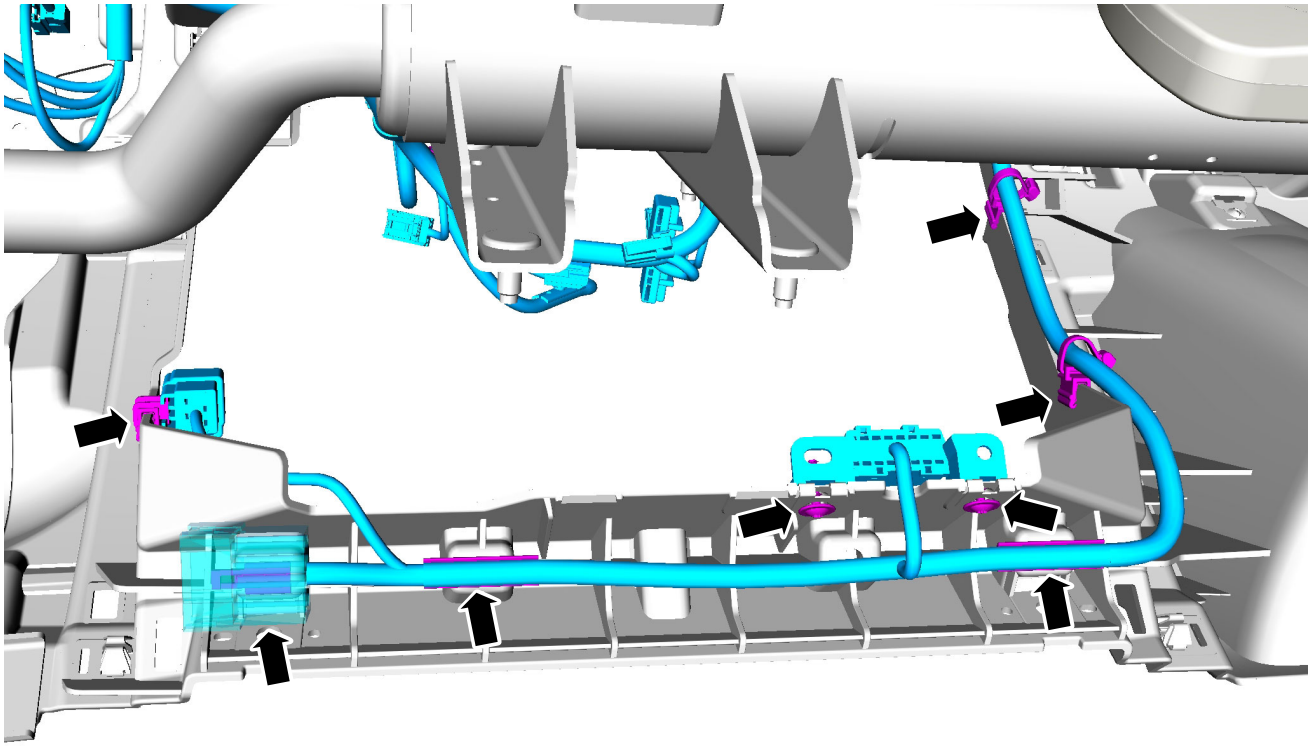

E76999

43. Torque: 8 Nm


E77000

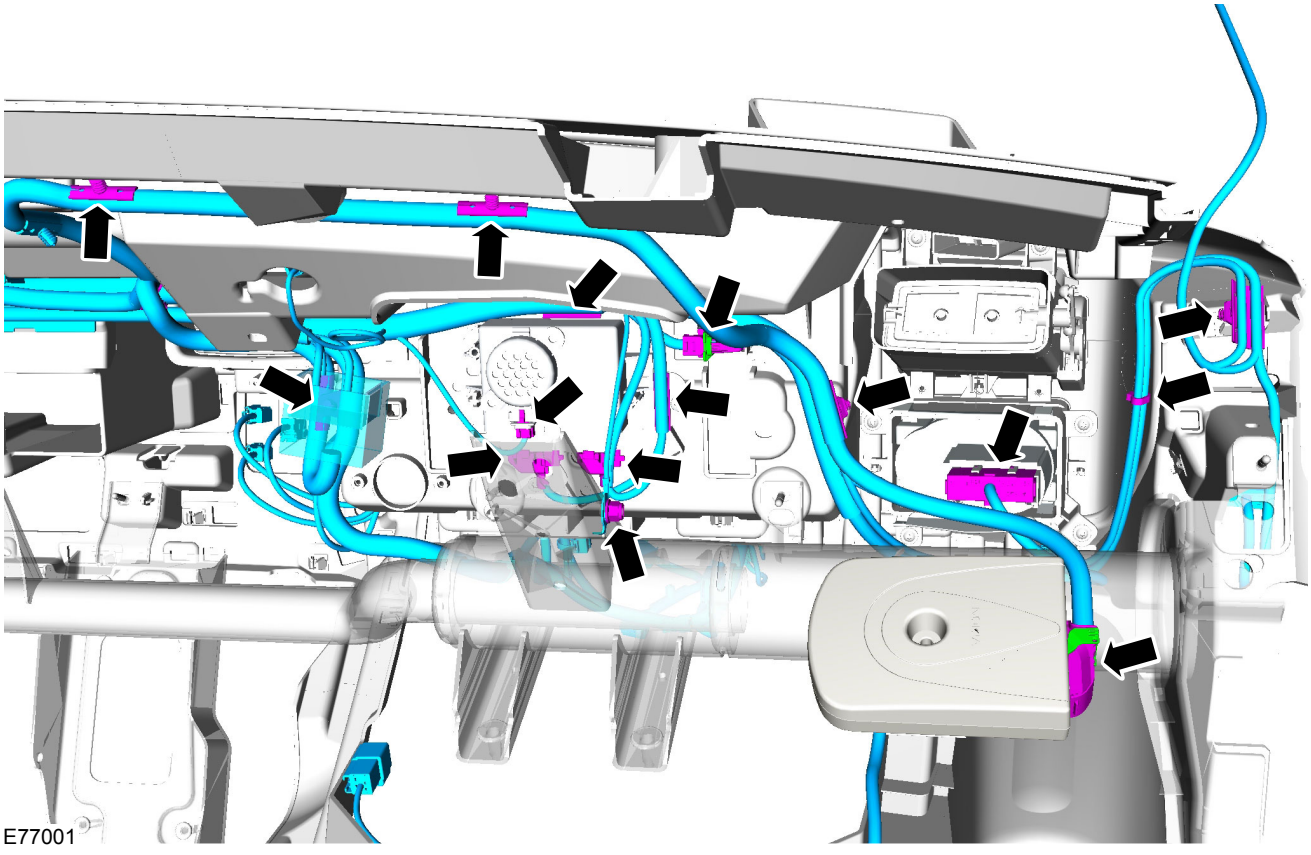
44.

REMOVAL AND INSTALLATION



E82675

45. Torque: 8 Nm

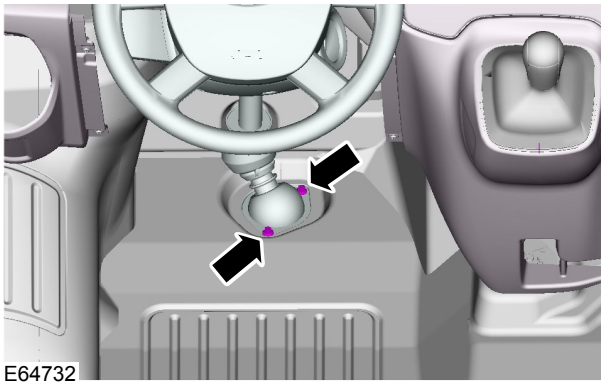


E77001

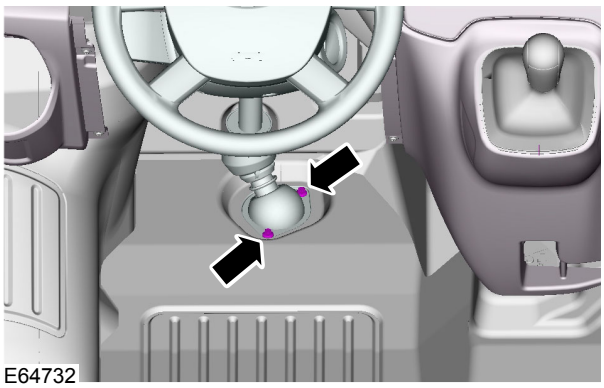
REMOVAL AND INSTALLATION

Installation

1. To install reverse the removal procedure.
2. Loosen the bolts four turns.



3. Start the engine, turn the steering wheel from lock to lock.
4. Torque: 12 Nm



SECTION 419-01 Anti-Theft - Passive

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Anti-Theft - Passive 419-01-2
Component location 419-01-2
Operation 419-01-2

DIAGNOSIS AND TESTING

Anti-Theft - Passive 419-01-4
Principles of Operation 419-01-4
Inspection and Verification 419-01-5
Symptom Chart 419-01-5

GENERAL PROCEDURES

Anti-Theft Security Access 419-01-7
Key and Remote Transmitter Programming Using Diagnostic Equipment 419-01-8
Erasing One or More Key Codes Using Diagnostic Equipment 419-01-9

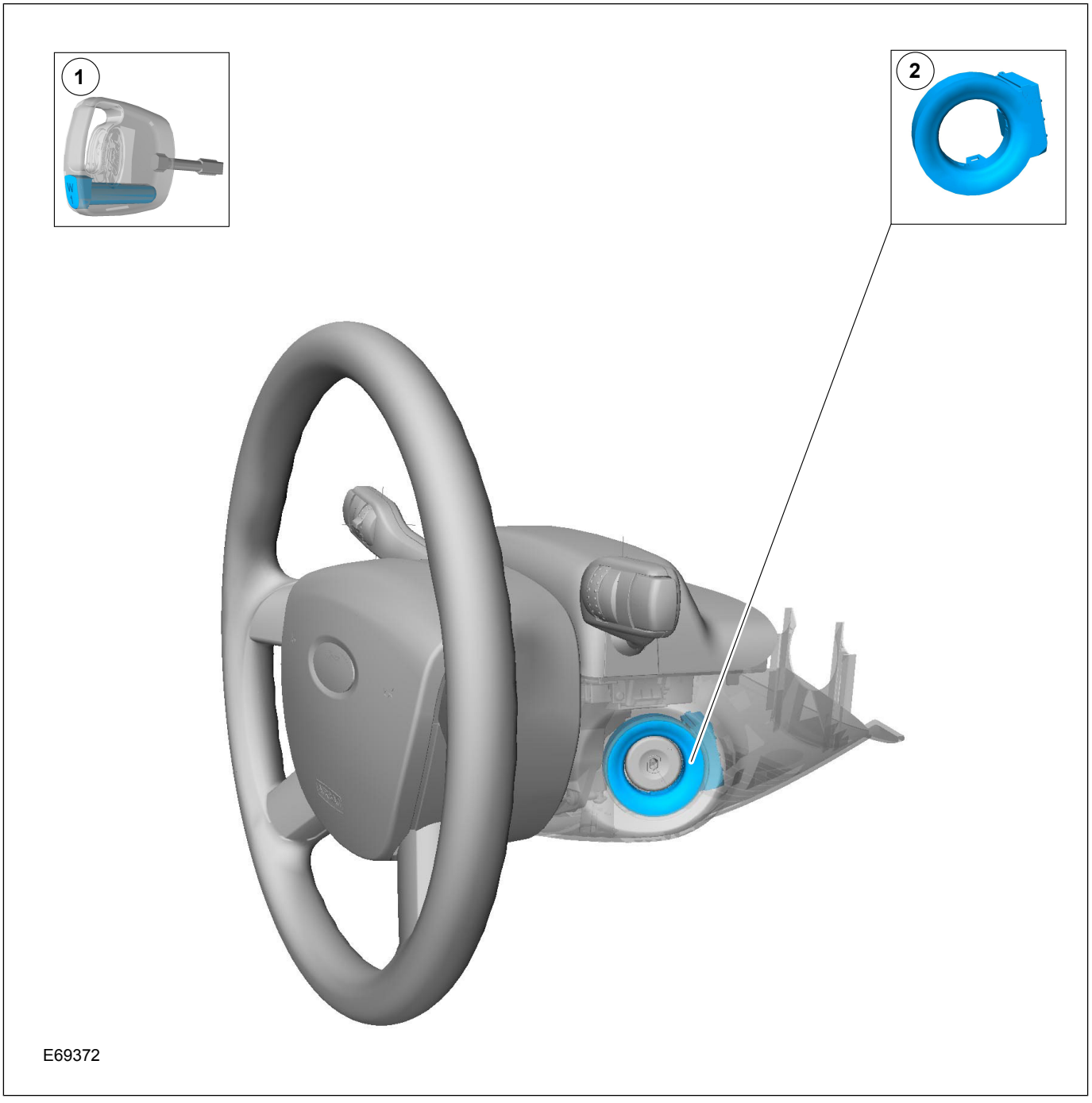
REMOVAL AND INSTALLATION

Passive Anti-Theft System (PATS) Transceiver 419-01-10

DESCRIPTION AND OPERATION

Anti-Theft - Passive

Component location



Item	Description
1	Passive anti-theft (PATS) transponder (within the ignition key)
2	PATS transceiver

Operation

PATS

The PATS is a passive system designed to increase the anti-theft security of the vehicle.

DESCRIPTION AND OPERATION

The PATS system uses specially encoded keys with a blue insert and the labelling W1.

The driver does not need to actively do anything to protect the vehicle. The PATS is activated automatically 5 seconds after the ignition is switched off.

System readiness is indicated by the PATS LED flashing every 2 seconds.

If a valid key is inserted into the ignition lock cylinder and turned to position II, the code from the PATS transponder is received by the PATS transceiver. The code is then sent to the passenger junction box (PJB) which checks that a correct key has been inserted and communicates with the powertrain control module (PCM) to enable the engine to start.

A maximum of 8 ignition keys can be programmed to a vehicle equipped with PATS.

If the code received by the PATS transceiver does not agree with any of the codes programmed to the vehicle, or if errors occur in the PATS, the engine cannot be started.

DIAGNOSIS AND TESTING

Anti-Theft - Passive

Refer to Wiring Diagrams Section419-01B,for schematic and connector information.

Principles of Operation

The ignition key on vehicles with a PATS system is identified by a blue insert. Previous ignition keys with a red insert are not compatible with this vehicle and must not be used.

Each ignition key must be programmed into the central junction box (CJB) using the WDS before it can be used to start the engine.

NOTE: If a there is concern within the PATS, when the ignition key is turned to the RUN or START position, the PATS light emitting diode (LED) may stay ON for one minute. If this condition occurs, less than the minimum number of ignition keys are stored in the CJB. This will cause the engine to start a total of six times only.

NOTE: If a non-programmed ignition key is used to attempt to start the engine, the ignition key must be left in the RUN or START position for a minimum of twenty seconds before any attempt is made to start the engine with the correct programmed ignition key.

The only method available to program a new ignition key to the PATS system, is by using the WDS to program the ignition key into the PATS.

REFER to:Key and Remote Transmitter Programming Using Diagnostic Equipment (419-01 Anti-Theft - Passive, General Procedures).

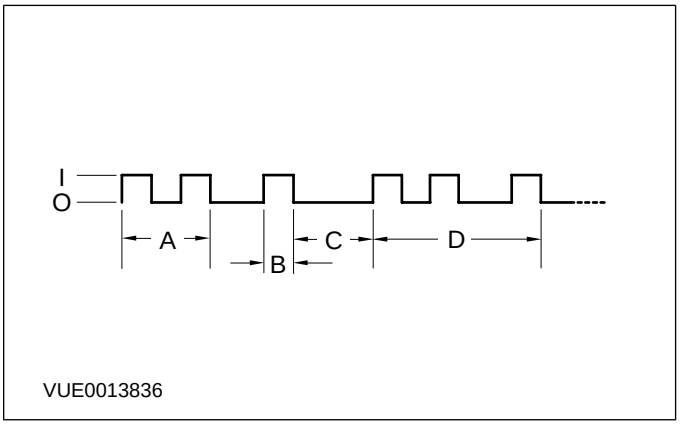
The PATS transceiver communicates with the transponder in the ignition key. The PATS transceiver is located around the ignition lock cylinder and contains an antenna connected to a small module. During each vehicle start sequence, the PATS transceiver reads the ignition key identification code and sends the data to the CJB.

The CJB carries out all of the PATS control functions, such as receiving the identification code from the ignition key and controlling engine enable. The CJB initiates the encoded ignition key interrogation sequence when the vehicle ignition switch is turned to RUN or START.

When the ignition key is turned to the OFF position, the CJB will remain powered up for approximately 0.16 milliseconds. This allows time for the CJB to store the rolling code in its memory.

The PATS uses a visual PATS LED which is situated within the instrument cluster. The PATS LED will self-test for three seconds when the ignition switch is turned to RUN or START under normal operation. The PATS also flashes the PATS LED every two seconds at ignition OFF to act as a visual deterrent.

The PATS LED also acts as a diagnostic lamp which will flash different codes depending on the PATS concern present. When the ignition key is turned to the RUN or START position and a PATS concern is present, the PATS LED will flash for one minute before flashing out the relevant fault code(s). It will flash the code(s) a total of ten times before resetting.



Code Flashing Example:

Code 21.

- 0 = LED OFF
- 1 = LED ON
- A = Two Flashes
- B = One Flash
- C= Three second delay period
- D = Repetition of flash code (10 times)

When the PATS LED begins to flash the code(s), it will indicate the first digit of the code by flashing in one second intervals until the number of flashes is equal to the first digit of the code. The PATS LED will then stop flashing for approximately two seconds before the second digit of the code(s) is displayed in the same way as the first. The PATS LED will then stop flashing for approximately three seconds before the process is repeated up to a total of ten times.

DIAGNOSIS AND TESTING

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Visual Inspection Chart

Mechanical	Electrical
– Ignition lock cylinder – PATS ignition key – Non-PATS ignition key – Unprogrammed ignition key – More than one PATS key on key chain	– Fuse(s) – Wiring harness – Electrical connector(s) – PATS transceiver – CJB

Symptom Chart

Symptom	Possible Sources	Action
• Engine does not turn over and the PATS LED is flashing code 11.	• PATS transceiver not connected.	• CHECK the PATS transceiver electrical connector for correct installation.
• Engine does not turn over and the PATS LED is flashing code 12.	• PATS transceiver.	• INSTALL a new PATS transceiver. REFER to: Passive Anti-Theft System (PATS) Transceiver (419-01 Anti-Theft - Passive, Removal and Installation).
• Engine does not turn over and the PATS LED is flashing code 13.	• No ignition key data was received. • The CJB has failed to correctly store an ignition key code.	• Non-PATS ignition key used. INSTALL a new ignition key. REFER to: Key and Remote Transmitter Programming Using Diagnostic Equipment (419-01 Anti-Theft - Passive, General Procedures).
• Engine does not turn over and the PATS LED is flashing code 14.	• Only part of the ignition key data was received.	• CHECK the PATS transceiver electrical connector for correct installation. • CHECK the battery voltage. • CHECK the ignition key. • REFER to the WDS.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Engine does not turn over and the PATS LED is flashing code 15.	• The ignition key being used does not match one of those stored in the CJB.	• PROGRAM the ignition key. REFER to:Key and Remote Transmitter Programming Using Diagnostic Equipment (419-01 Anti-Theft - Passive, General Procedures). If a non-matching ignition key was used, TURN the ignition ON for a minimum of 20 seconds before starting the engine with a correct ignition key. REFER to the WDS.
• Engine does not turn over and the PATS LED is flashing code 21.	• Less than the minimum number of ignition keys required for normal system operation is stored in the CJB.	• PROGRAM more ignition keys. REFER to:Key and Remote Transmitter Programming Using Diagnostic Equipment (419-01 Anti-Theft - Passive, General Procedures).
• Engine does not turn over and the PATS LED is flashing code 23.	• Ignition key status has not been sent to the CJB.	• REFER to the WDS.
• The PATS LED is always or never on - does not go out after three seconds when the ignition key is in the RUN or START position.	• Circuit. • PATS LED. • CJB.	• REFER to the WDS.

GENERAL PROCEDURES

Anti-Theft Security Access

General Equipment

Worldwide Diagnostic System (WDS)

NOTE: This procedure requires access to the Global Secure Vehicle Information System (GSEVIN) database in order to obtain the coded security access.

1. From the diagnostic tool menu Select: Body/Security/PATS Functions. Follow the instructions on the screen.

   General Equipment: Worldwide Diagnostic System (WDS)
2. • When installing a new passenger junction box (PJB), the following sequence must be completed:
   • 1. Ignition Key Programming.
   • 2. Module Initialization.
3. • When installing a new powertrain control module (PCM) the following must be completed:
   • 1. Module Initialization.

GENERAL PROCEDURES

Key and Remote Transmitter Programming Using Diagnostic Equipment

General Equipment

Worldwide Diagnostic System (WDS)

NOTE: This procedure requires access to the Global Secure Vehicle Information System (GSEVIN) database in order to obtain the coded security access.

NOTE: This procedure will not erase programmed ignition keys from the passive anti-theft system (PATS).

NOTE: A maximum of 8 ignition keys can be programmed to a vehicle equipped with a passive anti-theft system (PATS).

1. From the diagnostic tool menu Select: Body/Security/PATS Functions. Follow the instructions on the screen.

   General Equipment: Worldwide Diagnostic System (WDS)

2. From the diagnostic tool menu Select: Ignition Key Programming. Follow the instructions on the screen.

GENERAL PROCEDURES

Erasing One or More Key Codes Using Diagnostic Equipment

General Equipment

Worldwide Diagnostic System (WDS)

NOTE: This procedure requires access to the Global Secure Vehicle Information System (GSEVIN) database in order to obtain the coded security access.

NOTE: A minimum of 2 ignition keys with the correct mechanical cut must be available to carry out a key programming procedure.

NOTE: Make sure that all the ignition keys for the vehicle are available before carrying out this procedure.

1. From the diagnostic tool menu Select: Body/Security/PATS Functions. Follow the instructions on the screen.

   General Equipment: Worldwide Diagnostic System (WDS)

2. From the diagnostic tool menu Select: Ignition Key Erase. Follow the instructions on the screen.

REMOVAL AND INSTALLATION

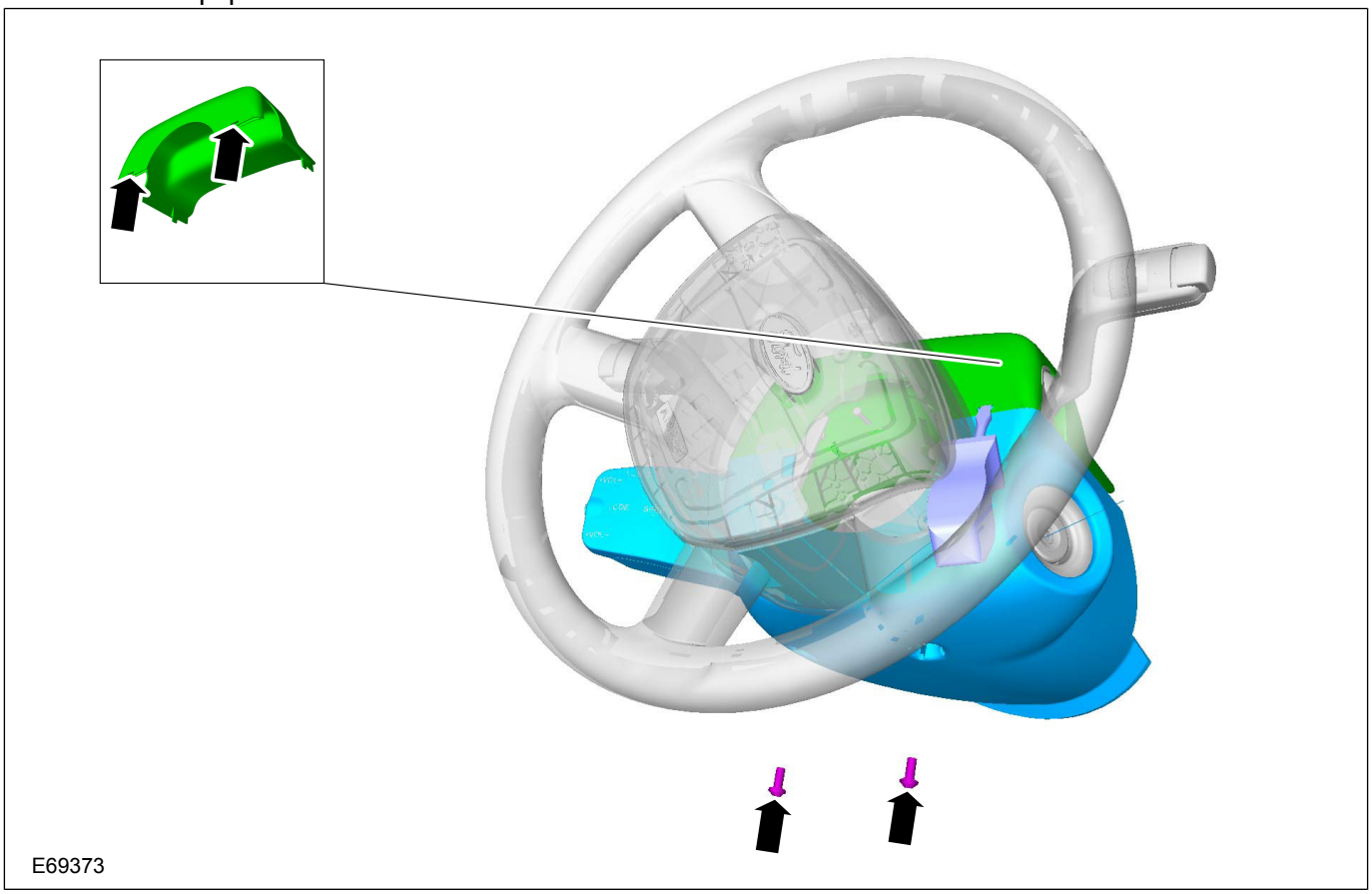
Passive Anti-Theft System (PATS) Transceiver

General Equipment

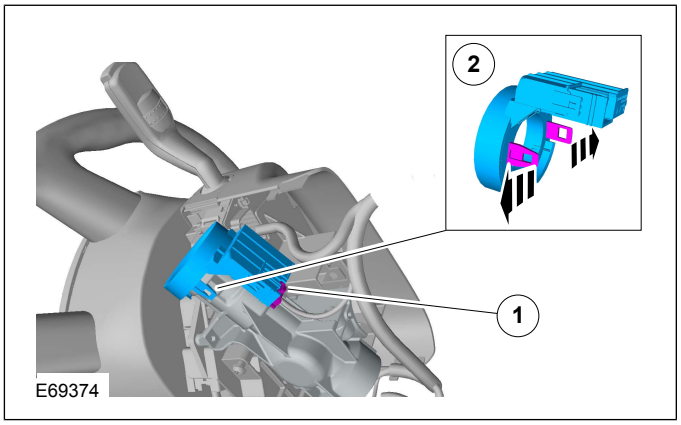
Flat-bladed screwdriver

Removal

1. General Equipment: Flat-bladed screwdriver



2.



Installation

1. To install, reverse the removal procedure.

SECTION 419-10 Multifunction Electronic Modules

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

DESCRIPTION AND OPERATION

Module Controlled Functions..... 419-10-2
GEM..... 419-10-2
Automatic headlamps..... 419-10-2
Headlamp switch-off delay..... 419-10-2
Combined rain sensor/light sensor..... 419-10-3
Interior lighting..... 419-10-3
Battery protection function..... 419-10-4
Heated windscreen..... 419-10-4
Heated rear window and heated external mirrors..... 419-10-5
Windshield wash/wipe system..... 419-10-5
Mode of operation of the rain sensor..... 419-10-6
Rear window wash/wipe system..... 419-10-7
Speed control system..... 419-10-8
central door locking..... 419-10-8
Key-free vehicle system..... 419-10-10
PATS..... 419-10-11
Recharging function for the remote control..... 419-10-11
Smart Charge system..... 419-10-11
Ambient air temperature..... 419-10-12
Ignition overload protection..... 419-10-12
Electric window regulators..... 419-10-12
Brake fluid level..... 419-10-12
Energy management..... 419-10-12
Hazard warning lights for an accident..... 419-10-13
Emergency function..... 419-10-13
Service mode..... 419-10-13
Module Configuration..... 419-10-14

DIAGNOSIS AND TESTING

Generic Electronic Module (GEM)..... 419-10-16
Description of operation..... 419-10-16
Inspection and Testing..... 419-10-17
Diagnostic Trouble Code (DTC) Table..... 419-10-18
Symptom chart..... 419-10-23
Pinpoint test..... 419-10-23

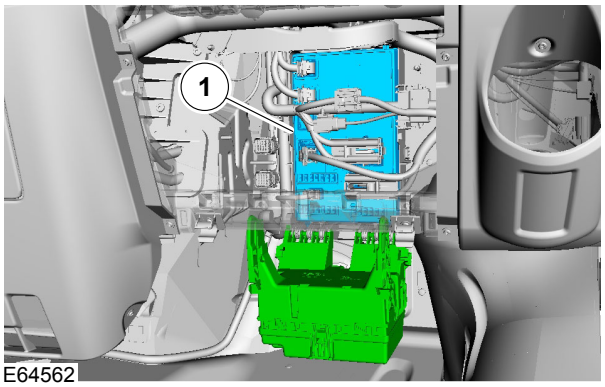
REMOVAL AND INSTALLATION

Generic Electronic Module (GEM)..... 419-10-26

DESCRIPTION AND OPERATION

Module Controlled Functions

GEM.



The generic electronic module (GEM) is installed on the passenger side underneath the dashboard.

It replaces separate components such as the central locking module, the timer relay and the fuse box in the passenger compartment.

The generic electronic module (GEM) comprises a power distribution section (including fuses and relays) and an electronic control module, which controls the operation of most of the electronic convenience systems.

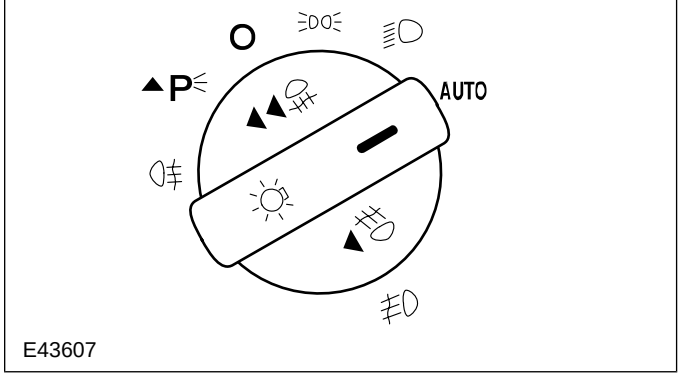
Three different generic electronic modules are fitted depending on the equipment featured in the vehicle. In service only the variant for the maximum equipment level is available.

All of the GEM variants include a clock and an alarm function which transmits the clock time to other modules via the CAN network.. The clock time is adjusted via the radio or the instrument cluster.

The following functions are performed or controlled by the generic electronic module (GEM):

- Current distribution
- External lighting (certain external lighting functions operate via cable connections from the light switch)
- Interior lighting
- Wipers
- Heated windshield
- Speed control system (reads the speed control switches and transmits signals on the CAN bus)
- Parking aid
- Locking / Unlocking
- Anti-theft
- Handbrake (it monitors the switch and transmits the signal on the CAN bus)
- Monitoring of the brake fluid level.
- Fuel pump (petrol engines only)
- Fuel gauge
- Interrogation of the ambient temperature sensor
- Battery charging (smart charge, partially)
- Electric booster heater
- Communications via the mid-speed CAN bus

Automatic headlamps



The dipped beam headlamps, side lights and license plate lamps are switched on automatically if all of the following conditions are satisfied:

- Ignition switch in the "II" or "III" position
- Light switch in the "AUTO" position
- Detected ambient light conditions below a stored threshold value

The dipped beam, the side lights and the license plate lamps are switched on or off by the generic electronic module (GEM) according to the input signals of the combined rain sensor/light sensor. This takes place in the generic electronic module (GEM) by activating the dipped beam relay and the automatic headlamps relay (side lights/license plate lamps).

Headlamp switch-off delay

The headlamp switch-off delay function uses the dipped beam headlamps to illuminate the area surrounding the vehicle. The side lights and the license plate lamps are also switched on.

DESCRIPTION AND OPERATION

The function is activated by switching on the main beam headlamps with the ignition key removed from the lock.

The headlamp switch-off delay function is active for 30 seconds and then switches off automatically.

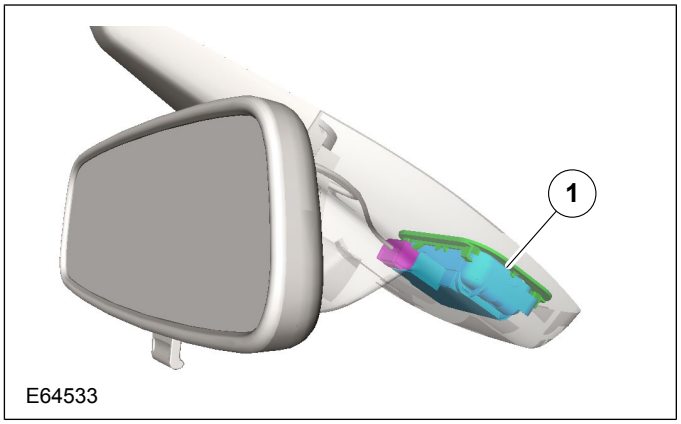
When a door or the tailgate is open, the switch-off time is extended to 180 seconds. After the last door has been closed, the switch-off time is reset to 30 seconds.

The headlamp switch-off delay can be deactivated prematurely by operating the high beam lever again or by switching on the ignition.

The switch-off time is set at the factory and can be reprogrammed to a maximum of 180 seconds using WDS.

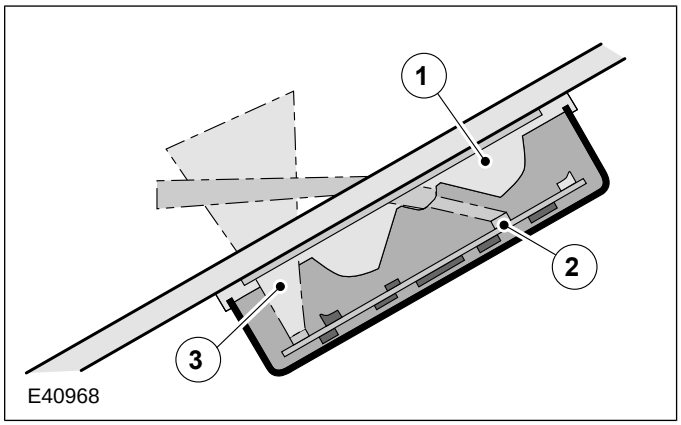
Combined rain sensor/light sensor

The combined rain sensor/light sensor (1) is attached to the windshield, near to the interior rear view mirror.



The ambient light sensor determines the general light intensity. For this purpose, it records the light over as wide an angle as possible, without taking the direction of incidence into account.

The front light sensor determines the light intensity directly in front of the vehicle.



Item	Description
1	Lens
2	Front light sensor
3	Ambient light sensor

If both the ambient light sensor and the front light sensor detect a sudden reduction in light intensity at the same time, then an algorithm-based calculation is used to determine the fact that the vehicle has entered a tunnel, a multi-storey car park or a long underpass.

In this case, the request for switching on the exterior lighting and the indicator light in the instrument cluster is transmitted to the generic electronic module (GEM.

If the vehicle enters into the shade thrown by a large truck, the two sensors will register different light intensities.. In this case, the algorithm-based calculation will not result in the lights being switched on.

Interior lighting

Depending upon vehicle specification, the interior lighting controlled by the generic electronic module (GEM) comprises:

- Left and right-hand footwell lamps
- Front and rear dome lamps (in "door contact" switch position)

Depending upon vehicle specification, the interior lamps which can be switched by the operator include:

- Front and rear dome lamps (in "On" switch position)
- Map lights
- Mirror lights in sun visors
- Glove compartment lamp
- Luggage compartment lamp

DESCRIPTION AND OPERATION

The interior lighting controlled by the generic electronic module (GEM) is switched on if one of the following conditions is satisfied:

- One of the vehicle's doors is opened.
- The ignition key is in the "0" or "I" position and the vehicle is unlocked.
- The ignition key is turned from the "II" to the "I" or "0" position.

The interior lighting controlled by the generic electronic module (GEM) is switched off if all doors are closed and one of the following conditions is satisfied:

- 25 seconds have elapsed since the last door was closed.
- The ignition key is turned from the "0" or "I" to the "II" position.
- The ignition key is in the "0" or "I" position while the vehicle is locked.

The dimmer function is not used if the interior lighting is switched off via the battery protection function.

Battery protection function

In order to prevent the battery from discharging due to permanently switched on current consumers, the left and right-hand footwell lamps and the front and rear dome lamps (in "door contact" switch position) are switched off by the generic electronic module (GEM) after 10 minutes.

After 30 minutes, the interior lamps which can be switched by the driver (map reading lamps, mirror lights in the sun visors, glove compartment lamp, luggage compartment lamp) as well as the auto-dimming interior mirror (if equipped) are switched off by the power-saving relay.

In addition, all warning signals from the generic electronic module (GEM) are deactivated after 30 minutes.

The timer is activated if the ignition switch is turned to the "0" or "I" position.

If the interior lamps are switched off due to the battery protection function, they will be switched on again if any of the following conditions is satisfied:

- the ignition switch is turned to the "II" or "III" position
- a door (including the boot or liftgate) is ajar or opened.
- A lock is released.

In this case, the timer is reset again.

Furthermore, the battery protection function is activated by the generic electronic module (GEM) when the threshold value for low battery voltage is reached.

Heated windscreen

The heated windshield is switched on by the generic electronic module (GEM) under the following conditions:

- The heated windscreen switch has been pressed, the ignition switch is in the position "II" and the charge warning lamp is off.
- The "defrost" function of the EATC (electronic automatic temperature control) has been activated, the ignition switch is in the "II" position and the charging system warning indicator light is switched off.
- The battery voltage has exceeded 16 V for more than 20 seconds (power management strategy). Manual requests for switching off the heated windshield by pressing the switch, are ignored at this time.

If the battery voltage returns to the normal range, disabling of the heated windshield is cancelled. It is then switched on, if it was previously switched on by the driver and if 4 minutes have not yet elapsed since actuation of the heated windshield switch.

The heated windshield is switched off by the generic electronic module (GEM) under the following conditions:

- If more than 4 minutes have elapsed since actuation of the heated windshield switch.
- The ignition switch is turned to the "I" or "0" position.
- The "Defrost" function is deactivated or the switch for the heated windscreen is pressed again while the heated windscreen is still switched on.
- The charging system warning indicator is switched on.
- The battery voltage falls below the threshold value for low battery voltage for more than 20 seconds (power management strategy). Manual requests for switching on the heated windshield by pressing the switch, are ignored at this time.

If the battery voltage returns to the normal range, disabling of the heated windshield is cancelled. It is then switched off.

DESCRIPTION AND OPERATION

Heated rear window and heated external mirrors

The heated rear window and the heated exterior mirrors are switched on by the generic electronic module (GEM) under the following conditions.

- The switch for the heated rear window is pressed and the ignition switch is in the "II" position.
- The "defrost" function of the air conditioning is activated and the ignition switch is in the position "II".
- The battery voltage has exceeded 16 V for more than 20 seconds (power management strategy). Manual requests to switch off the heated rear window by pressing the button are ignored at this time.

If the battery voltage returns to the normal range, disabling of the heated rear window is cancelled. It is then switched on, if it was previously switched on by the driver and if 14 minutes have not yet elapsed since actuation of the heated windshield switch.

On vehicles with door modules, the generic electronic module (GEM) transmits the request signal for switching on the heated exterior mirrors to the door modules via the CAN bus.

The heated rear window and the heated exterior mirrors are switched off by the generic electronic module (GEM) under the following conditions

- If more than 14 minutes have elapsed since actuation of the heated rear window switch.
- The ignition switch is turned to the "0" or "I" position.
- The switch for the heated rear window is pressed or the "defrost" function of the air conditioning is deactivated while the heated rear window is switched on.
- The battery voltage has dropped below 10.3 V for more than 20 seconds (power management strategy). Manual requests for switching on the heated rear window by pressing the switch, are ignored at this time.

If the battery voltage returns to the normal range then the disabling of the heated rear window is cancelled - the heated rear window is then switched off.

On vehicles with door modules, the generic electronic module (GEM) transmits the request signal for switching off the heated exterior mirrors to the door modules via the CAN bus.

Windshield wash/wipe system

The windshield wash/wipe system will only operate if the ignition switch is in the "II" or "III" position.

Four wash functions are available: "Single wipe", "Speed 1", "Speed 2" and "Intermittent" or "Automatic wipe" (depending on the vehicle specification).

In "Speed 1" or "Speed 2" mode, the wipers are operating continuously at either normal speed or fast speed.

When the intermittent wipe mode is switched on the windshield wipers operate at normal speed with the following wiper delays:

- Wiper delay 1: 1 second
- Wiper delay 2: 3.5 seconds
- Wiper delay 3: 6 seconds
- Wiper delay 4: 9,5 seconds
- Wiper delay 5: 15.5 seconds
- Wiper delay 6: 22 seconds

NOTE: In the event of a failure, or if the control resistor is not connected the default time for the wiper delay is 8 seconds.

When the windshield washer switch is operated washer fluid is sprayed onto the windshield. After a short delay designed to protect the wiper blades the wipers perform 2 or 3 wipes at low speed.

If when the windshield washer switch is activated the windshield wipers are switched off, then a single wipe is performed 4 seconds after the wipers have returned to the home position after performing the 2 or 3 wipes.

If when the windshield washer switch is activated the wipers are in intermittent mode, and if the selected wiper delay time is longer than 6 seconds, then a single wipe is performed 6 seconds after the wipers have returned to the home position after performing the 2 or 3 wipes. If an interval of less than 6 seconds is selected, no after-wipe is performed.

The post wipe function on the windshield ensures that any water remaining on the windshield after washing is wiped away. It is only required if the wipers are switched off or they are set to intermittent mode.

Automatic windscreen wipers

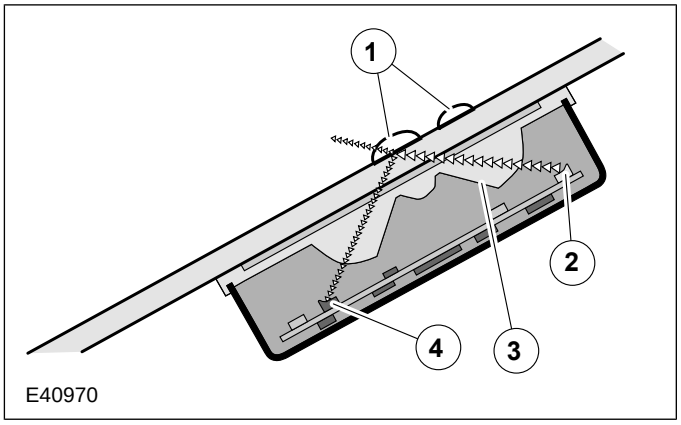
The rain sensor and the light sensor are integrated into one housing.

DESCRIPTION AND OPERATION

The rain sensor comprises an opto-electronic measuring and evaluation circuit. The sensor can calculate the amount of precipitation falling on the windshield and request that the windshield wipers are switched on.

On the basis of the information provided by the rain sensor, the windscreen wipers are then automatically set to the required wipe speed.

Mode of operation of the rain sensor



E40970

Item	Description
1	Raindrop
2	LED
3	Lens
4	Photodiode

CAUTIONS:

⚠ **The automatic windshield wipers must be switched off before the vehicle is driven into a car wash.**

⚠ **If the windshield is iced up, the wipers may only be activated by the rain sensor after the windshield has been completely defrosted.**

NOTE: The rain sensor is an optical measuring instrument. Contamination such as oil, grease or dust impair its correct operation. Before switching on the automatic windshield wipers, the windshield must be clean in the area of the rain sensor.

The rain sensor consists of three components:

- an LED
- a photodiode
- the lens

The LED emits a light beam of known intensity. The emitted beam emerges through the lens and is then reflected by the windshield.

The reflected light beam enters back through the lens and then reaches the photodiode. The corresponding value taken without moisture on the windshield is used as the reference value for the automatic calibration process.

Subsequent deviations from this value cause the windshield wipers to be switched on.

If rain lands on the windshield then the light reflected by the windshield has a lower intensity. This loss of intensity is registered by the photodiode and, proportionally to the loss of intensity, the module switches on the windshield wipers with the required wipe speed (in intermittent or continuous mode).

When the automatic windshield wipers are switched on (wiper switch set to intermittent mode) the rain sensor is switched on and performs an automatic calibration according to the current conditions at the windshield.

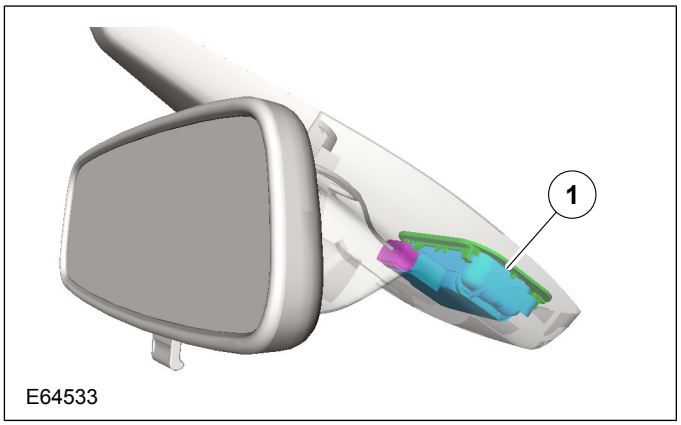
To perform the automatic calibration, the windshield wipers perform a single wipe regardless of whether the windshield is wet or dry. It only takes place if the wiper switch was not in the automatic setting before the ignition was switched on.

If the windshield remains dry after this wipe then the windshield wipers stop until moisture is registered on the windshield above the sensor.

The sensitivity of the rain sensor can be changed by adjusting the control resistor for the intermittent mode of the windshield wipers.

- Switch setting 1: High sensitivity
  - The wipers wipe even if only a small amount of water has been measured on the windshield.
- Switch setting 6: Low sensitivity
  - The wipers only wipe if a large amount of water has been measured on the windshield.

DESCRIPTION AND OPERATION



Item	Description
1	Installation position of the combined rain/light sensor

Rear window wash/wipe system

The rear window wash/wipe system will only operate if the ignition switch is in the position "II".

The generic electronic module (GEM) changes the wiper delay time of the rear window wiper according to the switch setting of the windshield wipers.

If the windshield wiper switch is in the "Off", "intermittent mode" or "automatic windshield wiper" (no wiping or low speed) position, then the wipe interval of the rear window wiper is 10 seconds.

If the windshield wiper switch is in the "normal speed", "high speed" or "automatic windshield wiper" (wiping at high speed) position, then the wipe interval of the rear window wiper is 6 seconds.

If the switch for the rear window washer is pressed, then washer fluid is sprayed onto the rear window, and the wiper operates continuously at low speed. When the switch is released the rear window wiper performs another 2-3 wipes.

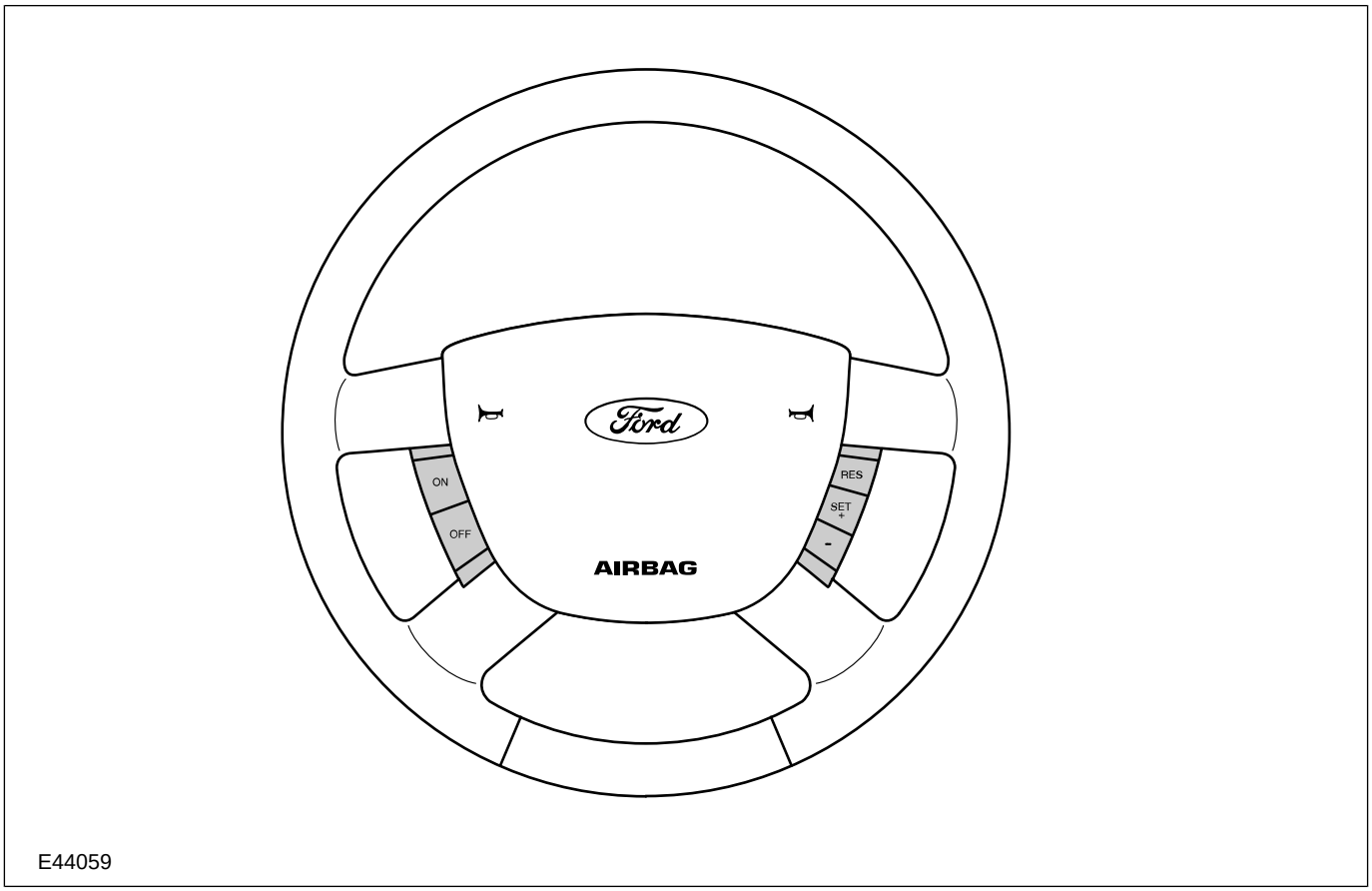
If the switch for the rear window washer fails while switched ON, or if it is continuously operated for longer than 60 seconds, then the switch signal is ignored by the generic electronic module (GEM), the wiper returns to the park position and a trouble code is stored for the switch. In the event of the switch sticking in the switched on position, the washer system pump continues to run constantly.

If reverse gear is engaged and the windshield wiper switch is in the normal, high speed or automatic windshield wiper (wiping at high speed) position, the rear window wiper operates continuously until the gearshift lever is moved back to the neutral position.

If reverse gear is engaged and the windshield wiper switch is in the "Off", "intermittent mode" or "automatic windshield wiper" (no wiping or low speed) position, then the rear window wiper follows the movement of the windshield wipers. If the wipers windshield wipers leave the rest position, then the rear window wiper also performs a wiping movement.

DESCRIPTION AND OPERATION

Speed control system



The speed control system consists of a switch unit which is part of the steering wheel component group. The switch unit has a direct interface to the generic electronic module (GEM), which in turn communicates with the powertrain control module (PCM).

The signals from the switches of the speed control system are received by the generic electronic module (GEM) as analog input voltage signals. The output voltage of the switches of the speed control system is determined by the relevant resistances of the individual switches installed in the switch unit.

The generic electronic module (GEM) transmits the relevant information as a message to the instrument cluster on the mid-speed CAN bus. From there, the message is forwarded to the powertrain control module (PCM) on the high-speed CAN bus.

The powertrain control module (PCM) adjusts the power output of the engine in order to maintain the selected vehicle speed.

central door locking

Locking/unlocking – central locking

The central locking system locks all doors, the liftgate and the tank flap, so that none of these can be opened from the outside of the vehicle. The locking of the tank flap is linked to the locking/unlocking of the driver's door.

On vehicles with door modules, all door lock motors and door lock switches are controlled via the door lock modules. The door ajar switch signals are transmitted directly to the generic electronic module (GEM).

On vehicles without door modules, all locking/unlocking functions are controlled via the generic electronic module (GEM).

Vehicles with door modules can be identified by means of the two-stage window control switch.

DESCRIPTION AND OPERATION

The central locking is actuated if one of the following conditions is satisfied:

- A key is inserted into one of the door locks and turned to the "locking" position.
- The "locking" button on the remote control is pressed once (provided the vehicle has not been configured for double locking).
- The "locking" button in the passenger compartment is pressed (if equipped).
- The inside door handle is pressed (if equipped).

If one of the front doors is not fully closed during the central locking procedure, all doors are locked and then unlocked again. This procedure is signaled acoustically.

If during the central locking process one of the rear doors is not fully closed then all of the doors are still centrally locked.

After the open door has been closed, central locking is confirmed by two short flashes of the turn signal lamps.

Locking/unlocking – double locking

The double locking system locks all doors so that they cannot be opened from outside the vehicle. In addition to the central locking function, the double locking function also disconnects the inside door handles from the locking mechanism, as a result of which it is also no longer possible to open the doors from inside the vehicle.

The double locking will only operate if the ignition lock is in the position "0" or "I".

The double locking is activated if one of the following conditions is satisfied:

- A key is inserted into a door lock and turned to the "locking" position twice within 3 seconds.
- The "locking" button on the remote control is pressed once (provided the vehicle has been configured for activation of the double locking after a single press of the locking button on the remote control).
- The "locking" button on the remote control is pressed twice within 3 seconds (if the vehicle has not been configured for activation of the double locking after a single press of the locking button on the remote control).

If the ignition lock has been turned to the position "II" or one of the rear doors is not fully closed then the vehicle is centrally locked but not double locked.

If, on a double-locked vehicle, the ignition switch is turned to the "II" or "III" position and a valid PATS signal is transmitted, the system switches from double locking to central locking.

Double locking is confirmed by two short flashes of the turn signal lamps. No flashing takes place for central locking on a vehicle with double locking.

Locking/unlocking – central unlocking

The central locking system unlocks all doors of the vehicle and the fuel filler flap.

The central locking is actuated if one of the following conditions is satisfied:

- The door lock is turned to the unlocking position.
- The release button on the radio remote control is pressed once (provided that the vehicle is not configured for unlocking via the driver's door lock).
- The release button on the radio remote control is pressed twice within 3 seconds (provided that the vehicle is not configured for unlocking via the driver's door lock).
- On a centrally locked vehicle the internal door handle is pulled to the "unlocking" position.
- The "unlocking" button in the passenger compartment is pressed.

If the vehicle has been configured for unlocking via the driver's door lock and the "unlocking" button on the remote control is only pressed once, then just the driver's door and the tank flap are unlocked.

If the "unlocking" button on the remote control is then pressed again within 3 seconds the remaining doors are unlocked via the central unlocking function.

If the vehicle was double locked beforehand, then the other doors are centrally locked, whereas the driver's door is unlocked.

Unlocking of the vehicle with the ignition switched off, is confirmed by one long flash of the turn signal lamps.

DESCRIPTION AND OPERATION

Locking/unlocking - automatic re-locking

The automatic re-locking function returns the locking system of the vehicle to its last status if it was centrally locked or double locked and the following conditions are satisfied:

- The vehicle is unlocked via remote control.
- Neither a door nor the liftgate has been opened within 45 seconds.
- The ignition is not switched on.

Locking/unlocking - automatic central locking

Depending on the configuration of the vehicle, it is locked by the automatic central locking if the following conditions are satisfied:

- The ignition switch is turned from the position "0" through "I" and "II" to "III" and then returns to "II" (engine running).
- all doors and tailgate are closed
- The vehicle speed exceeds 7 km/h.

The automatic central locking can be activated or deactivated within 30 seconds by performing the following programming sequence (all doors must be closed and remain closed during programming):

- Turn the ignition key to position "II".
- Push and pull the internal door handle on one of the front doors three times, or press the "unlocking" button in the passenger compartment three times.
- Turn the ignition key to the "0" or "I" position.
- Push and pull the internal door handle on one of the front doors three times, or press the "unlocking" button in the passenger compartment three times.
- Turn the ignition key to position "II".
- The automatic central locking system was switched to programming mode (confirmation via a short acoustic signal).
- Push and pull the internal door handle or press the "locking" button in the passenger compartment followed by the "unlocking" button.

This activates the previously deactivated automatic central locking or deactivates the previously activated automatic central locking.

Deactivation of the automatic central locking is confirmed by a short acoustic signal; activation is confirmed by a short acoustic signal followed by a long acoustic signal.

Programming mode is quit by either turning the ignition switch to position "I" or "0" or automatically, 5 minutes after activating programming mode (confirmation via a short acoustic signal).

Within Europe, vehicles are only delivered with disabled automatic central locking function. This function can be enabled via WDS, if required.

Liftgate

The liftgate unlocking function unlocks the liftgate if the ignition switch is turned to either of the "II" or "III" positions and the vehicle speed is below 7 km/h, or if the ignition switch is in the "0" or "I" position and one of the following conditions is satisfied:

- The liftgate unlocking button on the outside of the vehicle is pressed, provided the vehicle has been unlocked either via the driver's door lock or centrally.
- The liftgate unlocking button on the remote control is pressed once (provided the vehicle has been configured for liftgate unlocking after a single press of the button on the remote control).
- The liftgate unlocking button on the remote control is pressed twice within 3 seconds (if the vehicle has not been configured for liftgate unlocking after a single press of the button on the remote control).

Key-free vehicle system

A key-free vehicle system is optionally available, in which receivers on both front door handles, in the rear section and in the interior check whether a valid "passive key", which is programmed to the vehicle, is within the detection area in order to prepare the locking mechanism for opening the doors and then to enable the ignition lock, following actuation of the clutch pedal (vehicles with manual transmission) or brake pedal (vehicles with automatic transmission).

The reception signals are transmitted to the key-free vehicle system module, which then controls all further locking/unlocking functions.

After leaving the vehicle, it can be locked via sensors on the front door handles or on the liftgate handle (press once) or double locked (press twice). In this case, a request signal (lock/unlock) is transmitted by the key-free vehicle system module to the generic electronic module (GEM) via the

DESCRIPTION AND OPERATION

mid-speed CAN bus. The generic electronic module (GEM) then actuates the door modules via the mid-speed CAN bus, which unlock or lock the vehicle.

All door opening/closing functions can also be performed via the remote control buttons on the "passive key". In addition, there is an emergency key in the "passive key" which, together with an adapter, serves to open and start the vehicle in an emergency.

PATS

NOTE: The PATS keys need to be relearned when the GEM is replaced.

The PATS functionality is integrated in the GEM. Accordingly, the transmitter/receiver unit is directly connected to the GEM (previously it was connected to the PCM).

Once the encoding of the key has been read (with the ignition key in position II), a corresponding message is sent by the GEM via the HS CAN databus to the PCM.

Depending on this query and on the key status, the PCM then issues the start enable.

The key has a plastic transponder. Coded access is used during programming of the key.

Recharging function for the remote control

A recharging function for the remote control is available as an optional extra. Here, the rechargeable battery which is integrated in the key (previously it was a non-rechargeable battery) is continuously recharged while the ignition is switched on.

The recharging function for the rechargeable battery uses an induction line which in the past has already been used for the function of the PATS transponder. This means that no further component groups are required.

Once the PATS key enquiry has been performed, the recharging process is initiated and performed by the GEM via the ring antenna of the transmitter/receiver unit at the ignition lock.

The recharging function provides a power supply which ensures that the remote control remains operative at all times. There is no need to replace the battery.

Smart Charge system

In addition to the familiar functions, the Smart Charge system also performs the following functions:

- Automatic deactivation of non-critical high power electrical consumers when the battery voltage is low in order to reduce the level of current drawn.
- Automatic activation of non-critical high power electrical consumers when the battery voltage is excessively high in order to protect components which are sensitive to increased voltages.

The battery charging current is optimized through continuous calculation of the battery temperature and monitoring of the alternator output voltage.

The alternator load is signaled to the powertrain control module (PCM) in order to provide it with an early indication when an electric component is to be switched on or off, thereby also providing information about imminent changes to the amount of torque demanded by the alternator. By evaluating this information, the powertrain control module (PCM) is capable of increasing the stability of the engine under idling.

The two remaining functions of the Smart Charge system are controlled by the generic electronic module (GEM).

Electrical consumers are switched off when the battery voltage is low if the generic electronic module (GEM) determines (as a result of the message received from the powertrain control module (PCM) on the CAN bus via the instrument cluster) that the battery voltage has dropped below the threshold value.

If the threshold value for low battery voltage is reached, the generic electronic module (GEM) automatically deactivates the following consumers, in this sequence and with a 5-second time interval:

- Heated windscreen
- Heated rear window
- Electric booster heater (vehicles with diesel engines)
- A/C system

If the battery voltage then increases above the lower threshold value, the disabling of all previously-deactivated electrical consumers is cancelled by the generic electronic module (GEM). They then have switched off status and must be switched back on by the driver.

DESCRIPTION AND OPERATION

Electric consumers are switched on when the battery voltage is excessively high if the generic electronic module (GEM) determines that the battery voltage has increased above the threshold for overvoltage and the charge warning lamp has come on.

If the threshold value is reached, the generic electronic module (GEM) automatically activates the following consumers, in this sequence and with a 5-second time interval:

- Heated rear window
- Heated windscreen

If the battery voltage again falls below the threshold value, the heated rear window and the heated windshield are automatically deactivated by the generic electronic module (GEM). However, if they were switched on by the driver before the automatic activation, they will then be switched on again in turn with a 5-second time interval.

Ambient air temperature

The ambient air temperature sensor is connected via two cables to the generic electronic module (GEM). It measures the outside air temperature to an accuracy of around ±0.5 °C. The generic electronic module (GEM) broadcasts the ambient air temperature on the mid-speed CAN bus, where it can be evaluated by various systems.

Ignition overload protection

The ignition overload protection intermittently disconnects certain circuits in order to restrict the current being drawn from the battery while the starter motor is operating.

The position of the ignition switch is transmit by the instrument cluster via the mid-speed CAN bus.

The ignition overload protection relay which is integrated in the battery junction box is activated by the generic electronic module (GEM) if the message "ignition switch in position III" is received from the instrument cluster.

The activated ignition overload protection then switches off the following electrical consumers:

- EXTERIOR LIGHTING
- Windscreen/rear window wash/wipe systems
- Backup lamps
- Heated washer nozzles
- Control unit for gas discharge headlamps
- Seat heating
- Electric window regulators

Electric window regulators

To operate the power windows, the ignition key must be in the "II" or "III" position. The power windows open or close the door windows when the switch is moved to the corresponding position.

The movement of the glass stops if the window regulator button is released or if the ignition key is turned from the "II" or "III" position to "I" or "0".

The driver door window can only be operated via the driver door switch; the other windows can be opened and closed via the driver door switch panel or the relevant door switch.

If the window on the front passenger's door or one of the rear doors is operated via the switch on the switch panel in the driver's door, then the driver's door module receives the cable-transmitted signal from the switch and forwards it on the CAN bus to the relevant door module, which then moves the window glass accordingly.

A switch is provided on the switch panel on the driver's door to disable the window winder switches on the rear doors.

Brake fluid level

For normal brake fluid levels, the brake fluid level switch is closed and switches a ground signal to the generic electronic module (GEM) via a wire.

If the brake fluid level falls below the threshold value and the level switch opens for more than two seconds, the generic electronic module (GEM) generates a CAN signal and transmits it to the instrument cluster.

Energy management

The energy management system offers various modes which enable an effective power supply to be provided for individual modules according to their particular requirements.

The energy management function is integrated in the generic electronic module (GEM). Some of the modes can be set via the menu in the instrument cluster.

Four different vehicle modes are available:

DESCRIPTION AND OPERATION

Factory mode:

- Factory mode is activated during production of the vehicle. In this mode, relays are shut off to reduce the power supply to a minimum. Transport mode is activated when the vehicle leaves the factory.

Transport mode:

- Transport mode is activated en route from the factory to the dealer. The vehicle can be driven without adverse effects on the safety systems.
- Individual modules or electrical systems are switched off (e.g. anti-theft alarm system, audio systems, radio remote control and electric window winders are deactivated).
- This ensures that the battery has enough power when the vehicle is handed over to the customer.

If the engine is started while the system is in transport mode then the mode is interrupted only temporarily. It is resumed again as soon as the ignition is switched back off.

Transport mode must be deactivated by the dealer. To do this, the brake needs to be pressed five times within the space of 10 seconds and the hazard warning light switch needs to be pressed twice.

When the transport mode is deactivated the generic electronic module (GEM) automatically changes into normal mode.

Normal mode:

- In normal mode, all functions of all electrical systems are available when the engine is running.

Crash mode:

- Crash mode is activated if a sufficiently serious vehicle impact is registered.
- Here, the voltage supply to individual systems is switched off (e.g. to the fuel pump).
- The crash mode is deactivated as soon as the ignition key is turned to position 0 and then again to position II.

Hazard warning lights for an accident

Accident detection is performed by the RCM. The signal is sent via the MS CAN bus to the GEM.

If an event is detected the hazard warning lights are actuated by the GEM (see also: crash mode). It can be switched off via the hazard flasher switch.

Emergency function

The generic electronic module (GEM) can perform restricted emergency functions.

At regular intervals, the micro-controller applies a check signal to a monitoring function within the Generic Electronic Module (GEM). If this check signal is not received then the generic electronic module (GEM) switches to the emergency function after a preset time.

In this case, the dipped beam headlamps and the side lights are permanently switched on regardless of the light switch position. The windshield wiper can also still be operated, although to do this the wiper switch needs to be set to level I. Intermittent wiping is not available.

In order to safeguard the fuel supply, the fuel pump relay is actuated by the generic electronic module (GEM) on vehicles with a petrol engine.

On vehicles with medium to high levels of equipment the function of the horn remains intact. In addition, on these vehicles it is not possible to double-lock an unlocked vehicle.

When the check signal recurs, the Generic Electronic Module (GEM) switches back to normal operation.

Service mode

A diagnosis of the generic electronic module (GEM) can be performed with WDS. Furthermore, an integrated service mode enables testing of the input signals without the need for further tools. To enable activation of service mode:

- switch off the ignition,
- switch off all other electrical consumers,
- apply the handbrake,
- shift to neutral

Activating the service mode

The service mode is activated if one of the front door contact switches is operated 8 times within a space of 10 seconds. If after the door contact switch is first operated it is not operated a total of 8 times within 10 seconds then the 10 second period starts again from the beginning.

A signal sounds and the turn signal lamps illuminate twice to indicate that service mode has been successfully activated.

DESCRIPTION AND OPERATION

NOTE: The anti-theft system cannot be activated on vehicles fitted with an anti-theft alarm system if the service mode is activated.

Input signals

The following is a list of the switch signals to be tested, in no particular order:

- Ignition switch, terminal 15 (turn the ignition switch to 0, then turn the ignition switch to II)
- Ignition switch, terminal 75 (turn the ignition switch to 0, then turn the ignition switch to I)
- Door contact switch - hood (on vehicles equipped with an anti-theft system) (open the hood)
- Door contact switch - rear left (open the door)
- Door contact switch - rear right (open the door)
- Door contact switch - front left (open the door)
- Door contact switch - front right (open the door)
- Liftgate contact switch (open the liftgate)
- Brake fluid level
- Speed control system (only with the ignition switch in position II) (press and release the switch)
- Activating switch - double locking - driver's door
- Deactivating switch - double locking - driver's door
- Door locking switch - driver's door
- Door unlocking switch - driver's door
- Activating switch - double locking - rear door
- Deactivating switch - double locking - rear door
- Door locking switch - rear door
- Clutch Pedal Position Sensor
- Accelerator pedal position sensor (only with the ignition switch in position II) (depress and release the accelerator pedal)
- Radio (disconnect and reconnect)
- Dipped beam headlamps (only with the ignition switch in position II)
- Side lights (only with the ignition switch in position II)
- Autolamps (only with the ignition switch in position II)
- Turn signals (right, left, hazard warning lights)
- Main beam headlamps (only with the ignition switch in position II)
- Headlamp flasher (only with the ignition switch in position II)
- Backup lamp switch (only with the ignition switch in position II)
- Windshield wiper, level I (only with the ignition switch in position II)
- Windshield wiper, level II (only with the ignition switch in position II)
- Windshield wiper, intermittent wipe setting (only with the ignition switch in position II) (change the intermittent mode)
- Rear window wiper, intermittent wipe setting (only with the ignition switch in position II)
- Switch - heated rear window (only with the ignition switch in position II)
- Switch - heated windshield (only with the ignition switch in position II)
- Switch - parking brake indicator lamp (only with the ignition switch in position II)
- Rear window washer system (only with the ignition switch in position II)
- Windshield washer system (only with the ignition switch in position II)

The input of the relevant signal at the generic electronic module (GEM) is indicated with a signal tone and by the turn signal lamps and the turn signal lamp indicator lights in the instrument cluster illuminating once.

It is not possible to check the output signals during the self-test.

Ending the service mode

The GEM will exit the service mode automatically if one of the following conditions occurs:

- 20 seconds pass without anything being selected or operated.
- The headlamp flasher is operated and the ignition is switched OFF at the same time.
- The ignition switch is turned to position III.
- The voltage supply is too low (< 9 Volt).
- The voltage supply is too high (> 16 Volt).

A signal tone sounds twice to indicate that the service mode has been exited.

Module Configuration

The Transit 2006.5 utilizes a new form of module configuration called "central module configuration".

Here, all of the required configuration parameters are stored in the GEM at the factory, and from there they are transmitted via the CAN bus network to all of the individual modules.

DESCRIPTION AND OPERATION

WDS now includes a new routine for replacing or subsequently changing the configuration data. This new routine is used to perform the central module configuration.

However, in this case the data are no longer read into WDS like before - instead, they are transmitted by the GEM to the relevant module. WDS is only used to initiate and monitor the process.

For safety reasons all of the configuration data which are saved in the GEM are also backed up in the instrument cluster. This means that if the GEM is replaced then the required configuration data can read out from the instrument cluster with the aid of WDS and transmitted to the new GEM.

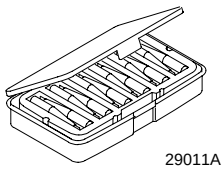
The GEM checks the configuration data for consistency and stores a diagnostic trouble code in the event of a fault (WDS DTC). In the event of a fault the function of the GEM may be restricted.

If the GEM is replaced then the keys for both the remote control and for the PATS will need to be re-learned.

DIAGNOSIS AND TESTING

Generic Electronic Module (GEM)

Special Tool(s)

 29011A	Set of adapter plugs for test probes 418-S035

General Equipment

Digital multimeter
Worldwide Diagnostic System (WDS)

Description of operation

A diagnosis of the generic electronic module (GEM) can be performed with WDS. Furthermore, an integrated service mode enables testing of the input signals without the need for further tools. To enable activation of service mode:

- switch off the ignition,
- switch off all other electrical consumers,
- apply the handbrake,
- shift to neutral

.

Activating the service mode

The service mode will be activated when one of the front door contact switches is operated 8 times within 10 seconds. If the 8 operations do not occur within 10 seconds after the door switch is first operated, the 10 second period starts again from the beginning.

A signal sounds and the direction indicator lamps (warning lamps) flash twice to indicate that service mode has been successfully activated.

NOTE: If the alarm is activated (in vehicles fitted with an anti-theft alarm system), service mode cannot be activated.

Input signals

The following is a list of the switch signals to be tested, in no particular order:

- Ignition switch terminal 15 (turn the ignition switch to position 0, then turn it to position II)
- Ignition switch terminal 75 (turn the ignition switch to position 0, then turn it to position I)
- Engine hood contact switch (on vehicles with an anti-theft alarm system)(open the hood)
- Rear left-hand door contact switch (open the door)
- Rear right-hand door contact switch (open the door)
- Front left-hand door contact switch (open the door)
- Front right-hand door contact switch (open the door)
- Tailgate contact switch (open the tailgate)
- Brake fluid level
- Cruise control system (only with ignition switch in position II)(press and release the switch)
- Activation switch - double locking - driver's door
- Deactivation switch - double locking - driver's door
- Door locking switch - driver's door
- Door lock release switch - driver's door
- Activation switch - double locking - rear door
- Deactivation switch - double locking - rear door
- Door locking switch - rear door
- Clutch Pedal Position Sensor
- Accelerator pedal position sensor (only with ignition switch in position II)(press and release the accelerator pedal)
- Radio (disconnect and connect)
- Dipped beam (only with ignition switch in position II)
- Side lights (only with ignition switch in position II)
- Autolamps (only with ignition switch in position II)
- Turn signals (right, left, hazard warning lights)
- Main beam (only with ignition switch in position II)
- Headlamp flasher (only with ignition switch in position II)
- Reversing lamp switch (only with ignition switch in position II)
- Windshield wiper level I (only with ignition switch in position II)
- Windshield wiper level II (only with ignition switch in position II)
- Windshield wiper intermittent wipe (only with ignition switch in position II)(change intermittent rate)

DIAGNOSIS AND TESTING

- Rear window wiper intermittent wipe (only with ignition switch in position II)
- Switch - heated rear window (only with ignition switch in position II)
- Switch - heated windshield (only with ignition switch in position II)
- Switch - parking brake warning lamp (only with ignition switch in position II)
- Rear window washer system (only with ignition switch in position II)
- Windshield washer system (only with ignition switch in position II)

The input of the particular signal at the central electronic module will be indicated by a signal tone together with a single flash of the turn signals and the turn signal warning lamps in the instrument cluster.

It is not possible to test the output signals during self-test.

Ending the service mode

The GEM will exit the service mode automatically if one of the following conditions occurs:

- After 20 seconds without activation
- Simultaneous operation of the headlamp flasher and ignition OFF
- Ignition switch turned to position III
- Voltage supply too low (< 9 Volts)
- Voltage supply too high (> 16 Volts)

Termination of service mode is indicated by a signal tone sounding twice.

Inspection and Testing

1. VERIFY the customer concern.
2. Visually CHECK for any obvious mechanical or electrical damage.

NOTE: Ensure correct locking of the wiring harness connector.

Visual Inspection

Electrical
Fuses.
Wiring harness.
Electrical connectors.

3. RECTIFY any obvious causes for a concern found during the visual inspection before performing any further tests. TEST the system for normal operation.
4. If the concern persists after the visual inspection, PERFORM a fault diagnosis with WDS and RECTIFY any displayed faults in accordance with the displayed fault description. TEST the system for normal operation.
5. For vehicles with no stored fault(s), PROCEED in accordance with the Symptom Chart according to the fault symptom.
6. Following checking or elimination of the fault and after completion of operations, the fault memories of all vehicle modules must be READ OUT and any stored faults must be DELETED. READ OUT all fault memories again following a road test.

DIAGNOSIS AND TESTING

Diagnostic Trouble Code (DTC) Table

DTC	Description	Action
B109F	Circuit of interior scanning sensor faulty.	REFER to: Anti-Theft - Active (419-01A, Diagnosis and Testing).
B10AD	Circuit of rain sensor faulty.	REFER to: Wipers and Washers (501-16, Diagnosis and Testing).
B10B1	Circuit of central locking switch faulty.	REFER to: Locks, Latches and Entry Systems (501-14, Diagnosis and Testing).
B1090	Circuit of rear door lock release switch faulty.	REFER to: Locks, Latches and Entry Systems (501-14, Diagnosis and Testing).
B1090	Circuit of front door lock release switch faulty.	REFER to: Locks, Latches and Entry Systems (501-14, Diagnosis and Testing).
B10A1	Circuit of tow bar detector faulty.	REFER to:Trailer Lamps (417-01, Diagnosis and Testing).
B10A2	Circuit of crash sensor faulty.	REFER to: Air Bag and Safety Belt Pretensioner Supplemental Restraint System (SRS) (501-20B, Diagnosis and Testing).
B1D16	Circuit of driver's side door contact switch faulty.	REFER to: Locks, Latches and Entry Systems (501-14, Diagnosis and Testing).
B10A7	Circuit of tailgate unlocking switch faulty.	REFER to: Locks, Latches and Entry Systems (501-14, Diagnosis and Testing).
B10AC	Circuit of cruise control switch faulty.	Refer to WDS.
P0704	Circuit of clutch pedal position switch faulty.	Refer to WDS.

DIAGNOSIS AND TESTING

DTC	Description	Action
C0041	Circuit of brake pedal switch faulty.	REFER to: Stoplamps (417-01, Diagnosis and Testing).
B1C77	Circuit of rear window wiper relay faulty.	REFER to: Wipers and Washers (501-16, Diagnosis and Testing).
B1C83	Circuit of heated rear window relay faulty (short to voltage).	REFER to:Fenster, Rahmen und Betätigungsmechanismen (501-11, Diagnosis and Testing).
B1008	Circuit of windshield washer motor operating switch faulty.	REFER to: Wipers and Washers (501-16, Diagnosis and Testing).
B1D06	Circuit of left-hand turn signal lamps faulty.	REFER to: Turn Signal and Hazard Lamps (417-01, Diagnosis and Testing).
B1D07	Circuit of right-hand turn signal lamps faulty.	REFER to: Turn Signal and Hazard Lamps (417-01, Diagnosis and Testing).
B1D36	Circuit of switch for left-hand turn signal lamps faulty.	REFER to: Turn Signal and Hazard Lamps (417-01, Diagnosis and Testing).
B1D07	Circuit of switch for right-hand turn signal lamps faulty.	REFER to: Turn Signal and Hazard Lamps (417-01, Diagnosis and Testing).
B109D	Circuit of rear interior lighting faulty.	REFER to: Interior Lighting (417-02, Diagnosis and Testing).
B109C	Circuit of front interior lighting faulty.	REFER to: Interior Lighting (417-02, Diagnosis and Testing).
B109A	Circuit of main beam relay faulty.	REFER to: Headlamps (417-01, Diagnosis and Testing).
B10A6	Circuit of headlamp switch faulty.	REFER to: Headlamps (417-01, Diagnosis and Testing).
B1007	Circuit of main beam switch faulty.	REFER to: Headlamps (417-01, Diagnosis and Testing).
B1098	Circuit of left-hand side lamps faulty.	REFER to: Parking, Rear and License Plate Lamps (417-01, Diagnosis and Testing).
B1099	Circuit of right-hand side lamps faulty.	REFER to: Parking, Rear and License Plate Lamps (417-01, Diagnosis and Testing).

DIAGNOSIS AND TESTING

DTC	Description	Action
B109B	Circuit of license plate lamp faulty.	REFER to: Parking, Rear and License Plate Lamps (417-01, Diagnosis and Testing).
P0812	Circuit of reversing lamp switch faulty.	REFER to: Reversing Lamps (417-01, Diagnosis and Testing).
B10A8	Circuit of headlamp relay faulty.	REFER to: Headlamps (417-01, Diagnosis and Testing).
B1093	Circuit for connecting second battery faulty	Refer to WDS.
B1094	Circuit for disconnecting second battery faulty	Refer to WDS.
B1D35	Circuit of hazard warning lamps switch faulty.	REFER to: Turn Signal and Hazard Lamps (417-01, Diagnosis and Testing).
B1097	Circuit of heated windshield relay faulty.	REFER to: Glass Frames and Mechanisms (501-11, Diagnosis and Testing).
B1013	Circuit of heated rear window relay faulty.	REFER to: Glass Frames and Mechanisms (501-11, Diagnosis and Testing).
B1012	Circuit of heated windshield switch faulty.	REFER to: Glass Frames and Mechanisms (501-11, Diagnosis and Testing).
B1096	Circuit of windshield washer system slow/fast relay faulty.	REFER to: Wipers and Washers (501-16, Diagnosis and Testing).
B1051	Circuit of windshield washer system switch faulty.	REFER to: Wipers and Washers (501-16, Diagnosis and Testing).
P0070	Circuit of ambient temperature monitoring sensor faulty.	Refer to WDS.

DIAGNOSIS AND TESTING

DTC	Description	Action
B1095	Circuit of windshield washer system on/off relay faulty.	REFER to: Wipers and Washers (501-16, Diagnosis and Testing).
B1052	Circuit of switch for windshield wash/wipe system switch or for rear window washer system faulty.	REFER to: Wipers and Washers (501-16, Diagnosis and Testing).
B1029	Circuit for accelerator pedal sensor faulty.	REFER to: Acceleration Control (310-02B, Diagnosis and Testing), Acceleration Control (310-02A, Diagnosis and Testing),
B1C45	Circuit of windshield wiper end switch (park position) faulty.	REFER to: Wipers and Washers (501-16, Diagnosis and Testing).
B1092	Circuit of daytime running lamps relay faulty.	REFER to: Headlamps (417-01, Diagnosis and Testing).
B1A84, U2101	Module configuration faulty.	Make certain that the latest release of the software is loaded in WDS and that the correct variant of the GEM is installed. CONFIGURE GEM again using WDS. If the fault occurs again, RENEW THE GEM.
B10AA	Circuit of the audio system anti-theft device is faulty.	REFER to: Anti-Theft - Active (419-01A, Diagnosis and Testing).
B109E	Circuit of the remote unlocking faulty.	REFER to: Locks, Latches and Entry Systems (501-14, Diagnosis and Testing).
B10AB	Synchronisation fault between the remote unlocking and the GEM.	Refer to WDS.

DIAGNOSIS AND TESTING

DTC	Description	Action
B1D17	Wiring of the battery backed horn for the anti-theft system (BBS) faulty.	REFER to: Anti-Theft - Active (419-01A, Diagnosis and Testing).
B1C55	Circuit of anti-theft horn relay faulty.	REFER to: Anti-Theft - Active (419-01A, Diagnosis and Testing).
B10E4	Circuit of double locking relay faulty.	REFER to: Locks, Latches and Entry Systems (501-14, Diagnosis and Testing).
B104F	Circuit of the left-hand glass break sensor of the anti-theft system faulty.	REFER to: Anti-Theft - Active (419-01A, Diagnosis and Testing).
B1050	Circuit of the left-hand glass break sensor of the anti-theft system faulty.	REFER to: Anti-Theft - Active (419-01A, Diagnosis and Testing).
B10D5, B10D6, B10D7, B10D8, B10DA	PATS system fault.	Refer to WDS.
B10B2	Circuit of engine run relay faulty.	Refer to WDS.
B1B69	Voltage supply (terminal 30) faulty.	GO to Pinpoint Test A.
B10A5	Circuit of alarm horn faulty.	REFER to: Anti-Theft - Active (419-01A, Diagnosis and Testing).
B1046	Circuit of fog lamp switch faulty.	REFER to: Fog Lamps (417-01, Diagnosis and Testing).
B1047	Circuit of rear fog lamp switch faulty.	REFER to: Fog Lamps (417-01, Diagnosis and Testing).
B1053	Circuit for fuel gauge sensor faulty.	REFER to:(413-01) Instrument Cluster (Diagnosis and Testing),
P0230	Circuit of fuel pump relay faulty.	Refer to WDS.
B1048	Circuit of brake fluid level "too low" sensor faulty.	REFER to:(413-01) Instrument Cluster (Diagnosis and Testing),

DIAGNOSIS AND TESTING

DTC	Description	Action
U0151	No communication with the restraints control module.	REFER to: Communications Network (418-00, Diagnosis and Testing).
U0155	No communication with the electronic instrument cluster.	REFER to: Communications Network (418-00, Diagnosis and Testing).
U0121	No communication with the anti-block brake system module.	REFER to: Communications Network (418-00, Diagnosis and Testing).
U0100	No communication with the powertrain control module (PCM).	REFER to: Communications Network (418-00, Diagnosis and Testing).
U0001	No communications possible via the HS CAN bus.	REFER to: Communications Network (418-00, Diagnosis and Testing).
U0010	No communications possible via the MS CAN bus.	REFER to: Communications Network (418-00, Diagnosis and Testing).

Symptom chart

Symptom chart

Symptom	Possible Sources	Action
• Generic electronic module (GEM) not communicating with the diagnostic unit.	• Fuse(s). • Circuit(s). • Generic electronic module (GEM).	• REFER to: Communications Network (418-00, Diagnosis and Testing).

Pinpoint test

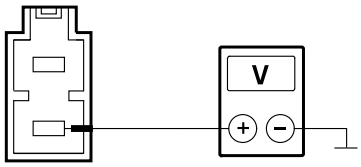
PINPOINT TEST A : VOLTAGE SUPPLY (TERM. 30) FAULTY.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: CHECK FUSE F7	
	1 Ignition switch in position 0.
	2 CHECK fuse F7 (BJB). • Is the fuse OK? → **Yes** GO toA2. → **No** RENEW fuse F7 (60 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A2: CHECK THE VOLTAGE AT FUSE F7	
	1 Connect fuse F7 (BJB).
	2 Measure the voltage between fuse F7 (60 A) and ground. • Does the meter display battery voltage? → **Yes** GO to A3. → **No** REPAIR the voltage supply to fuse F7 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A3: CHECK FUSE F2	
	1 CHECK fuse F2 (BJB). • Is the fuse OK? → **Yes** GO to A4. → **No** RENEW fuse F2 (60 A). CHECK the operation of the system. If the fuse blows again, LOCATE and REPAIR the short using the Wiring Diagrams.
A4: CHECK THE VOLTAGE AT FUSE F2	
	1 Connect fuse F2 (BJB).
	2 Measure the voltage between fuse F2 (60 A) and ground. • Does the meter display battery voltage? → **Yes** GO to A5. → **No** REPAIR the voltage supply to fuse F2 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A5: CHECK THE VOLTAGE AT THE GEM	
	1 Disconnect Connector CBP02A of GEM.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the voltage between the GEM, connector CBP02A, pin 1, circuit SBF07A (RD/WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A6. → **No** LOCATE and REPAIR the break in the circuit between the GEM and fuse F7 with the aid of the Wiring Diagrams. CHECK the operation of the system.
A6: CHECK THE VOLTAGE AT THE GEM	
 E69614	1 Measure the voltage between the GEM, connector CBP02A, pin 2, circuit SBF02A (YE/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** TEST the GEM and RENEW as necessary. CHECK the operation of the system. → **No** LOCATE and REPAIR the break in the circuit between the GEM and fuse F2 with the aid of the Wiring Diagrams. CHECK the operation of the system.

REMOVAL AND INSTALLATION

Generic Electronic Module (GEM)

Removal

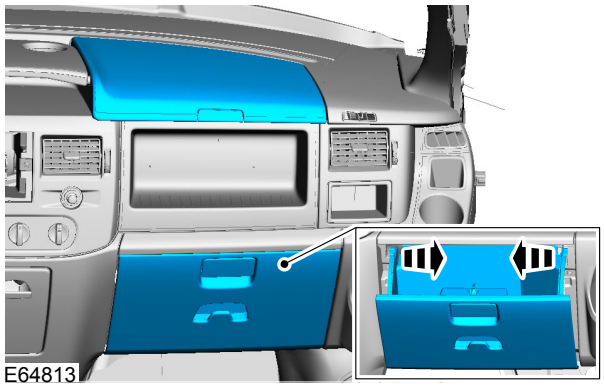
CAUTIONS:

Never swap the GEM between two vehicles.

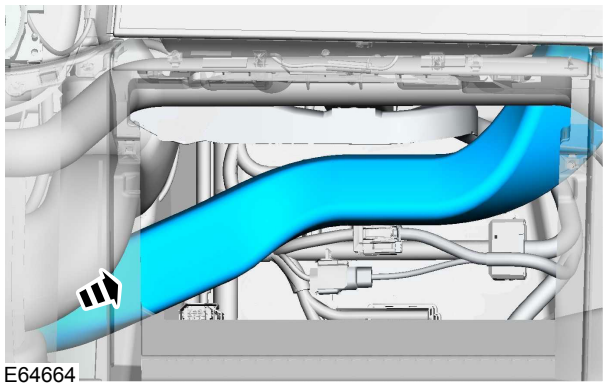
Compare the number of relays and fuses in the defective CJB and the new CJB. Transfer from the defective CJB any relays and fuses which are not in the new CJB. In doing so, pay attention that fuses with the correct Ampere rating are used, by referring to the wiring diagrams. Remove any surplus relays and fuses from the new CJB.

NOTE: The GEM is integrated in the central junction box (CJB) and cannot be replaced as a separate unit.

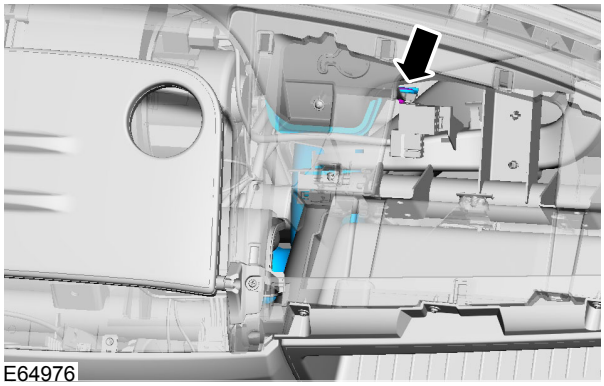
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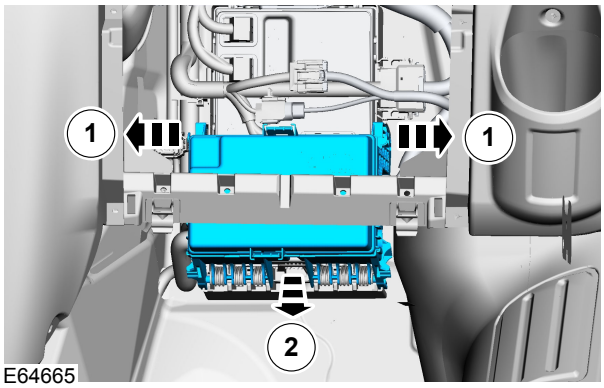
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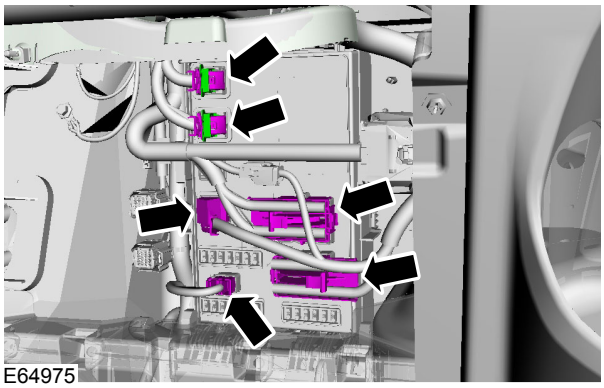
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4.

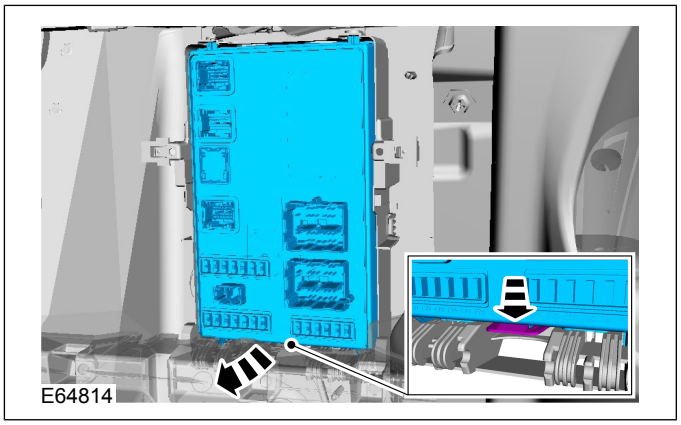


5.



REMOVAL AND INSTALLATION

6.



Installation

1. To install, reverse the removal procedure.
2. Programme the GEM.

   Refer to:Programmable Module Installation (418-01 Module Configuration, General Procedures).
3. Configure the GEM.

   Refer to:Module Configuration (418-01 Module Configuration, General Procedures).
4. Program the passive anti-theft system keys.

   Refer to:Key Programming Using Two Programmed Keys - Vehicles Without: Central Junction Box (CJB) (419-01 Anti-Theft - Passive, General Procedures).
5. Program remote transmitter.

   Refer to:Handles, Locks, Latches and Entry Systems (501-14 Handles, Locks, Latches and Entry Systems, Description and Operation).

SECTION 501-00 Body System - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 501-00-2

DESCRIPTION AND OPERATION

Body..... 501-00-3
Insulation..... 501-00-4
Body Sealer Types and Applications..... 501-00-5

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Clinched flange protection	ESK-M4G245-A
Two-component adhesive	A96SXM2G400AA
One-component glass adhesive	95SXT03863GA
Two-component glass adhesive	95SXT03863AA

DESCRIPTION AND OPERATION

Body

- The Ford Transit body has the following technical features:
  - Unitized sheet steel body with different roof variants and wheelbases.
  - At the front the bolted radiator grille opening panel and crossmember is made of plastic and painted in the vehicle body colour.
  - The fenders are bolted in place.
  - The windshield, side and rear windows are direct glazed.
- The seam seals in the side panel area are applied after painting. This offers the following advantages:
  - The sealing material does not become brittle.
  - Subsequent sealing operations can be carried out without additional painting.
- On vehicles with exhaust gas recirculation (EGR) all the body parts at risk from corrosion are zinc-coated (8 year corrosion perforation warranty).
- Passive safety through:
  - Programmed crumple zones (designed buckling locations) in the front side members.
  - Reinforcement between the A-pillars serving to absorb side impacts and to support the instrument panel.

DESCRIPTION AND OPERATION

Insulation

- Various foamed components are fitted to the A, B and C-pillars to reduce noise.
- Sound deadening elements are installed to reduce the size of cavities and prevent resonance. This has been made possible by the development of new sound deadening technologies and the use of hybrid materials. In service these elements must be preserved by employing equally effective alternative solutions.
- Ford-specific sound deadening and insulating materials are used in all other areas.

DESCRIPTION AND OPERATION

Body Sealer Types and Applications

1. Body sealing seams: To meet production quality requirements, the body panel joint areas must be resealed. Ford clinched flange protection material (specification: A84AG19560DAA) alone must be used for this. The Ford clinched flange protection material has the following properties:
   - Good viscosity.
   - Good sealing and adhesive properties.
   - Minimal shrinkage.
   - Permanent elasticity.
   - Short drying time.
   - Can be overpainted.
2. Further application possibilities: The Ford clinched flange protection material (specification: A84AG19560DAA) can also be used for minor sealing operations to rectify water leaks or wind noise.
3. Corrosion prevention materials: When body repairs are carried out, Ford glass adhesive, Ford underbody protection material and Ford cavity sealer alone must be used. Various proprietary corrosion protection materials approved by Ford can be used in all other applications.

SECTION 501-02 Front End Body Panels

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 501-02-2

DESCRIPTION AND OPERATION

Front End Body Panels..... 501-02-3

GENERAL PROCEDURES

Hood Alignment..... (41 213 0) 501-02-4

REMOVAL AND INSTALLATION

Fender..... 501-02-6

SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Hood lock mounting frame	25		

DESCRIPTION AND OPERATION

Front End Body Panels

1. Unlocking the hood:
    1. The hood is unlocked from the outside using the central vehicle key.
    2. The basic functions of the hood release mechanism are carried over from the Ford Focus.
    3. Advantages:
        - Integrating the hood lock into the vehicle central security system increases protection against theft.
        - The lock mechanism must be unlocked with the vehicle key.

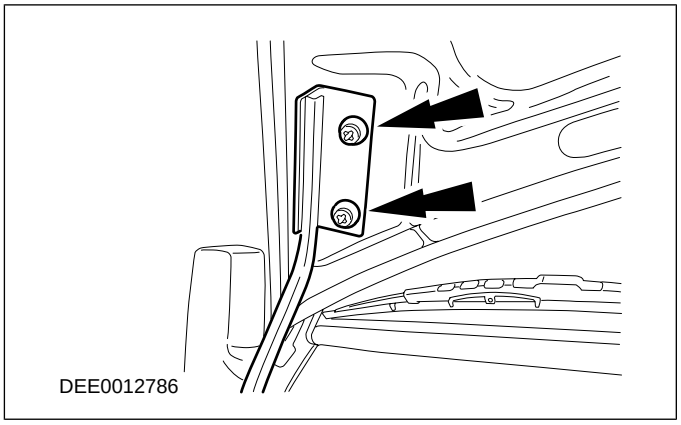
GENERAL PROCEDURES

Hood Alignment (41 213 0)

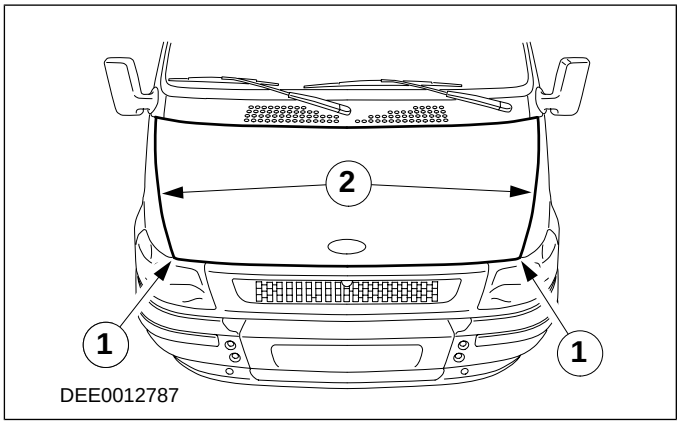
1. **NOTE:The hood is adjusted with the hood lock striker removed.**

   Remove the hood lock striker.

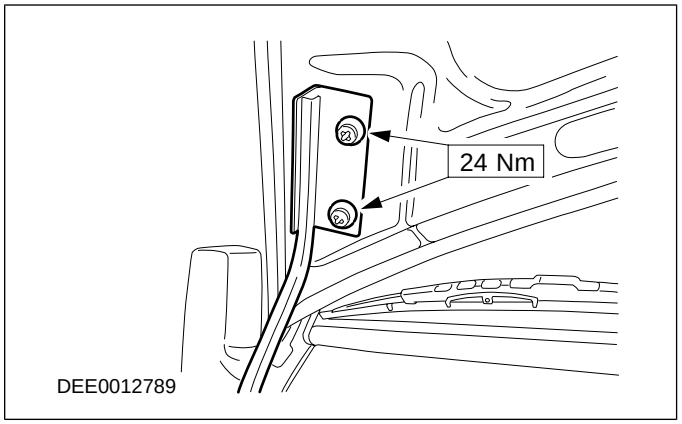
2. **Release the hood.**
   - Unscrew the retaining bolts (on both sides).



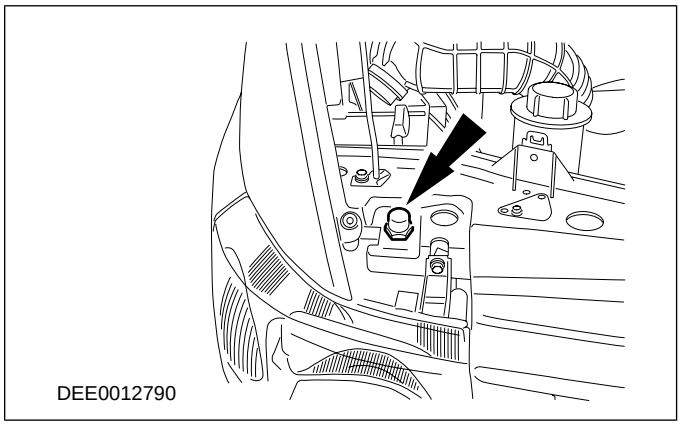
3. **Adjust the hood longitudinally and transversely.**
   1. The front edge of the hood and the front edges of the fenders must line up.
   2. Adjust the clearance between the hood and the fenders (4.0 mm ± 1.0 mm).



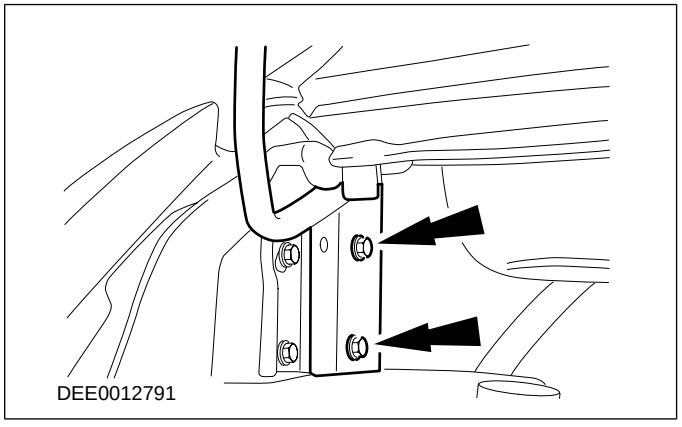
4. **Secure the hood.**
   - Tighten the retaining bolts (on both sides).



5. **Adjust the height at the front.**
   - With the bump rubbers adjust the hood to the height of the front edge of the fender (on both sides).



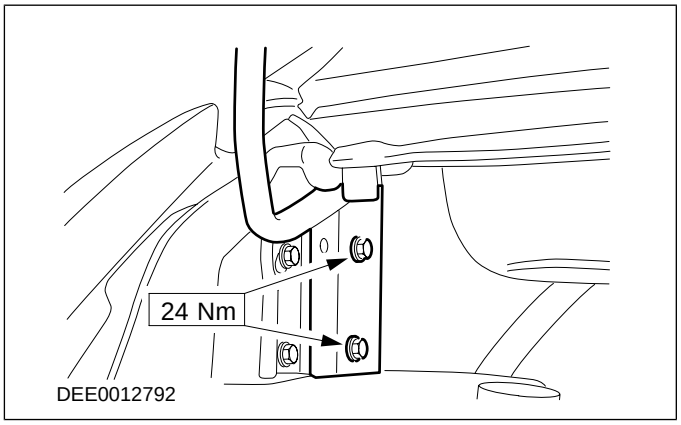
6. **Adjust the height at the rear.**
   - Release the hood hinge and adjust the hood to the height of the rear edge of the fender (on both sides).



7. **Secure the hood hinge.**

GENERAL PROCEDURES

- Tighten the retaining bolts (on both sides).



8. **NOTE:The clearance and edge alignment of the hood in relation to adjoining components must be adjusted correctly before the hood lock striker is installed.**

   Install the lock striker.

   - The lock striker must be installed free of stress.
   - The clearances and height must remain unchanged.

REMOVAL AND INSTALLATION

Fender

Removal

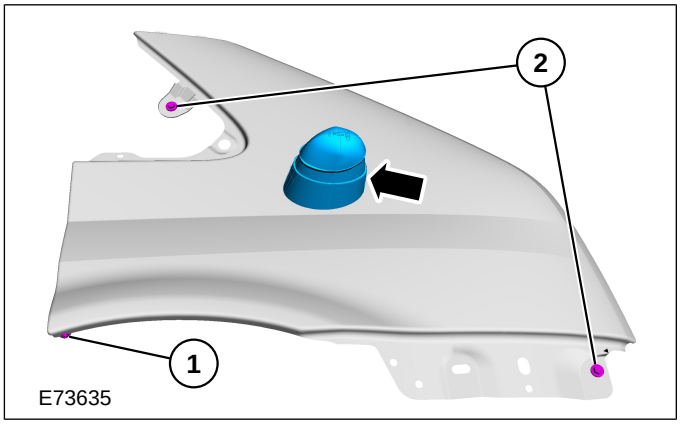
NOTE: Removal steps in this procedure may contain installation details.

1. Remove the following items:
1. Front bumper cover

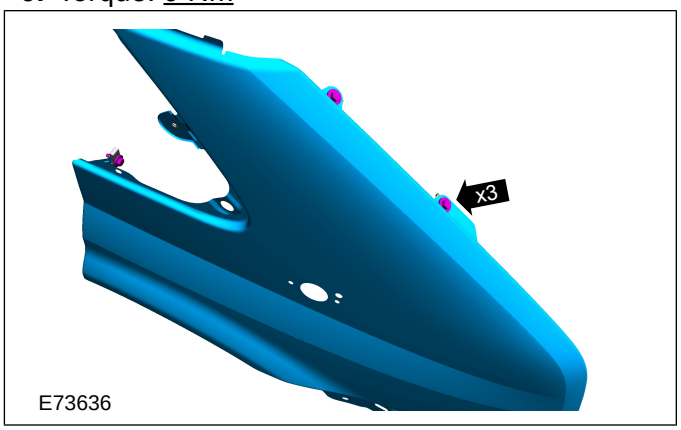
   Refer to:Front Bumper Cover (501-19 Bumpers, Removal and Installation).
2. Door mirror

   Refer to:Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation).

2. Torque:
- 1 7 Nm
- 2 9 Nm



3. Torque: 9 Nm



Installation

1. To install, reverse the assembly procedure.

SECTION 501-03 Body Closures

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 501-03-2

GENERAL PROCEDURES

Sliding Door Alignment..... 501-03-3

SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Front door hinge retaining bolts	30	22	–
Front door striker plate retaining bolts	25	18	–
Rear door hinge retaining bolts	30	22	–
Rear door striker plate retaining bolts	25	18	–
Door latch retaining screws	12	9	–
Liftgate hinge retaining bolts	30	22	–
Liftgate striker plate retaining bolts	25	18	–
Sliding door hinge retaining bolts	30	22	–
Sliding door striker plate retaining bolts	25	18	–
Sliding door lower arm adjustment screws	25	18	–

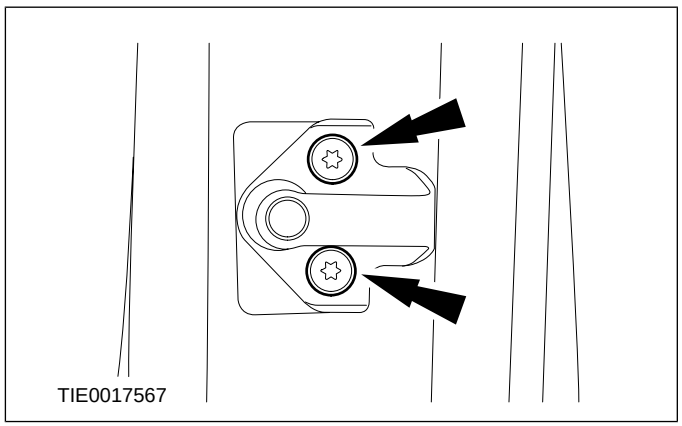
GENERAL PROCEDURES

Sliding Door Alignment

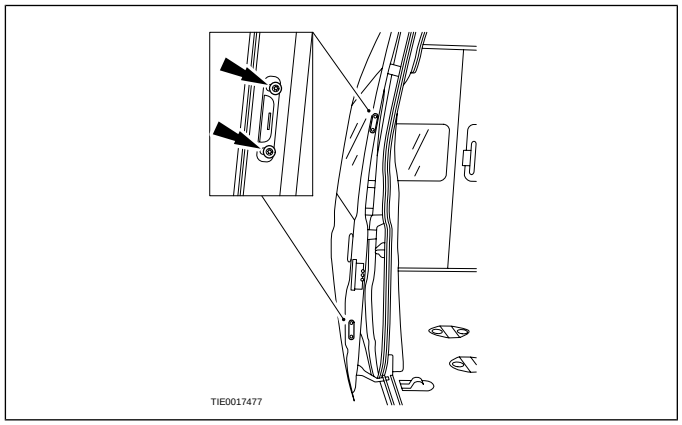
General Equipment

6mm margin blades

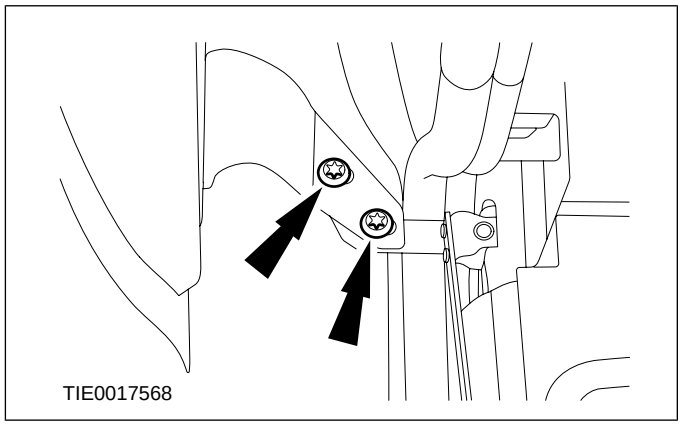
1. **Loosen the sliding door striker plate retaining bolts.**



2. **Loosen the sliding door guide retaining bolts.**

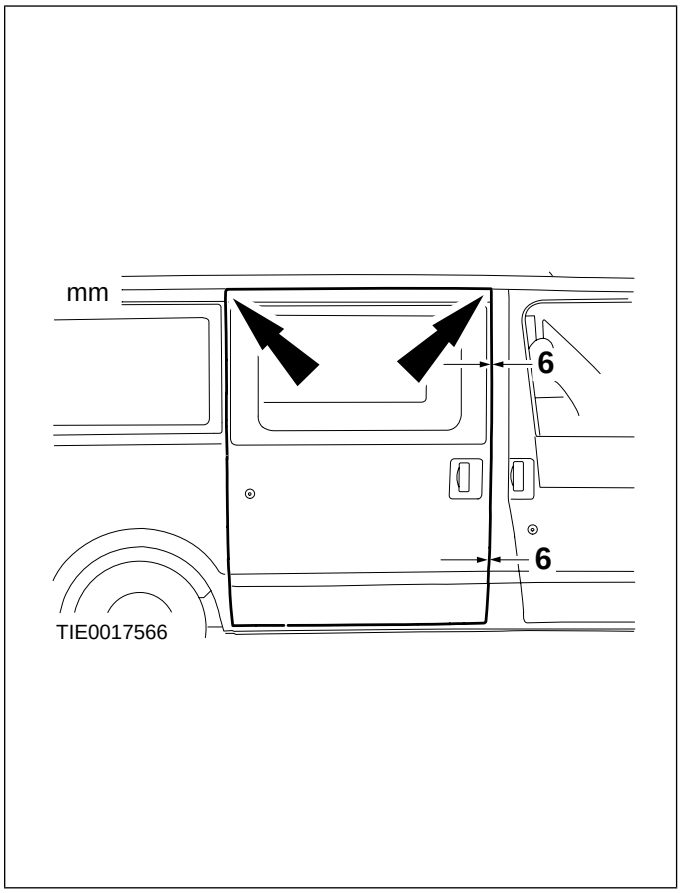


3. **Loosen the sliding door lower arm inner and outer adjustment screws.**

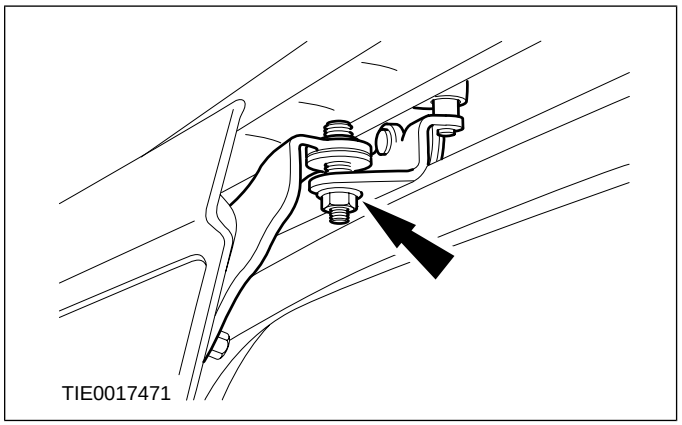


4. **NOTE:Make sure that the sliding door is in the fully closed position.**

Check the alignment of the sliding door in relation to the B-pillar and for any excessive gap in the top corners.



5. **Adjust the top roller adjustment screw to align the sliding door in relation to the B-pillar if necessary.**

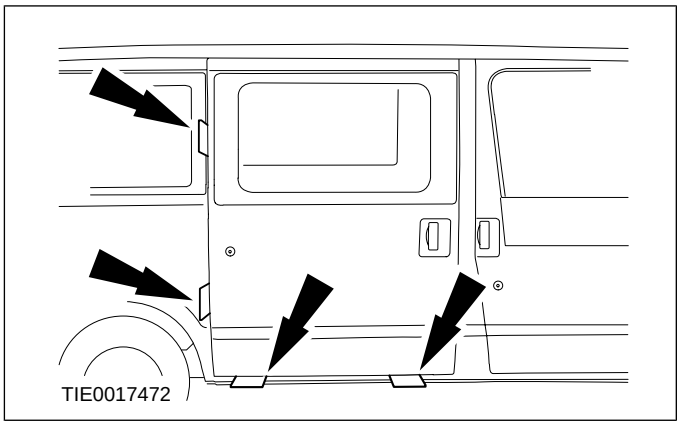


6. **NOTE:Make sure that the sliding door is in the fully closed position.**

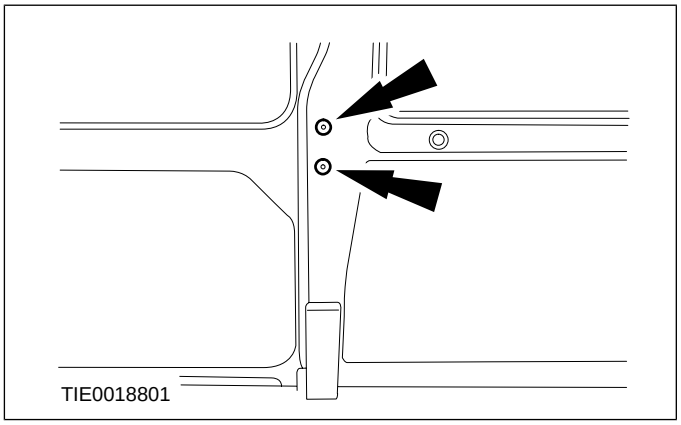
   Check the alignment of the sliding door in relation to the B-pillar.

GENERAL PROCEDURES

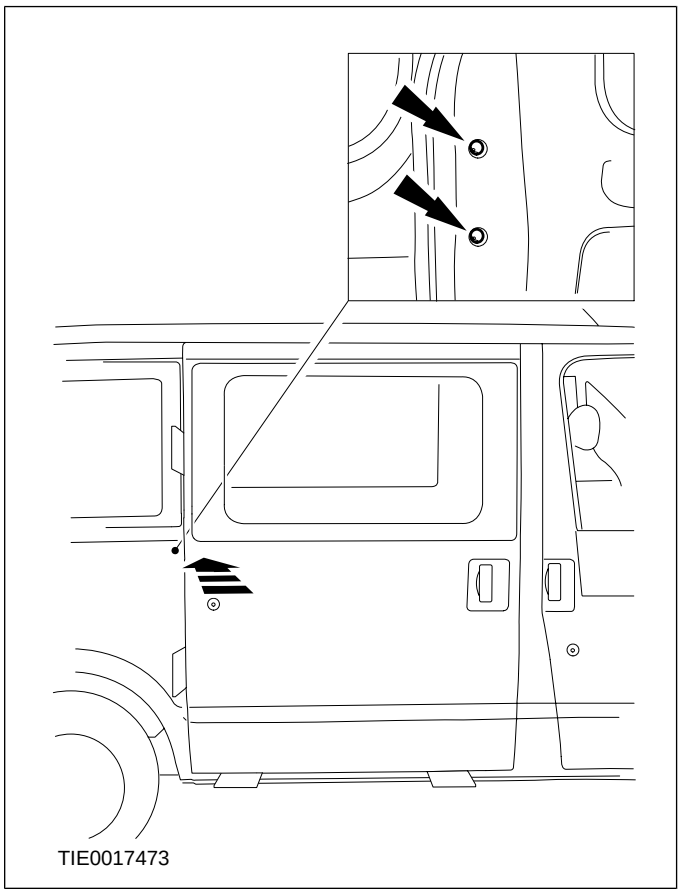
7. From the outside of the vehicle insert 6 mm margin blades between the lower edge of the sliding door and the body, and between the left-hand edge of the sliding door and the C-pillar.



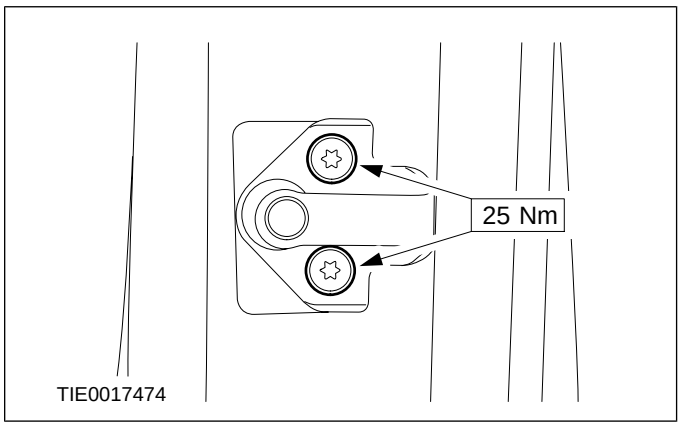
8. From the inside of the vehicle, loosen the center roller retaining bolts.



9. With the aid of another technician, push the rear of the sliding door until it aligns with the C-pillar and tighten the center roller retaining bolts.



10. Remove the 6 mm margin blades.
11. Tighten the sliding door striker plate retaining bolts.

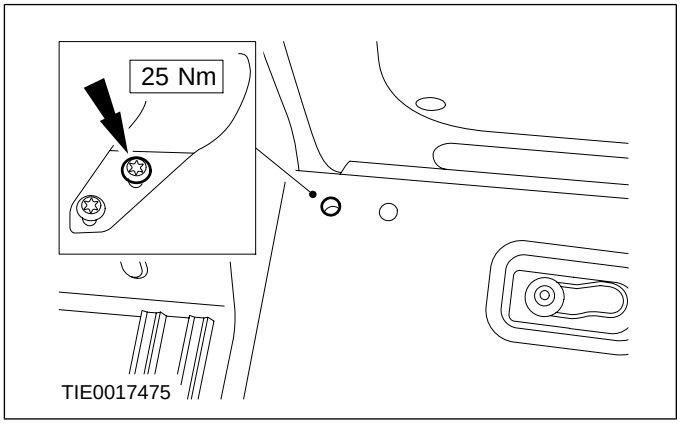


12. NOTE:Make sure that the sliding door is in the fully closed position.

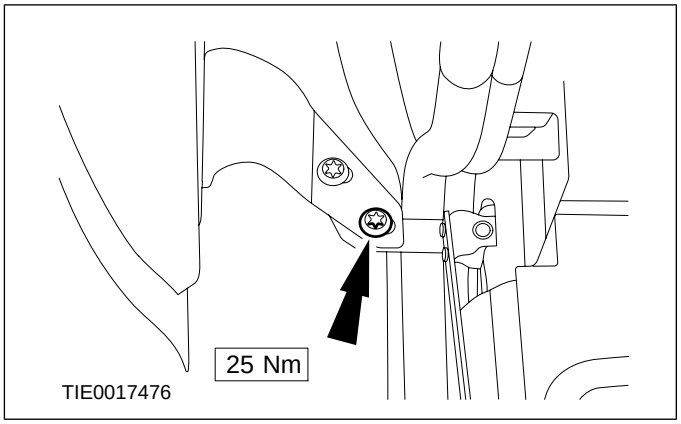
    Check the alignment of the sliding door.
13. Remove the scuff plate.

GENERAL PROCEDURES

14. With the aid of another technician, push the front of the sliding door until it aligns with the B-pillar and tighten the lower arm outer adjustment screw.



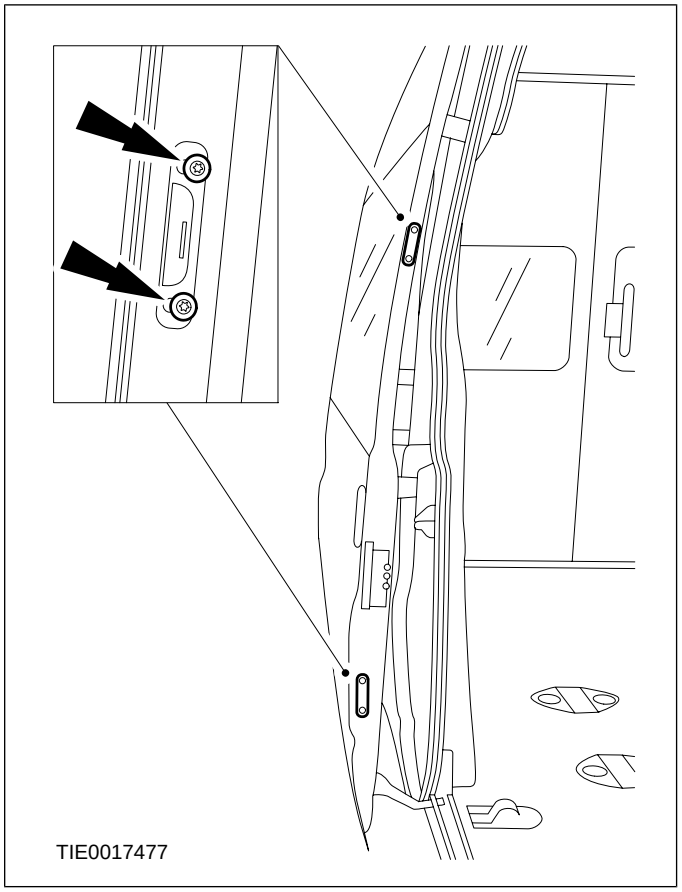
15. Tighten the lower arm inner adjustment screw.



16. NOTE:Make sure that the sliding door is in the fully closed position.

    Check the alignment of the sliding door.

17. Tighten the sliding door guide retaining bolts.



SECTION 501-05 Interior Trim and Ornamentation

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

REMOVAL AND INSTALLATION

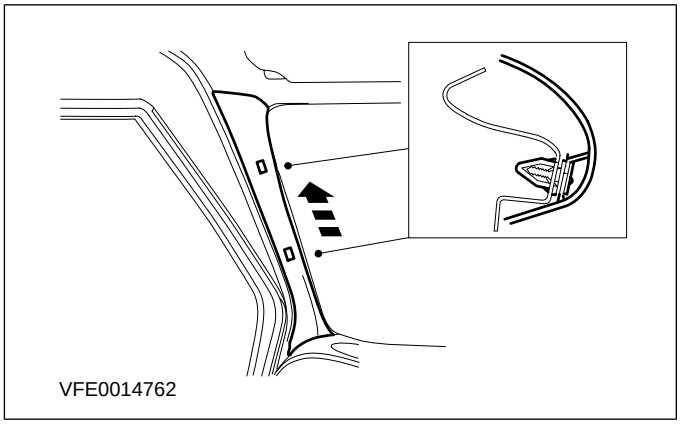
A-Pillar Trim Panel	(43 616 0)	501-05-2
B-Pillar Trim Panel	(43 617 0)	501-05-3
Front Door Trim Panel	(43 705 0)	501-05-5
Sliding Door Trim Panel		501-05-7
Rear Door Trim Panel — Van/Kombi/Bus	(43 706 0)	501-05-8
Rear Door Trim Panel — Chassis Cab	(43 706 0)	501-05-9
Liftgate Trim Panel	(43 744 0)	501-05-10
Loadspace Trim Panel LH	(43 746 0)	501-05-11
Loadspace Trim Panel RH	(43 746 0)	501-05-12
Front Headliner	(43 609 0)	501-05-13
Rear Headliner — Van/Kombi/Bus	(43 611 0)	501-05-15
Rear Headliner — Chassis Double Cab	(43 611 0)	501-05-16

REMOVAL AND INSTALLATION

A-Pillar Trim Panel (43 616 0)

Removal

1. Remove the A-pillar trim panel.



Installation

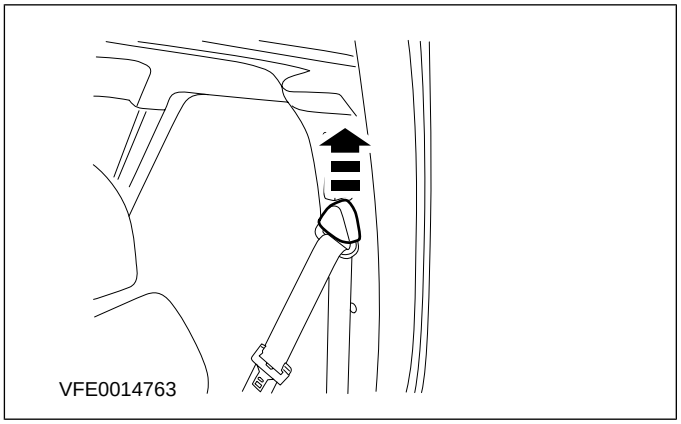
1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

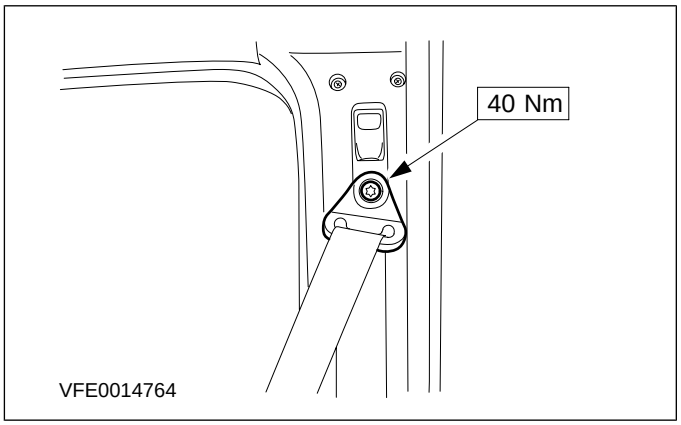
B-Pillar Trim Panel (43 617 0)

Removal

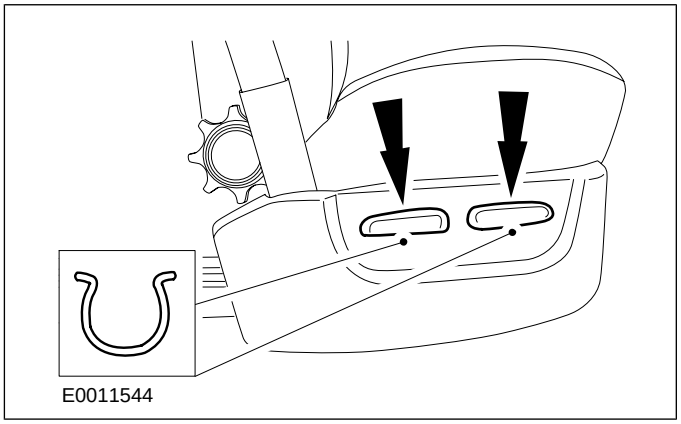
1. **Remove the safety belt upper anchor cover.**



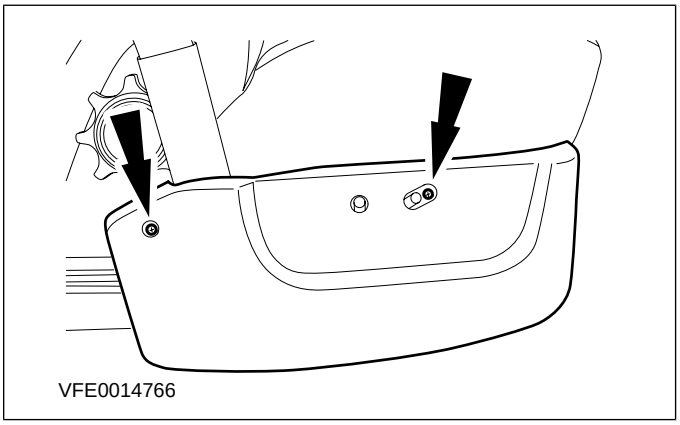
2. **Detach the safety belt upper anchor.**



3. **Remove the seat height adjust levers.**

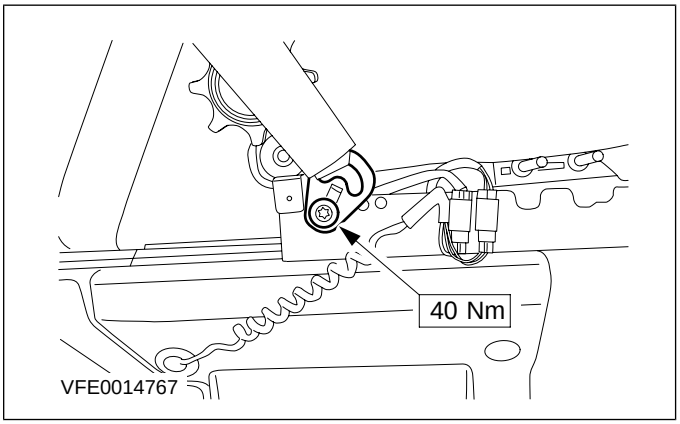


4. **Remove the seat outer trim panel.**

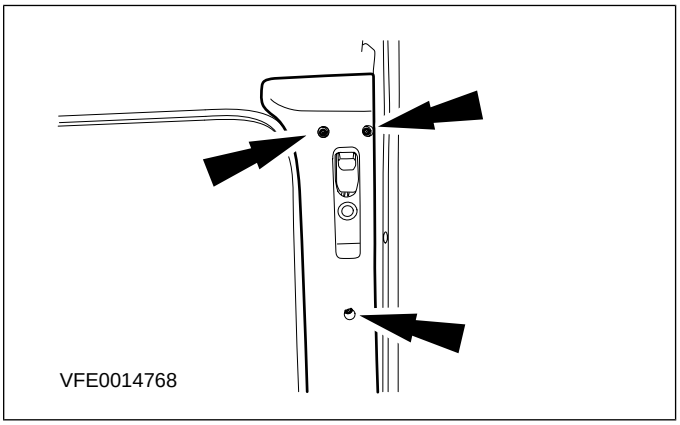


5. **CAUTION:The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt at all times when the safety belt is detached or removed.**

   Detach the safety belt lower anchor from the seat.

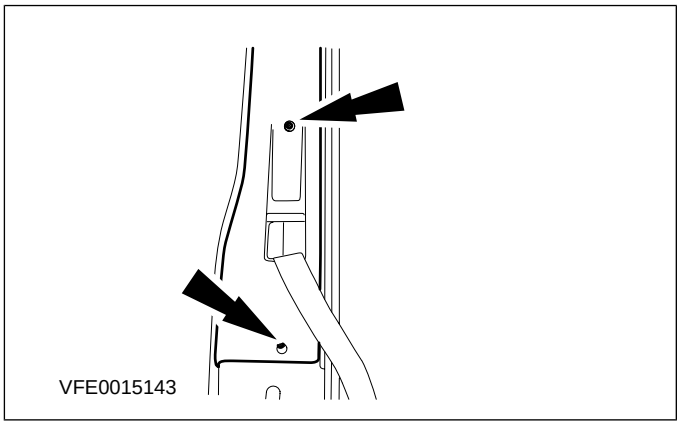


6. **Remove the B-pillar trim panel upper retaining screws.**



REMOVAL AND INSTALLATION

7. Remove the B-pillar trim panel.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

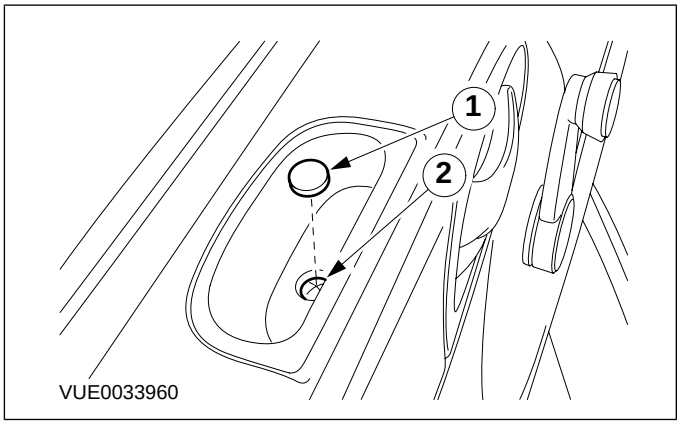
Front Door Trim Panel (43 705 0)

Removal

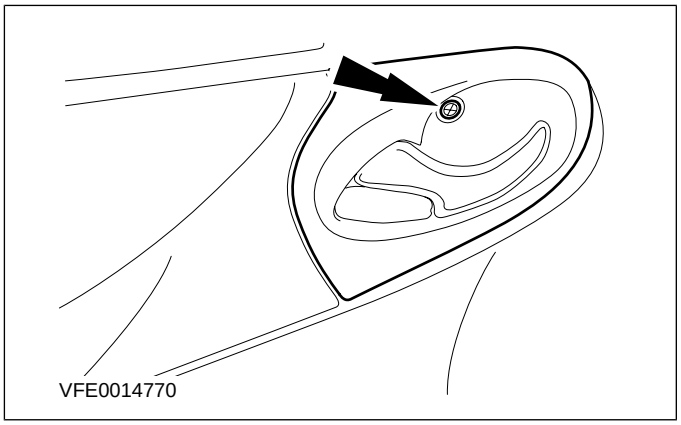
All vehicles

1. Detach the front door trim panel.

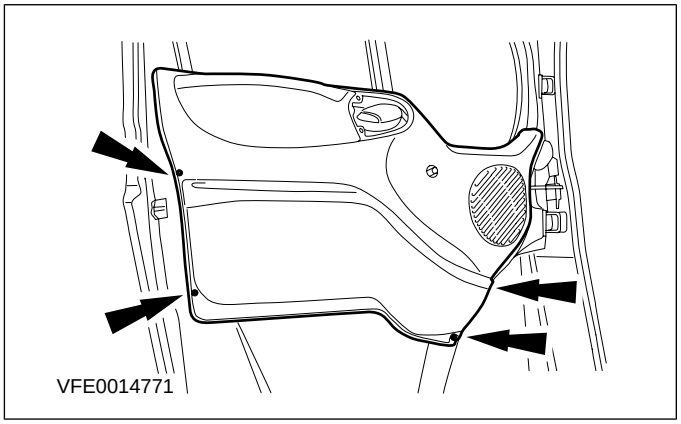
1. Remove the screw cover.
2. Remove the retaining screw.



2. Remove the front door latch remote control handle bezel.

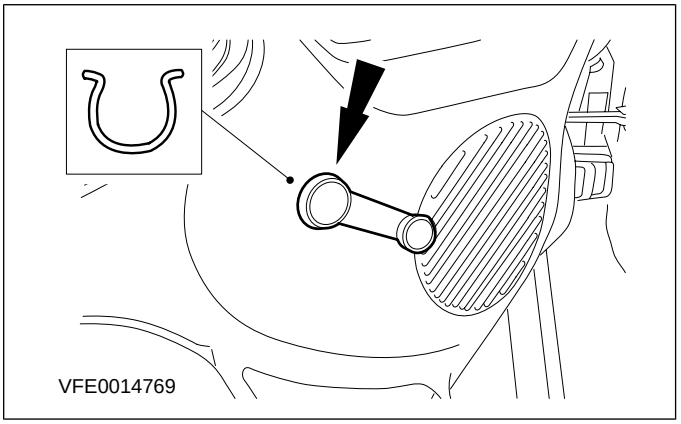


3. Remove the front door trim panel retaining screws.



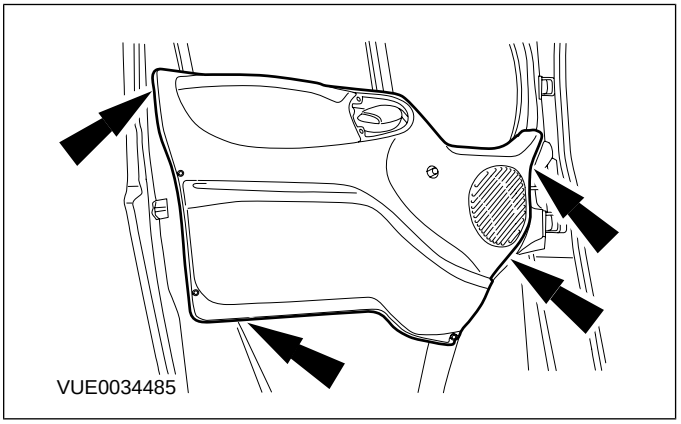
Vehicles without power windows

4. Remove the window regulator handle.



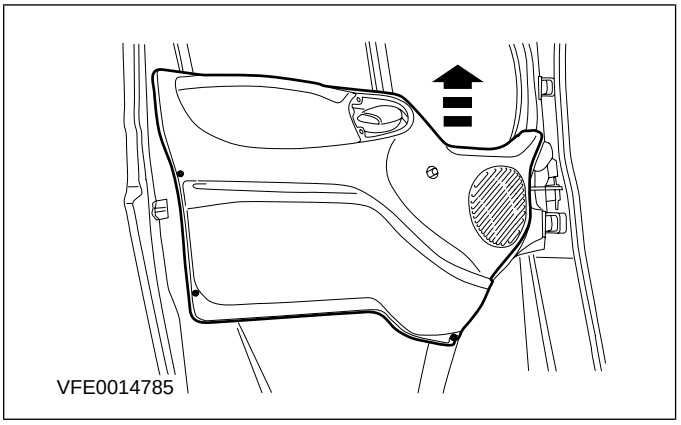
All vehicles

5. Detach the front door trim panel retaining clips from the door.



Vehicles without power windows

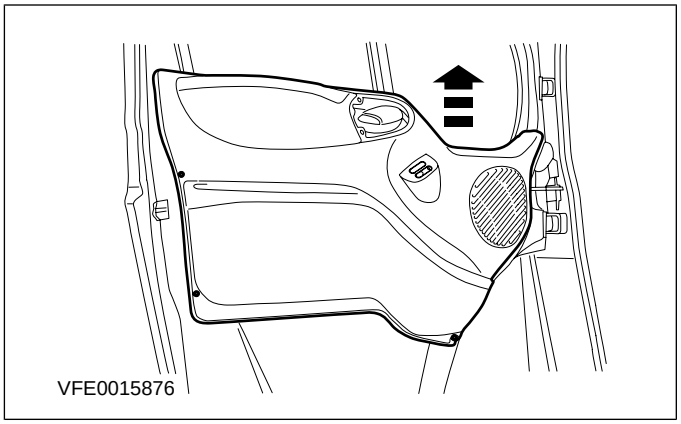
6. Remove the front door trim panel.



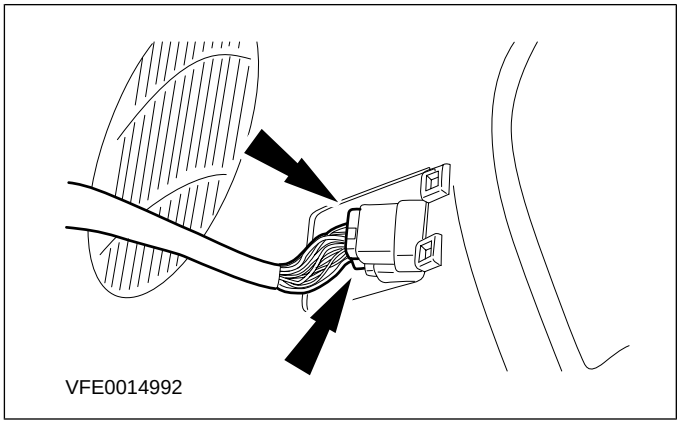
REMOVAL AND INSTALLATION

Vehicles with power windows

7. Detach the front door trim panel.



8. Disconnect the power window electrical connectors and remove the front door trim panel.



Installation

1. To install, reverse the removal procedure.

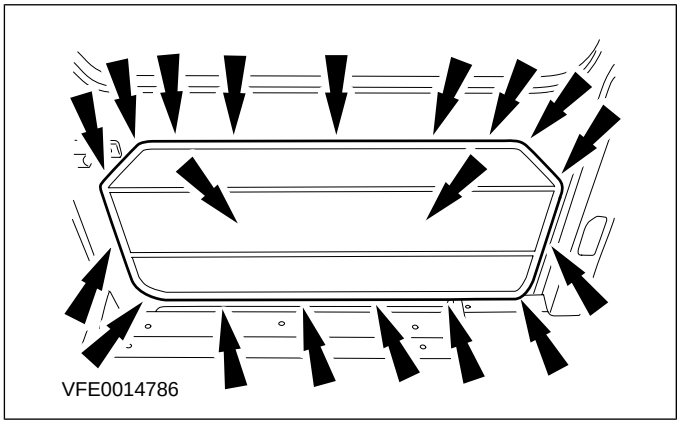
REMOVAL AND INSTALLATION

Sliding Door Trim Panel

Removal

1. **NOTE:High-level trim panel shown, low-level trim panel similar.**

   Remove the sliding side door trim panel.



Installation

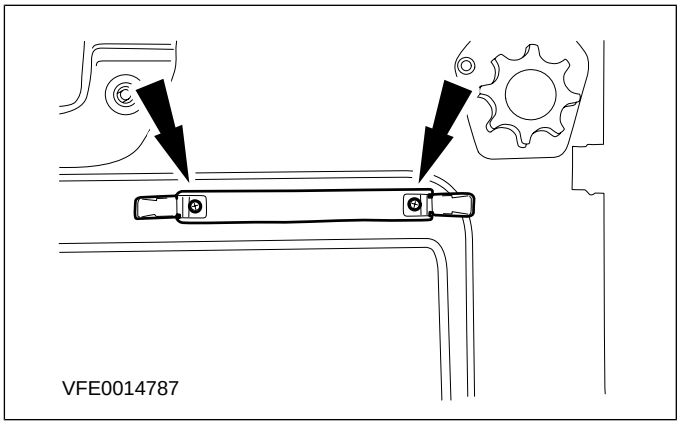
1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

Rear Door Trim Panel — Van/Kombi/Bus (43 706 0)

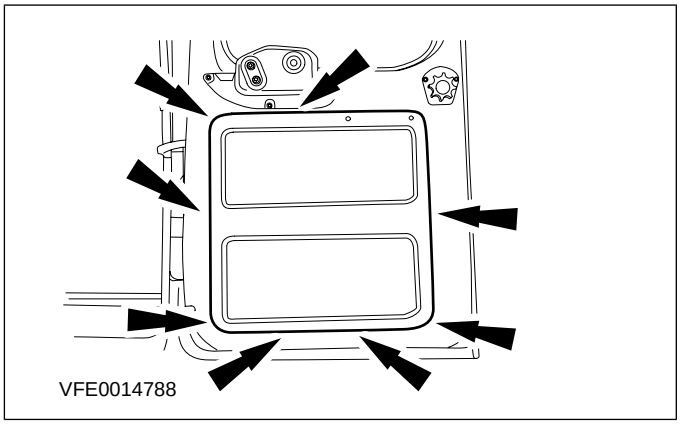
Removal

1. **Remove the rear door interior pull handle (if equipped).**
   - Lever open the covers to expose the bolts.



2. **NOTE:High-level trim panel shown, low-level trim panel similar.**

   Remove the rear door trim panel.



Installation

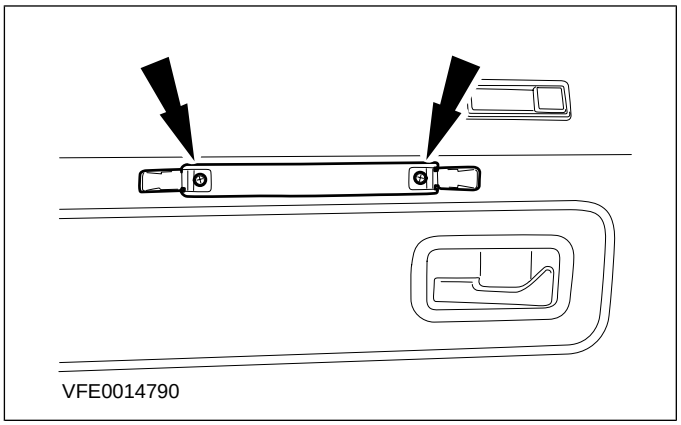
1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

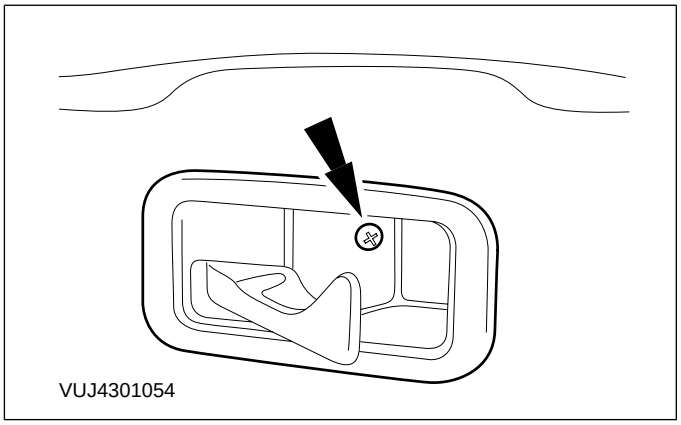
Rear Door Trim Panel — Chassis Cab (43 706 0)

Removal

1. **Remove the rear door interior pull handle.**
   - Lever open the covers to expose the bolts.

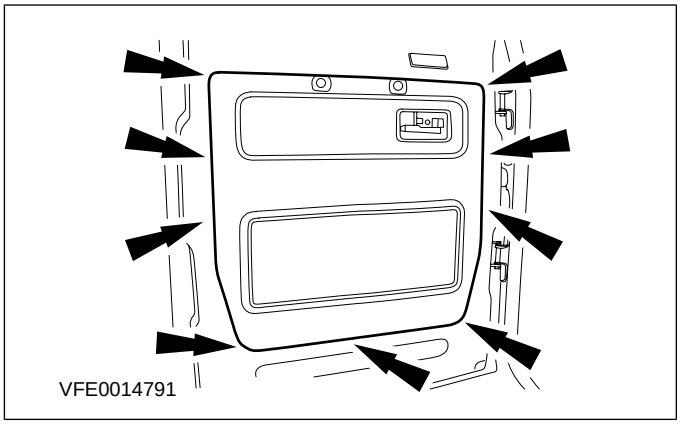

VFE0014790

2. **Remove the rear door latch remote control handle bezel.**


VUJ4301054

3. **NOTE:High-level trim panel shown, low-level trim panel similar.**

   Remove the rear door trim panel.


VFE0014791

Installation

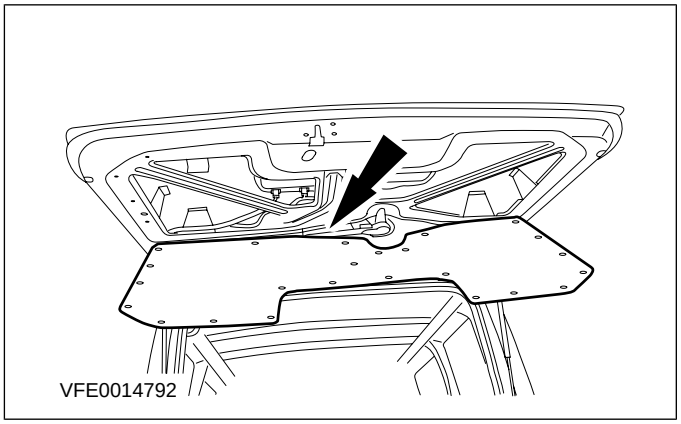
1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

Liftgate Trim Panel (43 744 0)

Removal

1. Remove the liftgate trim panel (24 clips).



Installation

1. To install, reverse the removal procedure.

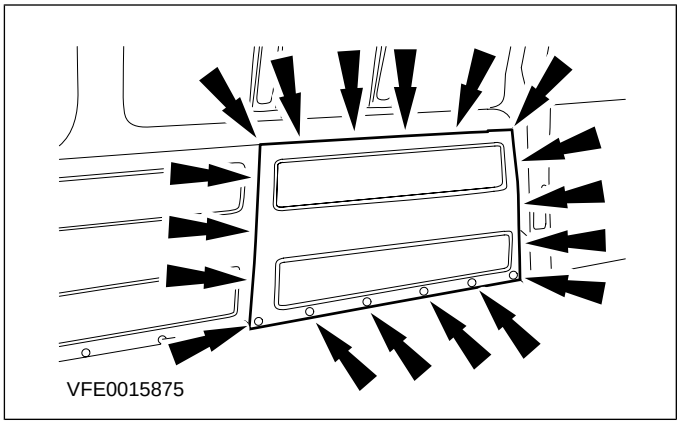
REMOVAL AND INSTALLATION

Loadspace Trim Panel LH (43 746 0)

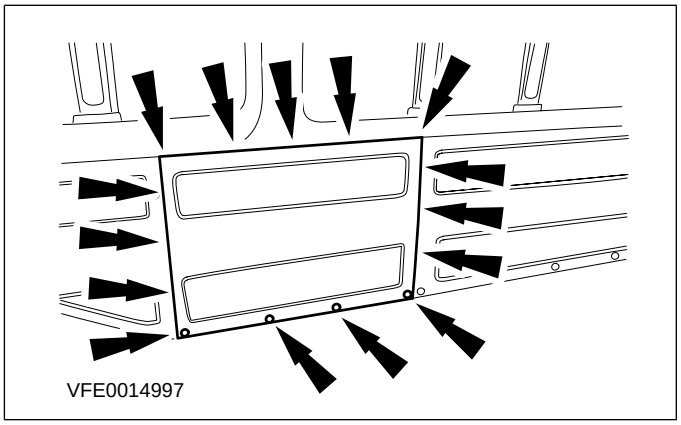
Removal

NOTE: High-level trim panel shown, low-level trim panel similar.

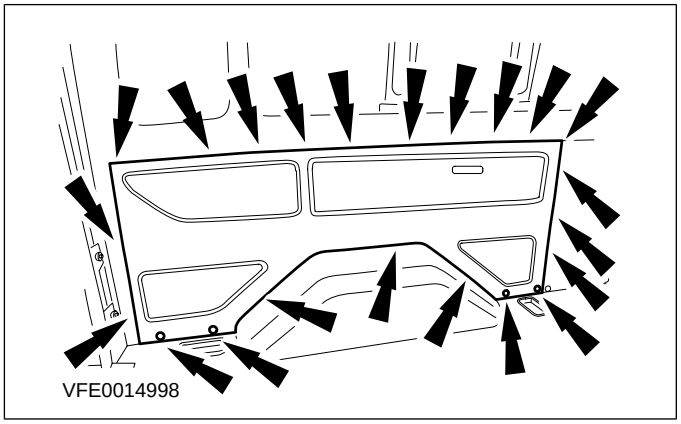
1. **Remove the front section of the load space trim panel.**



2. **Remove the middle section of the load space trim panel.**



3. **Remove the rear section of the load space trim panel.**



Installation

1. **To install, reverse the removal procedure.**

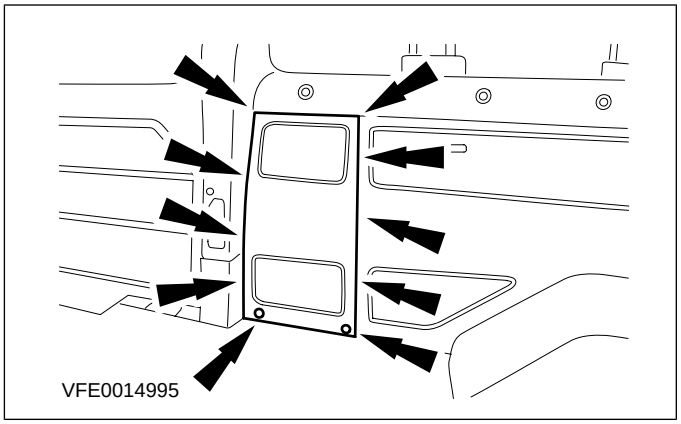
REMOVAL AND INSTALLATION

Loadspace Trim Panel RH (43 746 0)

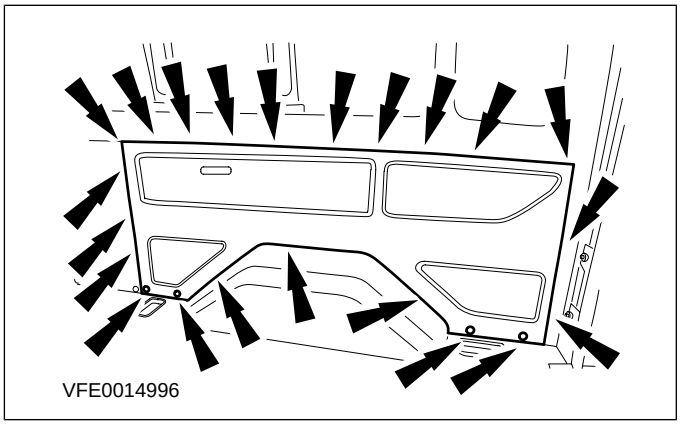
Removal

NOTE: High-level trim panel shown, low-level trim panel similar.

1. **Remove the front section of the load space trim panel.**



2. **Remove the rear section of the load space trim panel.**



Installation

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

Front Headliner (43 609 0)

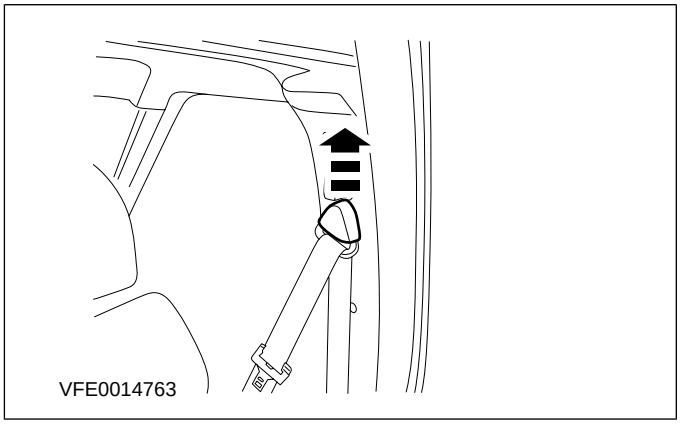
Removal

All vehicles

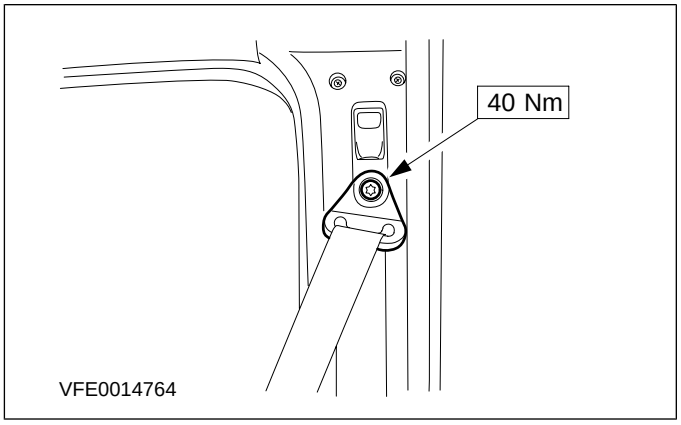
1. **Remove the A-pillar trim panels.**

   For additional information, refer to A-Pillar Trim Panel in this section.

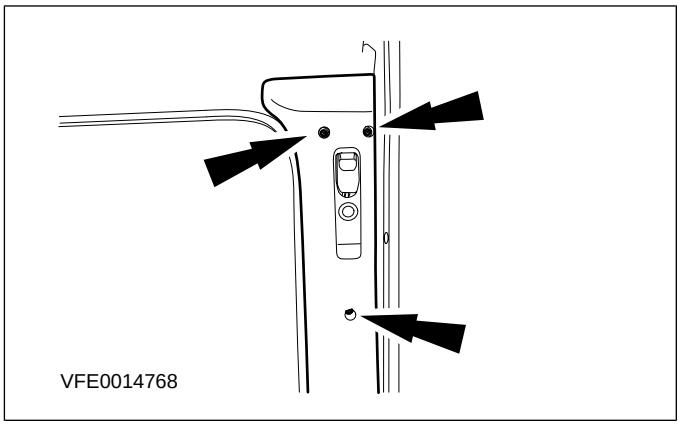
2. **Remove the safety belt upper anchor cover.**



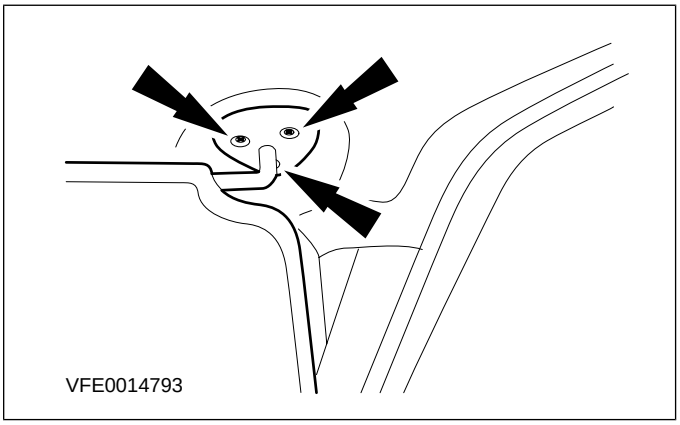
3. **Detach the safety belt upper anchor.**



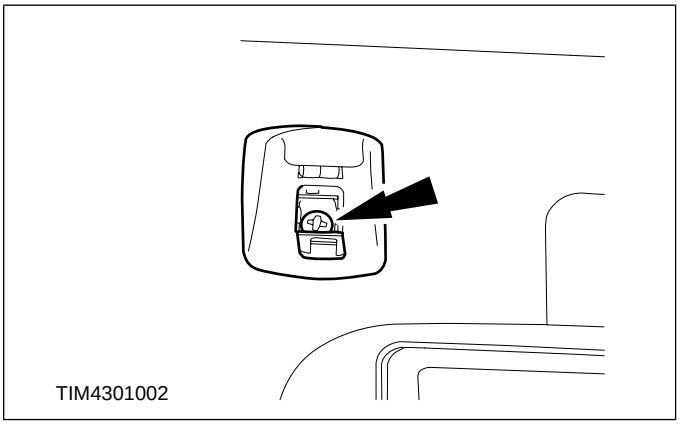
4. **Remove the B-pillar trim panel upper retaining screws.**



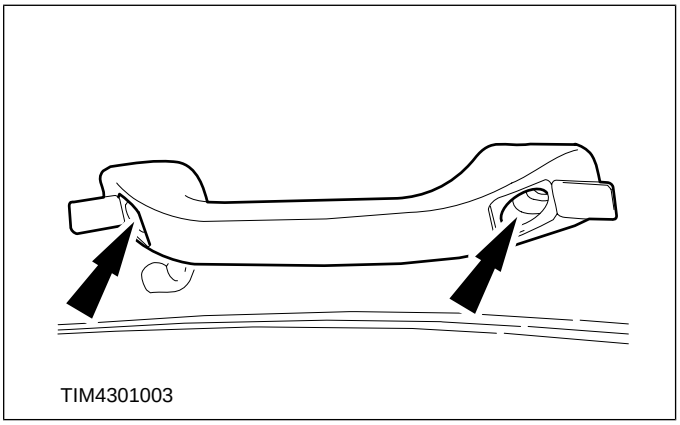
5. **Remove the sun visors.**



6. **Remove the sun visor retaining clips.**



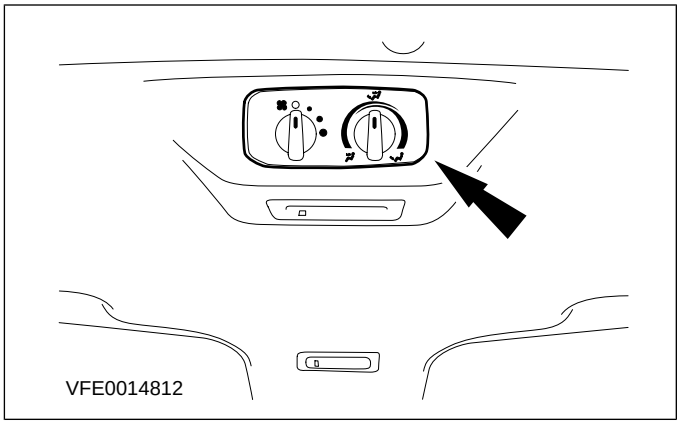
7. **Remove the passenger assist handle.**
   - Lever open the covers to expose the bolts.



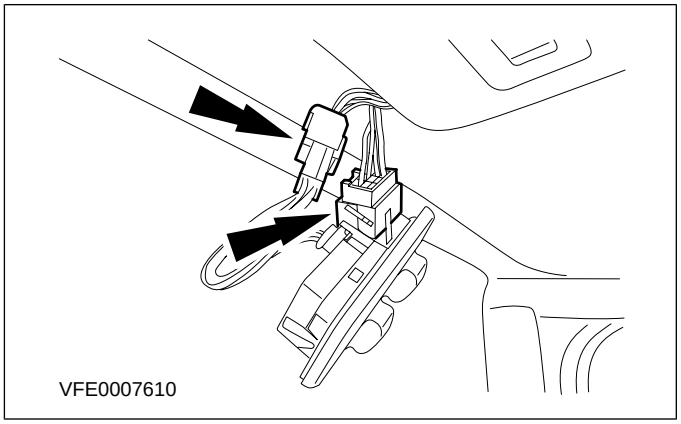
REMOVAL AND INSTALLATION

Vehicles with auxiliary heating

8. Detach the auxiliary heater control assembly.

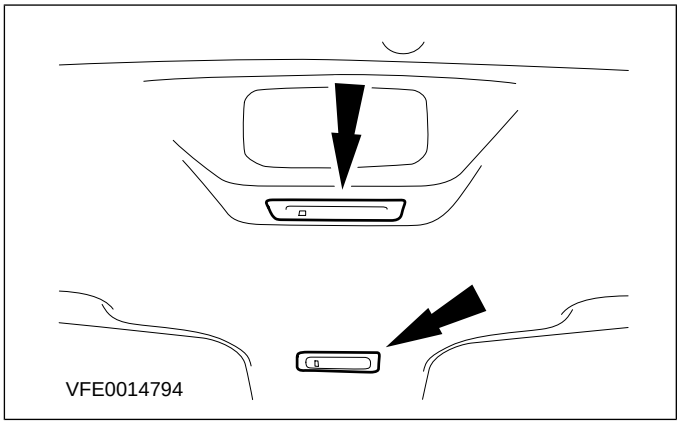

VFE0014812

9. Disconnect the electrical connectors and remove the auxiliary heater control assembly.

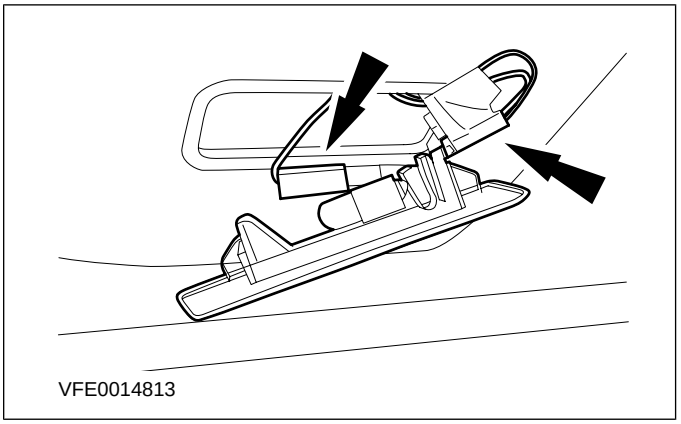

VFE0007610

All vehicles

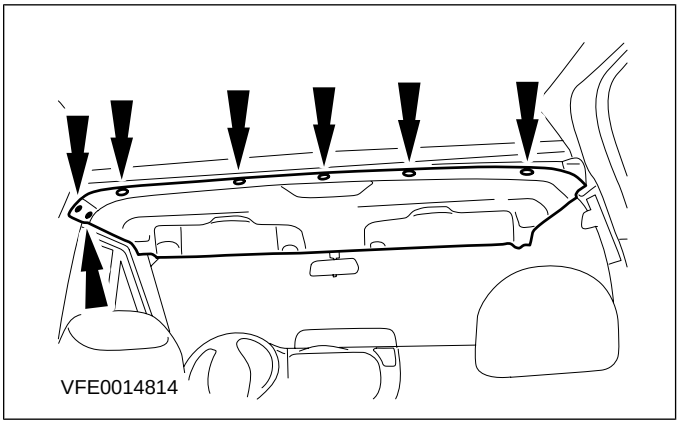
10. Detach the front interior lamps.


VFE0014794

11. Disconnect the electrical connectors and remove the front interior lamps.


VFE0014813

12. Remove the front headliner.


VFE0014814

Installation

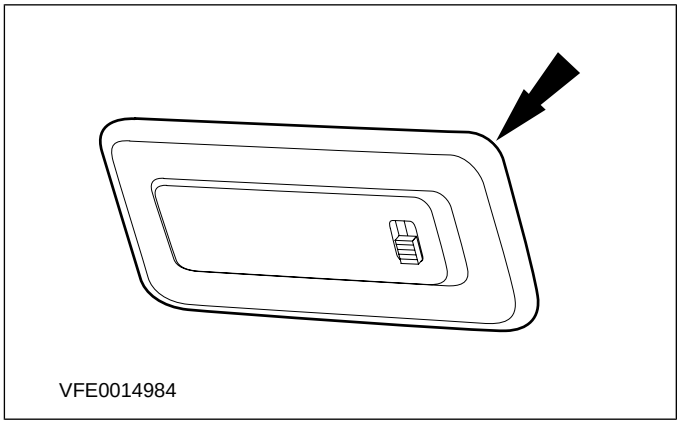
1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

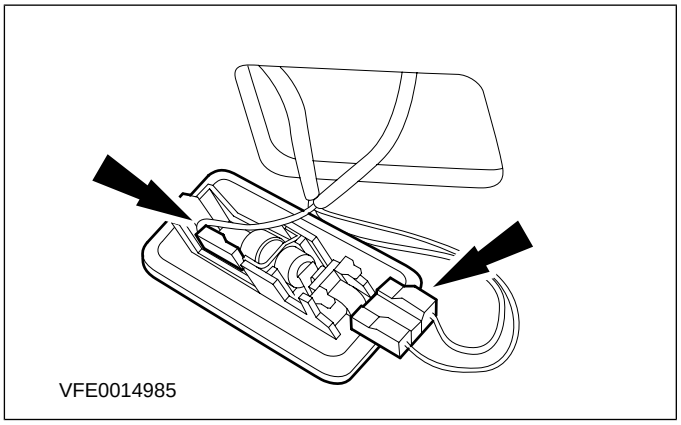
Rear Headliner — Van/Kombi/Bus (43 611 0)

Removal

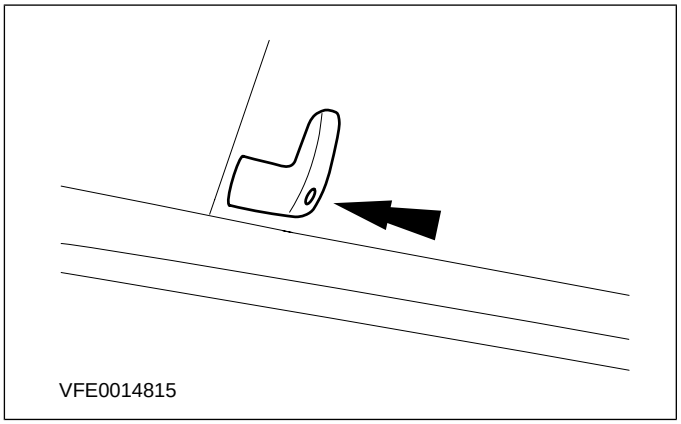
1. **Detach the rear interior lamps.**



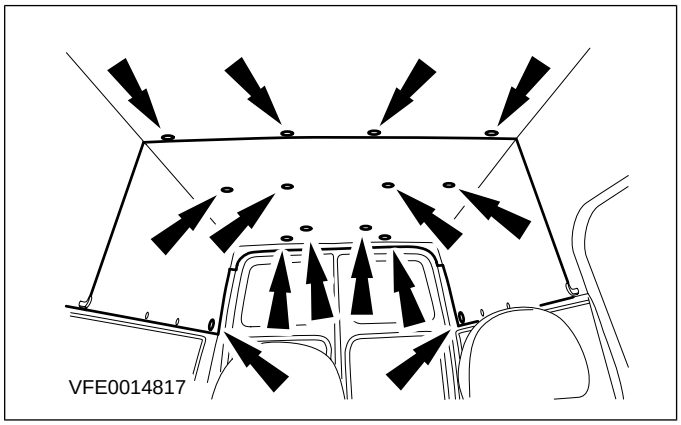
2. **Disconnect the electrical connectors and remove the interior lamps.**



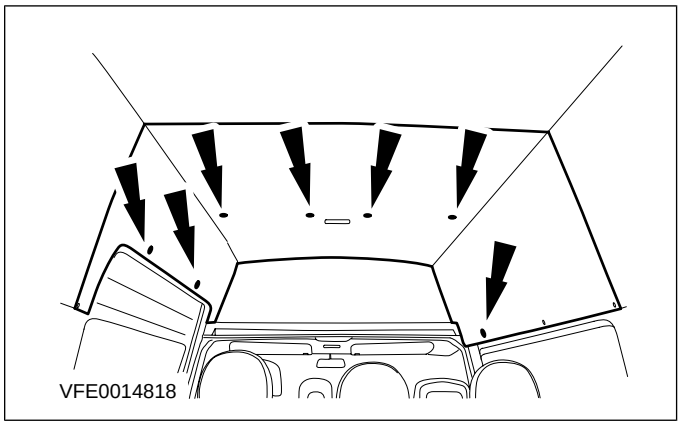
3. **Remove the coat hooks.**



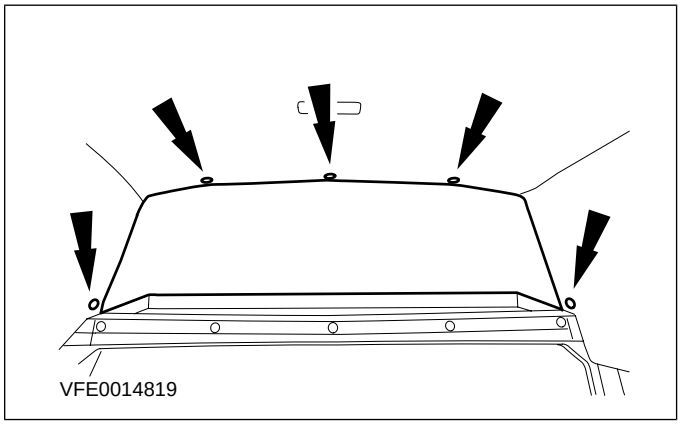
4. **Remove the rear section of the rear headliner.**



5. **Remove the middle section of the rear headliner.**



6. **Remove the front section of the rear headliner.**



Installation

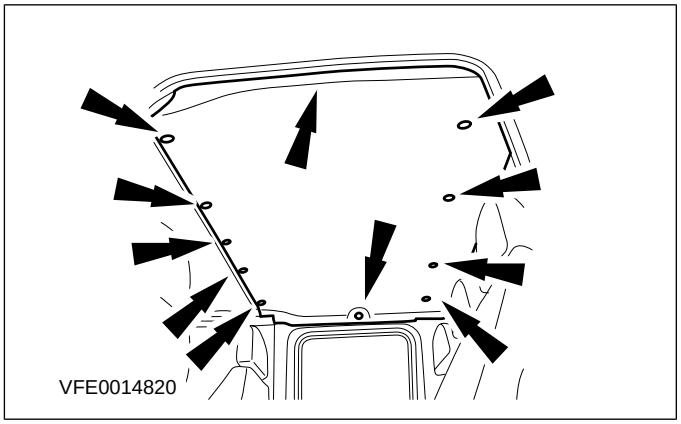
1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

Rear Headliner — Chassis Double Cab (43 611 0)

Removal

1. Remove the rear headliner.



Installation

1. To install, reverse the removal procedure.

SECTION 501-08 Exterior Trim and Ornamentation

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

REMOVAL AND INSTALLATION

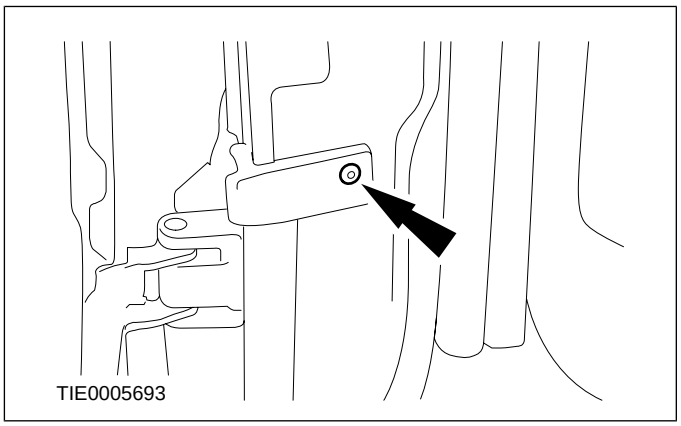
Rear Quarter Panel Moulding..... 501-08-2

REMOVAL AND INSTALLATION

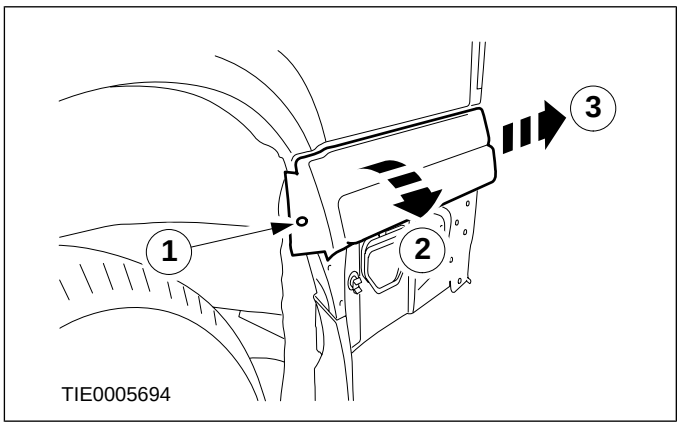
Rear Quarter Panel Moulding

Removal

1. **Remove the rear bumper cover. For additional information, refer to Section 501-19 [Bumpers].**
2. **Detach the rear quarter panel moulding from the inside of the door pillar.**



3. **Remove the rear quarter panel moulding.**
   1. Remove the rivet.
   2. Detach the two clips.
   3. Slide the moulding to the rear.



Installation

1. **To install, reverse the removal procedure.**

SECTION 501-09 Rear View Mirrors

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 501-09-2

DESCRIPTION AND OPERATION

Rear View Mirrors..... 501-09-3

DIAGNOSIS AND TESTING

Rear View Mirrors..... 501-09-4
Inspection and Verification..... 501-09-4
Pinpoint Tests..... 501-09-5

REMOVAL AND INSTALLATION

Exterior Mirror..... (43 364 0) 501-09-15

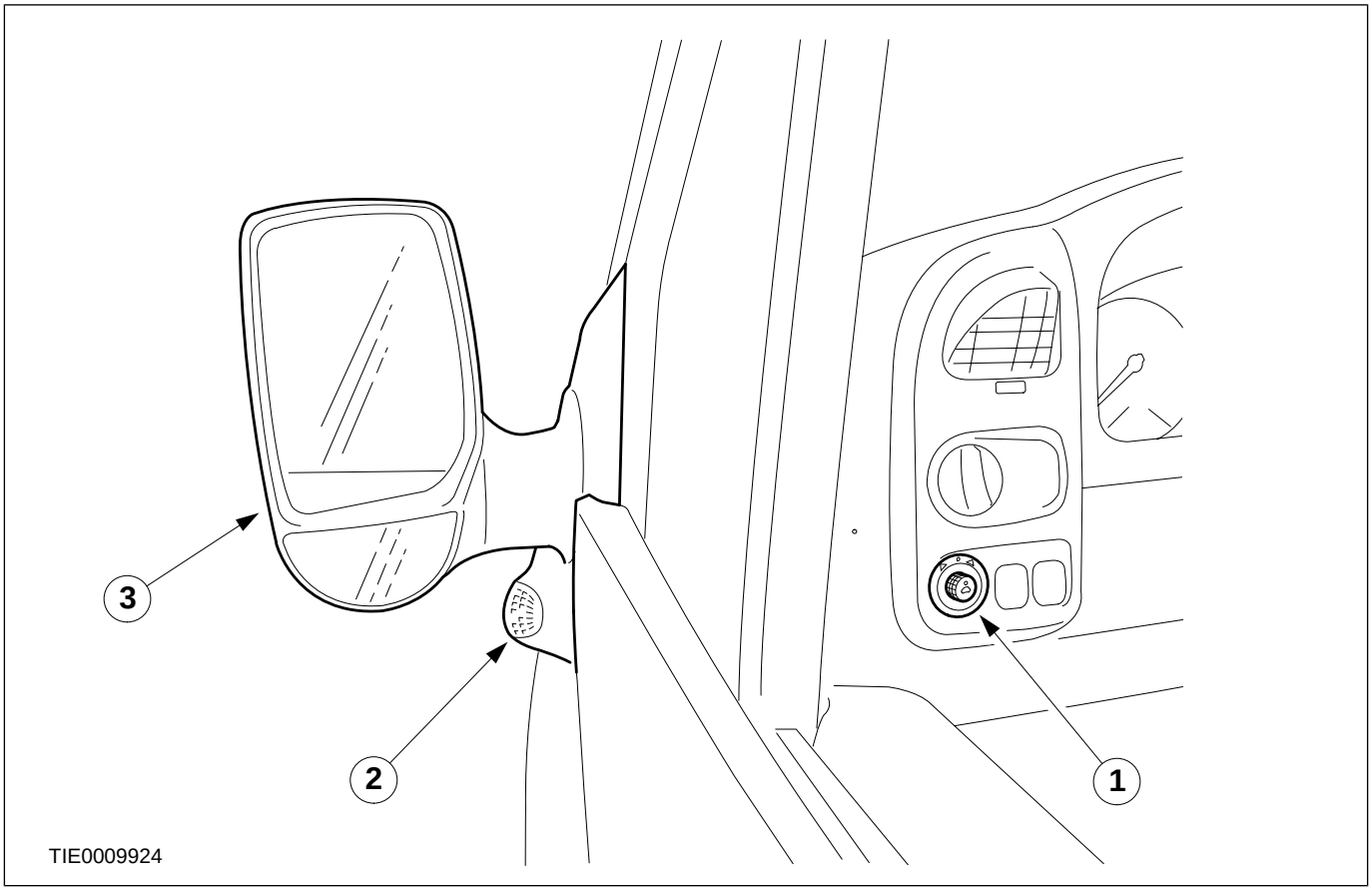
SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Exterior rear view mirror screws	5	-	44

DESCRIPTION AND OPERATION

Rear View Mirrors



Item	Description
1	Exterior rear view mirror control switch
2	Turn signal ``part of the exterior rear view mirror''
3	Exterior rear view mirror

Interior rear view mirrors are fitted as standard with a delete option on vehicles fitted with unglazed full bulkheads, rear doors or liftgate.

The vehicle is equipped with either manual or power adjust exterior rear view mirrors mounted on long or short arms, depending on vehicle specifications and incorporate a wide angle view mirror in the base of the mirror housing. The mirror glass is either convex or flat depending on market requirements.

The mirror sail incorporates a turn signal, depending on vehicle specification.

The power exterior rear view mirror glass has an integral heater element which is controlled by the heated rear window switch and relay. For additional information, refer to the Wiring Diagrams.

DIAGNOSIS AND TESTING

Rear View Mirrors

Refer to Wiring Diagrams Section501-09,for schematic and connector information.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Exterior mirror(s)	– Fuse(s) – Electrical connector(s) – Exterior mirror switch – Heated windshield switch – Heated rear window switch

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

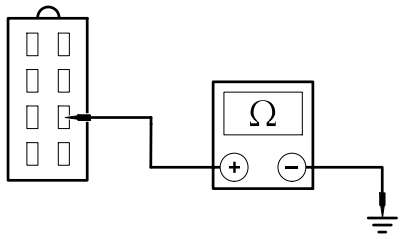
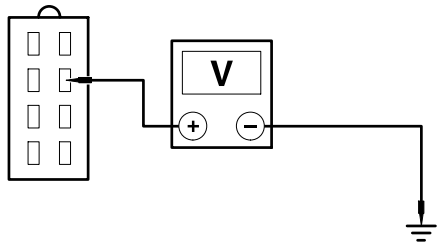
Symptom	Possible Sources	Action
• The exterior mirrors are inoperative	• Exterior mirror switch.	• CARRY OUT the Exterior Mirror Switch Component Test. REFER to the Wiring Diagrams.
	• Circuit(s).	• GO to Pinpoint Test A.
• A single exterior mirror is inoperative	• Exterior mirror switch.	• CARRY OUT the Exterior Mirror Switch Component Test. REFER to the Wiring Diagrams.
	• Exterior mirror motor(s) • Circuit(s).	• GO to Pinpoint Test B.
• A single exterior mirror does not function with switch logic	• Exterior mirror switch.	• CARRY OUT the Exterior Mirror Switch Component Test. REFER to the Wiring Diagrams.
	• Exterior mirror motor(s). • Circuit(s).	• GO to Pinpoint Test C.
• The heated exterior mirror is inoperative	• Heated windshield switch.	• CARRY OUT the Heated Windshield Switch Component Test. REFER to the Wiring Diagrams.
	• Heated rear window switch.	• CARRY OUT the Heated Rear Window Switch Component Test. REFER to the Wiring Diagrams.

DIAGNOSIS AND TESTING

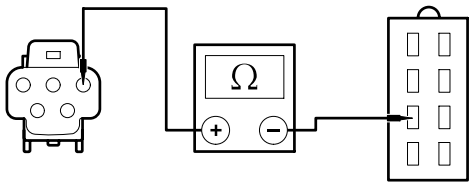
Symptom	Possible Sources	Action
	• Relay. • Heated mirror element(s). • Circuit(s).	• GO to Pinpoint Test D.

Pinpoint Tests

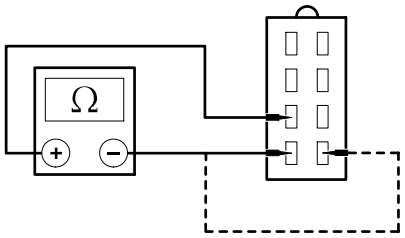
PINPOINT TEST A : THE EXTERIOR MIRRORS ARE INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
A1: CHECK THE EXTERIOR MIRROR SWITCH GROUND CIRCUIT FOR CONTINUITY	
	1 Disconnect Exterior Mirror Switch CPM20.
 TIE0014408	2 Measure the resistance between the exterior mirror switch CPM20 pin 4, circuit A_GD115K (BK/GY) harness side and ground. • Is the resistance less than 5 ohms? → **Yes** GO to A2. → **No** REPAIR circuit A_GD115K (BK/GY). TEST the system for normal operation.
A2: CHECK THE VOLTAGE TO THE EXTERIOR MIRROR SWITCH	
	1 Ignition switch in position II.
 TIE0014407	2 Measure the voltage between the exterior mirror switch CPM20 pin 6, circuit CB140H (YE/GN) harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A3. → **No** REPAIR circuit CB140H (YE/GN). TEST the system for normal operation.
A3: CHECK CIRCUIT RPM08 (GN/BU) FOR CONTINUITY	
	1 Disconnect Driver Side Exterior Mirror CPM26 or CPM31.

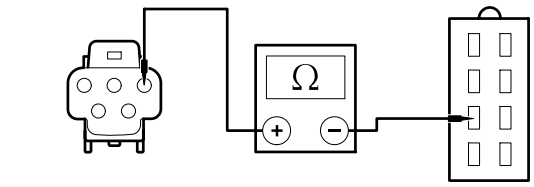
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0028888	2 Measure the resistance between the: Left-hand drive vehicles • Exterior mirror switch CPM20 pin 3, circuit RPM08A (GN/BU) harness side, and the left-hand exterior mirror CPM26 pin 1, circuit RPM08C (GN/BU), harness side. Right-hand drive vehicles • Exterior mirror switch CPM20 pin 3, circuit RPM08A (GN/BU) harness side, and the right-hand exterior mirror CPM31 pin 1, circuit RPM08D (GN/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** VERIFY the customer concern. → **No** REPAIR circuit RPM08A (GN/BU) or circuit RPM08B (GN/BU). TEST the system for normal operation.

PINPOINT TEST B : A SINGLE MIRROR IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
B1: CHECK THE EXTERIOR MIRROR MOTOR CIRCUIT FOR CONTINUITY	
	1 Disconnect Exterior Mirror Switch CPM20.
 TIE0014174	2 Measure the resistance between the: Left-hand side exterior mirror • Exterior mirror switch CPM20 pin 3, circuit RPM08A (GN/BU), harness side and the exterior mirror switch CPM20 pin 1, circuit CPM27A (GY/BU), harness side. Right-hand side exterior mirror • Exterior mirror switch CPM20 pin 3, circuit RPM08A (GN/BU), harness side and the exterior mirror switch CPM20 pin 2, circuit CPM32A (WH/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** VERIFY the customer concern. → **No** GO to B2.

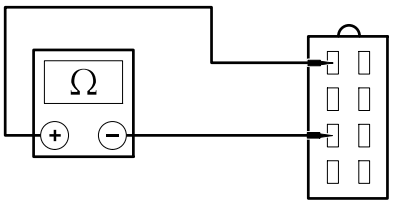
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B2: CHECK FOR CONTINUITY BETWEEN THE EXTERIOR MIRROR SWITCH AND THE EXTERIOR MIRROR	
	1 Disconnect Left-hand Side Exterior Mirror CPM26 or Right-hand Side Exterior Mirror CPM31.
 TIE0028888	2 Measure the resistance between the: Left-hand side exterior mirror • Exterior mirror switch CPM20 pin 3, circuit RPM08A (GN/BU), harness side and the left-hand side exterior mirror CPM26 pin 1, circuit RPM08C (GN/BU), harness side. Right-hand side exterior mirror • Exterior mirror switch CPM20 pin 3, circuit RPM08A (GN/BU), harness side and the right-hand side exterior mirror CPM31 pin 1, circuit RPM08D (GN/BU), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new exterior mirror. REFER to:Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit RPM08C (GN/BU) or circuit RPM08D (GN/BU). TEST the system for normal operation.

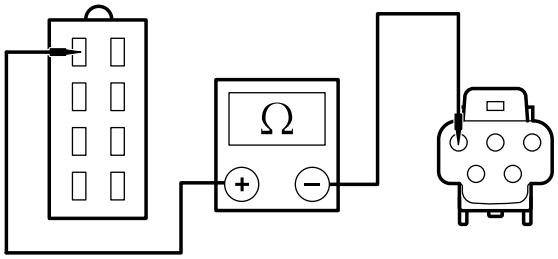
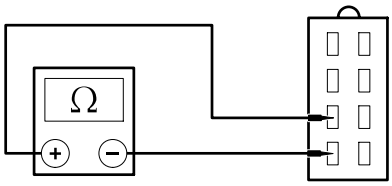
PINPOINT TEST C : A SINGLE MIRROR DOES NOT FUNCTION WITH SWITCH LOGIC

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
C1: CHECK THE EXTERIOR MIRROR FUNCTIONS WITH SWITCH LOGIC	
	1 Ignition switch in position II.

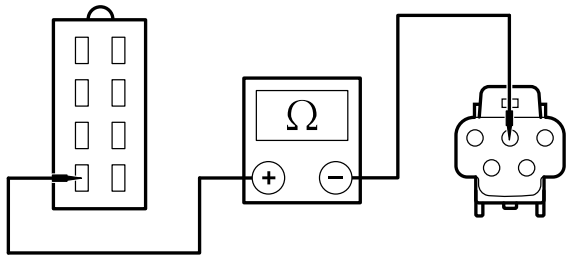
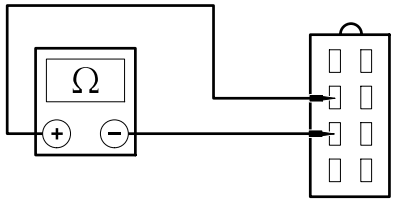
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Operate the exterior mirror switch. • Does the exterior mirror function with switch logic? → **Yes** VERIFY the customer concern. → **No** Left-hand side exterior mirror up/down function inoperative. GO to C2. Left-hand side exterior mirror left/right function is inoperative. GO to C4. Right-hand side exterior mirror up/down function is inoperative. GO to C6. Right-hand side exterior mirror left/right function is inoperative. GO to C8.
C2: CHECK THE LEFT-HAND EXTERIOR MIRROR UP/DOWN CIRCUIT	
	1 Disconnect Exterior Mirror Switch CPM20.
 TIE0023180	2 Measure the resistance between the exterior mirror switch CPM20 pin 3, circuit RPM08A (GN/BU), harness side and the exterior mirror switch CPM20 pin 7, circuit CPM29A (GN), harness side. • Is the resistance less than 50 ohms? → **Yes** VERIFY the customer concern. → **No** GO to C3.
C3: CHECK FOR CONTINUITY BETWEEN THE EXTERIOR MIRROR CONTROL SWITCH AND THE LEFT-HAND SIDE EXTERIOR MIRROR	
	1 Disconnect Left-hand Side Exterior Mirror CPM26.

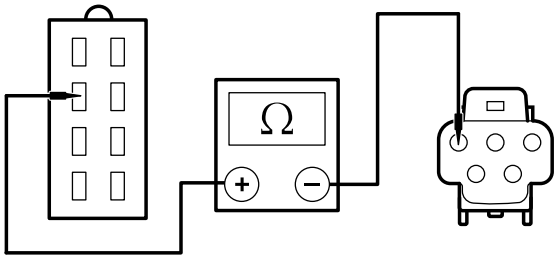
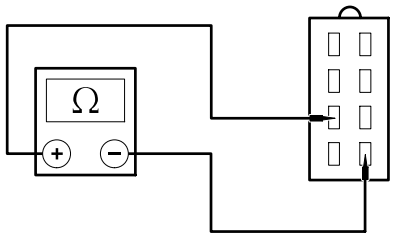
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E47071	2 Measure the resistance between the exterior mirror switch CPM20 pin 7, circuit CPM29A (GN) harness side, and the left-hand exterior mirror CPM26 pin 5, circuit CPM29B (GN) harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new left-hand side exterior mirror. REFER to:Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit CPM29A (GN) or circuit CPM29B (GN). TEST the system for normal operation.
C4: CHECK THE LEFT-HAND EXTERIOR MIRROR LEFT/RIGHT CIRCUIT	
	1 Disconnect Exterior Mirror Switch CPM20.
 TIE0023560	2 Measure the resistance between the exterior mirror switch CPM20 pin 3, circuit RPM08A (GN/BU), harness side and the exterior mirror switch CPM20 pin 1, circuit CPM27A (GY/BU), harness side. • Is the resistance less than 50 ohms? → **Yes** VERIFY the customer concern. → **No** GO to C5.
C5: CHECK FOR CONTINUITY BETWEEN THE EXTERIOR MIRROR CONTROL SWITCH AND THE LEFT-HAND SIDE EXTERIOR MIRROR	
	1 Disconnect Left-hand Side Exterior Mirror CPM26.

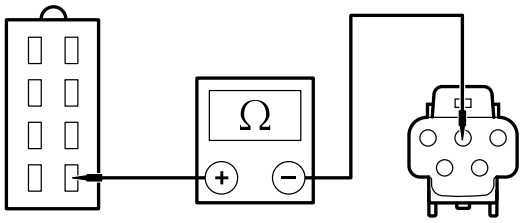
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E47070	2 Measure the resistance between the exterior mirror switch CPM20 pin 1, circuit CPM27A (GY/BU) harness side, and the left-hand exterior mirror CPM26 pin 4, circuit CPM27B (GY/BU) harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new left-hand side exterior mirror. REFER to:Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit CPM27A (GY/BU) or circuit CPM27B (GY/BU). TEST the system for normal operation.
C6: CHECK THE RIGHT-HAND EXTERIOR MIRROR UP/DOWN CIRCUIT	
	1 Disconnect Exterior Mirror Switch CPM20.
 TIE0023559	2 Measure the resistance between the exterior mirror switch CPM20 pin 3, circuit RPM08A (GN/BU), harness side and the exterior mirror switch CPM20 pin 5, circuit CPM34A (WH/BN), harness side. • Is the resistance less than 50 ohms? → **Yes** VERIFY the customer concern. → **No** GO to C7.
C7: CHECK FOR CONTINUITY BETWEEN THE EXTERIOR MIRROR CONTROL SWITCH AND THE RIGHT-HAND SIDE EXTERIOR MIRROR	
	1 Disconnect Right-hand Side Exterior Mirror CPM31.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E47069	2 Measure the resistance between the exterior mirror switch CPM20 pin 5, circuit CPM34A (WH/BN) harness side, and the right-hand exterior mirror CPM31 pin 5, circuit CPM34B (WH/BN) harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new right-hand side exterior mirror. REFER to:Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit circuit CPM34A (WH/BN) or circuit CPM34B (WH/BN). TEST the system for normal operation.
C8: CHECK THE RIGHT-HAND EXTERIOR MIRROR LEFT/RIGHT CIRCUIT	
	1 Disconnect Exterior Mirror Switch CPM20.
 TIE0023558	2 Measure the resistance between the exterior mirror switch CPM20 pin 3, circuit RPM08A (GN/BU), harness side and the exterior mirror switch CPM20 pin 2, circuit CPM32A (WH/BU), harness side. • Is the resistance less than 50 ohms? → **Yes** VERIFY the customer concern. → **No** GO to C9.
C9: CHECK FOR CONTINUITY BETWEEN THE EXTERIOR MIRROR CONTROL SWITCH AND THE RIGHT-HAND SIDE EXTERIOR MIRROR	
	1 Disconnect Right-hand Exterior Mirror CPM31.

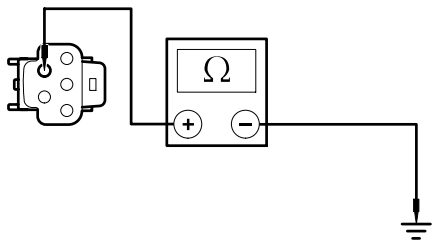
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E47068	2 Measure the resistance between the exterior mirror switch CPM20 pin 2, circuit CPM32A (WH/BU) harness side, and the right-hand exterior mirror CPM31 pin 4, circuit CPM32B (WH/BU) harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new right-hand side exterior mirror. REFER to:Exterior Mirror (501-09 Rear View Mirrors, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit circuit CPM32A (WH/BU) or circuit CPM32B (WH/BU). TEST the system for normal operation.

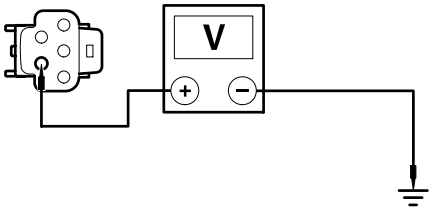
PINPOINT TEST D : THE HEATED EXTERIOR MIRROR IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
D1: CHECK THE VEHICLE FEATURES	
	1 Check the vehicle features. • Is the vehicle equipped with a heated rear window? → **Yes** GO to D2. → **No** GO to D3.
D2: CHECK THE OPERATION OF THE HEATED REAR WINDOW	
	1 Ignition switch in position II.
	2 Operate the heated rear window switch. • Does the heated rear window function correctly? → **Yes** GO to D4. → **No** REPAIR the heated rear window electrical circuit. REFER to:Glass, Frames and Mechanisms (501-11 Glass, Frames and Mechanisms, Diagnosis and Testing). TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D3: CHECK THE OPERATION OF THE HEATED WINDSHIELD	
	1 Ignition switch in position III.
	2 Ignition switch in position II.
	3 Operate the heated windshield switch. • Does the heated windshield function correctly? → **Yes** GO to D4. → **No** REPAIR the heated windshield electrical circuit. REFER to:Glass, Frames and Mechanisms (501-11 Glass, Frames and Mechanisms, Diagnosis and Testing). TEST the system for normal operation.
D4: CHECK THE INOPERATIVE EXTERIOR MIRROR GROUND CIRCUIT FOR CONTINUITY	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand Side Exterior Mirror CPM26 or Right-hand Side Exterior Mirror CPM31.
 TIE0003068	3 Measure the resistance between the: Vehicles with Thatcham category 1 alarm • Left-hand side exterior mirror CPM26 pin 2, circuit A_GD133C (BK), harness side and ground. • Right-hand side exterior mirror CPM31 pin 2, circuit A_GD138C (BK/WH), harness side and ground. Vehicles without Thatcham category 1 alarm • Left-hand side exterior mirror CPM26 pin 2, circuit A_GD133B (BK), harness side and ground. • Right-hand side exterior mirror CPM31 pin 2, circuit A_GD138R (BK), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** GO to D5. → **No** REPAIR circuit circuit A_GD133B (BK), or circuit A_GD133C (BK), or circuit A_GD138C (BK/WH) or circuit A_GD138R (BK). TEST the system for normal operation.

DIAGNOSIS AND TESTING

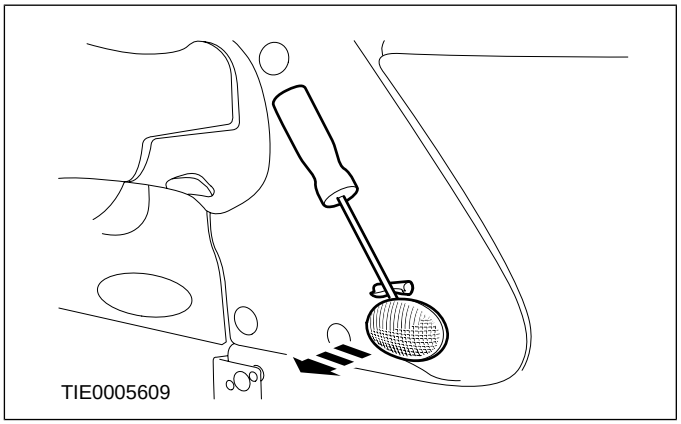
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D5: CHECK THE VOLTAGE TO THE INOPERATIVE EXTERIOR MIRROR	
	1 Ignition switch in position II.
	2 Operate the heated rear window control switch.
 TIE0003067	3 Measure the voltage between the: Vehicles with Thatcham category 1 alarm • Left-hand side exterior mirror CPM26 pin 3, circuit CB146B (WH/BU), harness side and ground. • Right-hand side exterior mirror CPM31 pin 3, circuit CB146C (WH/BU), harness side and ground. Vehicles without Thatcham category 1 alarm • Left-hand side exterior mirror CPM26 pin 3, circuit CB159C (VT/RD), harness side and ground. • Right-hand side exterior mirror CPM31 pin 3, circuit CB159B (VT/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** INSTALL a new heated exterior mirror glass. TEST the system for normal operation. → **No** REPAIR circuit circuit CB146B (WH/BU), or circuit CB146C (WH/BU), or circuit CB159B (VT/RD) or circuit CB159C (VT/RD). TEST the system for normal operation.

REMOVAL AND INSTALLATION

Exterior Mirror (43 364 0)

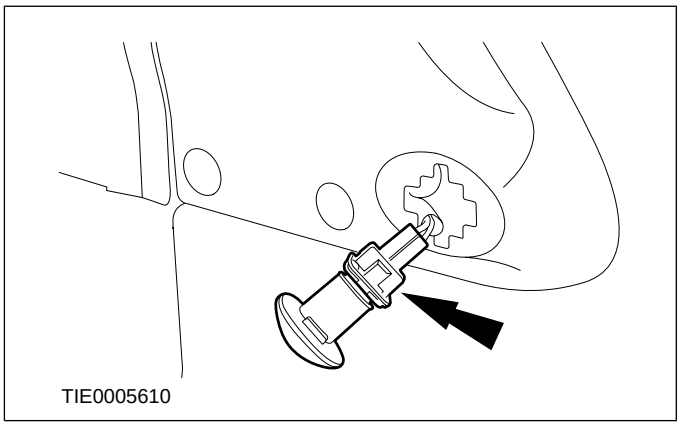
Removal

1. Using a suitable screwdriver, detach the turn signal from the trim panel.



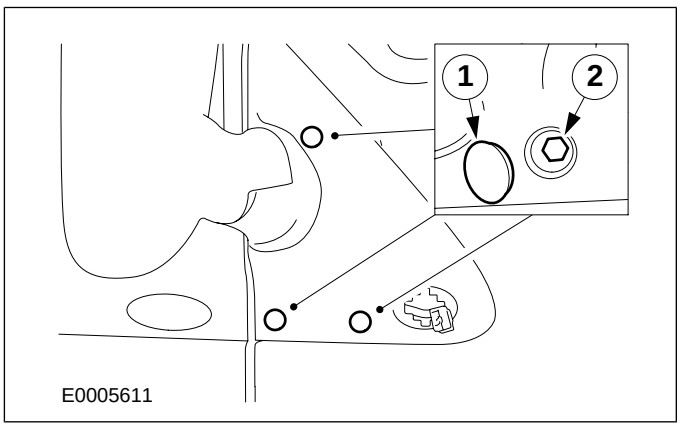
2. Remove the turn signal.

- Disconnect the electrical connector.



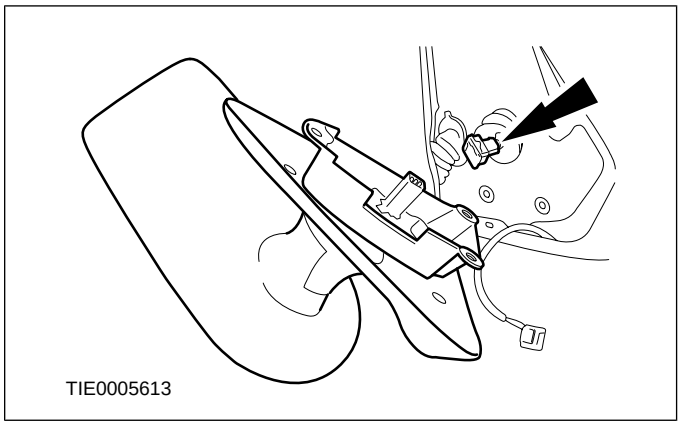
3. Detach the mirror.

1. Remove the screw covers.
2. Remove the screws.



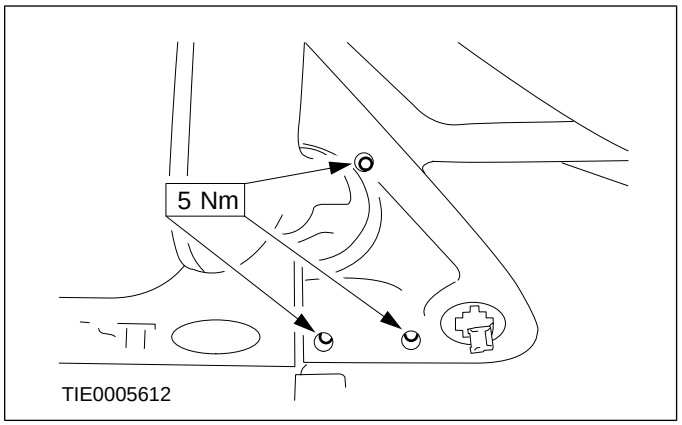
4. Remove the mirror.

- Disconnect the mirror electrical connector.



Installation

1. To install, reverse the removal procedure.



SECTION 501-10 Seating

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 501-10-2

DESCRIPTION AND OPERATION

Seats — Vehicles With: Central Junction Box (CJB) 501-10-3

DIAGNOSIS AND TESTING

Seats 501-10-4
- Inspection and Verification 501-10-4
- Symptom Chart 501-10-4
- Pinpoint Tests 501-10-4

REMOVAL AND INSTALLATION

Front Seat Backrest 501-10-12
Double Passenger Seat 501-10-13
Seat Track 501-10-15
Front Seat ..... (40 100 0) 501-10-16

DISASSEMBLY AND ASSEMBLY

Front Seat Cushion ..... (40 104 0) 501-10-18
Double Passenger Seat Cushion 501-10-20
Rear Seat Cushion — Chassis Double Cab 501-10-22
Treble Second Row Seat Cushion 501-10-24
Treble Third Row Seat Cushion 501-10-26
Front Seat Backrest ..... (40 106 0) 501-10-28
Double Passenger Seat Backrest 501-10-30
Rear Seat Backrest — Chassis Double Cab ..... (40 127 0) 501-10-33
Treble Second Row Seat Backrest 501-10-35
Treble Third Row Seat Backrest 501-10-38

SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Adjustable front seat track retaining bolts	25	18	-
Adjustable front seat pedestal retaining bolts	47	35	-
Fixed seat retaining bolts	47	35	-
Treble seat striker plate retaining bolts	90	66	-
Treble seat claw retaining bolts	25	18	-
Seat outer trim panel retaining screws	3	-	27
Seat front trim panel retaining screws	3	-	27
Seat rear trim panel retaining screws	3	-	27
Adjustable front seat armrest retaining bolt	29	21	-
Adjustable front seat backrest retaining bolts	25	18	-
Treble third row seat backrest retaining bolts	25	18	-
Treble third row seat backrest latch retaining bolts	25	18	-
Treble seat center armrest bracket retaining bolts	25	18	-
Treble seat center armrest pivot bolt	25	18	-
Treble seat release handle pivot bolt	8	-	71
Lumbar control retaining screws	2	-	18
Safety belt retractor retaining bolts	40	30	-
Safety belt buckle retaining bolts	40	30	-
Safety belt lower anchor bolts	40	30	-
Safety belt upper anchor bolts	40	30	-

DESCRIPTION AND OPERATION

Seats — Vehicles With: Central Junction Box (CJB)

The adjustable driver and passenger seat are pedestal mounted. The seats are equipped (depending on the seat specification) with fore and aft track movement, cushion tilt and height adjust and manually inflatable lumbar support.

A release handle under the front of the seat operates the fore and aft movement. Cushion tilt and height adjust are operated by two release levers mounted on the outboard trim panel. A manual pump mounted on the outboard side of the seat backrest operates the lumbar support.

The seat backrest has a headrestraint integrated into the standard backrest frame. The optional seat backrest has a height adjustable headrestraint and an armrest.

The adjustable driver and passenger seat have optional heated backrest and cushion. The heated seat switch is located on the front of the seat pedestal.

The single fixed passenger seat has an integrated headrestraint. The seat has a two-position floor mounting; the forward position is utilized on vans and kombis and depends on which full rear panel is fitted, the rearward position is used on all other variants.

The double passenger seat (depending on vehicle specification) can have either the integral or height adjustable headrestraints. On vehicles equipped with a passenger air bag the seat has an integral three-point lap and diagonal safety belt. The double passenger seat has a two-position floor mounting.

The Chassis Double Cab rear seat has a single fixed position and the seat backrest has adjustable headrestraints.

All third row and certain second row Kombi rear seats are detachable. The seat locking claws are released by cable operated by a rear mounted release handle. Detachable seats are equipped with spring loaded rollers which raise the seat when the locking claws are released.

The Kombi second row seat has a split backrest. The third row seat has a folding backrest which is locked in position by two latches.

Kombi rear seats are equipped with integral three-point lap and diagonal safety belts.

DIAGNOSIS AND TESTING

Seats

Refer to Wiring Diagrams Section501-10,for schematic and connector information.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Electrical
– Fuse – Wiring harness – Electrical connector(s) – Switch(es)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom Chart

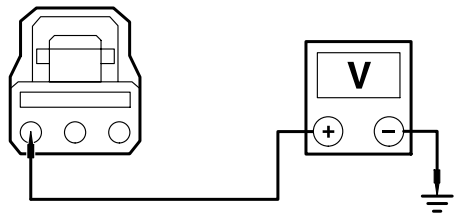
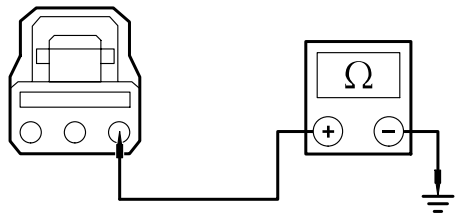
Symptom	Possible Sources	Action
• The heated seats are inoperative	• Circuit(s)	• GO to Pinpoint Test A.
• The heated seat is inoperative	• Switch	• CARRY OUT the Heated Seat Switch Component Test. REFER to the Wiring Diagrams.
	• Heater mat(s) • Circuit(s)	• GO to Pinpoint Test B.

Pinpoint Tests

PINPOINT TEST A : THE HEATED SEATS ARE INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
A1: CHECK FOR VOLTAGE TO THE LEFT-HAND HEATED SEAT	
	1 Disconnect Left-hand Heated Seat CI0176A.
	2 Ignition switch in position III.
	3 Ignition switch in position II.

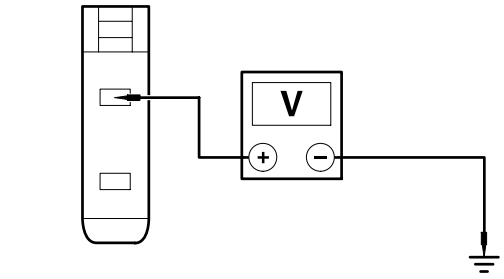
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Measure the voltage between the: Left-hand drive vehicles • left-hand heated seat CI7601D pin 3, circuit CB143B (GY), harness side and ground. Right-hand drive vehicles • left-hand heated seat CI0176A pin 3, circuit CB143C (GY), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to A2. → **No** Repair circuit CB143B (GY) or CB143C (GY). TEST the system for normal operation.
A2: CHECK THE LEFT-HAND HEATED SEAT GROUND CIRCUIT	
	1 Ignition switch in position 0.
 E69298	2 Measure the resistance between the: Left-hand drive vehicles • left-hand heated seat CI7601D pin 1, circuit A_GD138D (BK/WH), harness side and ground. Right-hand drive vehicles • left-hand heated seat CI0176A pin 1, circuit A_GD138E (BK/WH), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** VERIFY the customer concern. → **No** Repair circuit A_GD138D (BK/WH) or A_GD138E (BK/WH). TEST the system for normal operation.

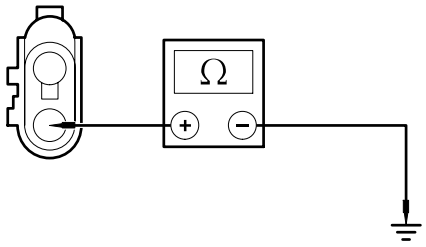
PINPOINT TEST B : THE HEATED SEAT IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
B1: CHECK FOR VOLTAGE TO THE INOPERATIVE HEATED SEAT SWITCH	
	1 Disconnect Inoperative Heated Seat Switch CHS29 or CHS30.
	2 Ignition switch in position III.
	3 Ignition switch in position II.

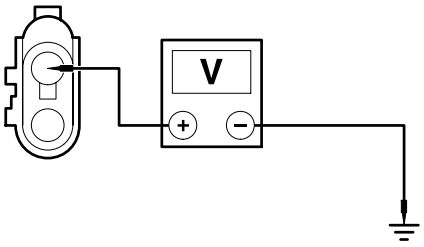
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0013528	4 Measure the voltage between the: Left-hand drive vehicles • inoperative driver heated seat switch CHS29 pin 1, circuit CB143A (GY), harness side and ground. • inoperative passenger heated seat switch CHS30 pin 1, circuit CB143C (GY), harness side and ground. Right-hand drive vehicles • inoperative driver heated seat switch CHS30 pin 1, circuit CB143D (GY), harness side and ground. • inoperative passenger heated seat switch CHS29 pin 1, circuit CB143E (GY), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to B2. → **No** REPAIR circuit CB143A (GY), or circuit CB143C (GY), or circuit CB143D (GY) or circuit CB143E (GY). TEST the system for normal operation.
B2: CHECK THE GROUND CIRCUIT FOR CONTINUITY	
	1 Ignition switch in position 0.
	2 Connect Inoperative Heated Seat Switch CHS29 or CHS30.
	3 Disconnect Inoperative Seat Backrest Heater Mat CHS01 or CHS06.

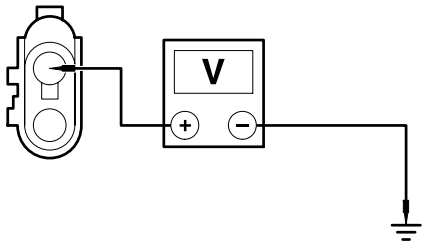
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0011129	4 Measure the resistance between the: Left-hand drive vehicles • inoperative driver side heated seat backrest heater mat CHS01 pin 2, circuit A_GD138Y (BK/WH), harness side and ground. • inoperative passenger side heated seat backrest heater mat CHS06 pin 2, circuit A_GD138W (BK/WH), harness side and ground. Right-hand drive vehicles • inoperative driver side heated seat backrest heater mat CHS06 pin 2, circuit A_GD138Y (BK/WH), harness side and ground. • inoperative passenger side heated seat backrest heater mat CHS01 pin 2, circuit A_GD138W (BK/WH), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** GO to B3. → **No** REPAIR circuit A_GD138W (BK/WH) or circuit A_GD138Y (BK/WH). TEST the system for normal operation.
B3: CHECK THE VOLTAGE TO THE INOPERATIVE HEATED SEAT BACKREST	
	1 Ignition switch in position III.
	2 Ignition switch in position II.
	3 Operate the inoperative heated seat switch CHS29 or CHS30.

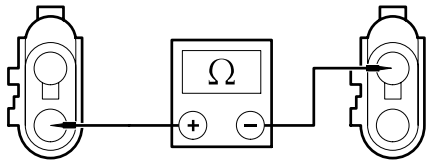
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0011128	4 Measure the voltage between the: Left-hand drive vehicles • inoperative driver side heated seat backrest heater mat CHS01 pin 1, circuit CHS11B (VT/GN), harness side and ground. • inoperative passenger side heated seat backrest heater mat CHS06 pin 1, circuit CHS12A (YE/GN), harness side and ground. Right-hand drive vehicles • inoperative driver side heated seat backrest heater mat CHS06 pin 1, circuit CHS12A (YE/GN), harness side and ground. • inoperative passenger side heated seat backrest heater mat CHS01 pin 1, circuit CHS11A (VT/GN), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** INSTALL a new heated seat backrest heater mat. TEST the system for normal operation. → **No** GO to B4.
B4: CHECK THE VOLTAGE TO THE INOPERATIVE HEATED SEAT CUSHION	
	1 Ignition switch in position 0.
	2 Disconnect Inoperative Seat Cushion Heater Mat CHS02 or CHS07.
	3 Ignition switch in position III.
	4 Ignition switch in position II.

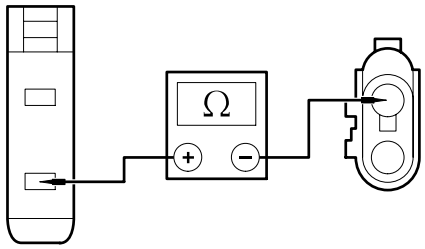
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E0011128	5 Measure the voltage between the: Left-hand drive vehicles • inoperative driver side heated seat cushion heater mat CHS02 pin 1, circuit CHS29A (WH/BU), harness side and ground. • inoperative passenger side heated seat cushion heater mat CHS07 pin 1, circuit CHS30A (GN/YE), harness side and ground. Right-hand drive vehicles • inoperative driver side heated seat cushion heater mat CHS07 pin 1, circuit CHS30A (GY/YE), harness side and ground. • inoperative passenger side heated seat cushion heater mat CHS07 pin 1, circuit CHS29A (BU/BK), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to B5. → **No** GO to B6.
B5: CHECK THE INOPERATIVE BACKREST SUB-HARNESS FOR CONTINUITY	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0013530	2 Measure the resistance between the: Left-hand drive vehicles • inoperative driver side heated seat backrest heater mat CHS01 pin 1, circuit CHS11B (VT/GN), harness side and the inoperative driver side heated seat cushion heater mat CHS02 pin 2, circuit CHS11B (VT/GN), harness side. • inoperative passenger side heated seat backrest heater mat CHS06 pin 1, circuit CHS12A (YE/GN), harness side and the inoperative passenger side heated seat cushion heater mat CHS07 pin 2, circuit CHS12A (YE/GN), harness side. Right-hand drive vehicles • inoperative driver side heated seat backrest heater mat CHS06 pin 1, circuit CHS12A (YE/GN), harness side and the inoperative driver side heated seat cushion heater mat CHS07 pin 2, circuit CHS12A (YE/GN), harness side. • inoperative passenger side heated seat backrest heater mat CHS01 pin 1, circuit CHS11A (VT/GN), harness side and the inoperative passenger side heated seat cushion heater mat CHS02 pin 2, circuit CHS11A (VT/GN), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new heated seat cushion heater mat. TEST the system for normal operation. → **No** REPAIR circuit CHS11A (VT/GN), or circuit CHS11B (VT/GN) or circuit CHS12A (YE/GN). TEST the system for normal operation.
B6: CHECK THE INOPERATIVE CUSHION HEATER SUB-HARNESS FOR CONTINUITY	
	1 Disconnect Inoperative Heated Seat Switch CHS29 or CHS30.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0013529	2 Measure the resistance between the: Left-hand drive vehicles • inoperative driver side heated seat switch CHS29 pin 2, circuit CHS29A (WH/BU), harness side and the inoperative driver side heated seat cushion heater mat CHS02 pin 1, circuit CHS29A (WH/BU), harness side. • inoperative passenger side heated seat switch CHS30 pin 1, circuit CHS30A (GY/YE), harness side and the inoperative passenger side heated seat cushion heater mat CHS07 pin 1, circuit CHS30A (GY/YE), harness side. Right-hand drive vehicles • inoperative driver side heated seat switch CHS30 pin 2, circuit CHS30A (GY/YE), harness side and the inoperative driver side heated seat cushion heater mat CHS07 pin 1, circuit CHS30A (GY/YE), harness side. • inoperative passenger side heated seat switch CHS29 pin 2, circuit CHS29A (BU/BK), harness side and the inoperative passenger side heated seat cushion heater mat CHS02 pin 1, circuit CHS29A (BU/BK), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new heated seat switch. TEST the system for normal operation. → **No** REPAIR circuit CHS29A (WH/BU), or circuit CHS29A (BU/BK) or circuit CHS30A (GY/YE). TEST the system for normal operation.

REMOVAL AND INSTALLATION

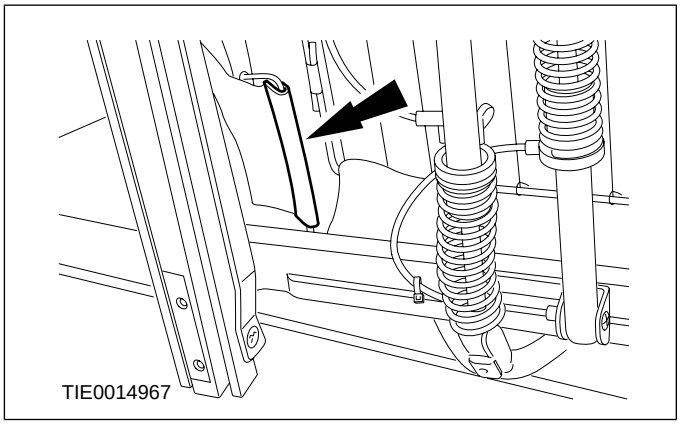
Front Seat Backrest

Removal

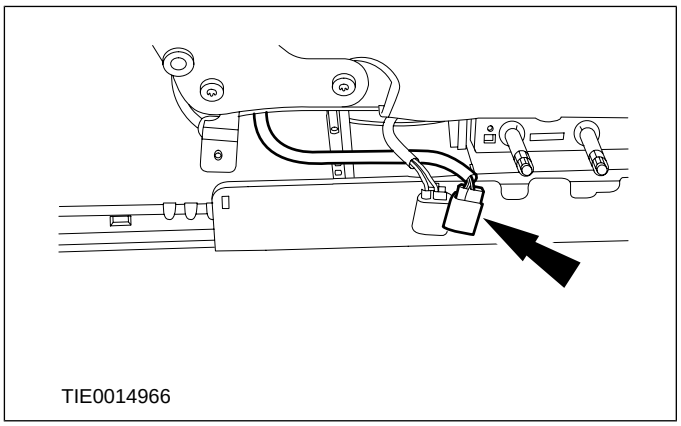
1. **Remove the front seat.**

   For additional information, refer to:Front Seat (501-10 Seating, Removal and Installation).

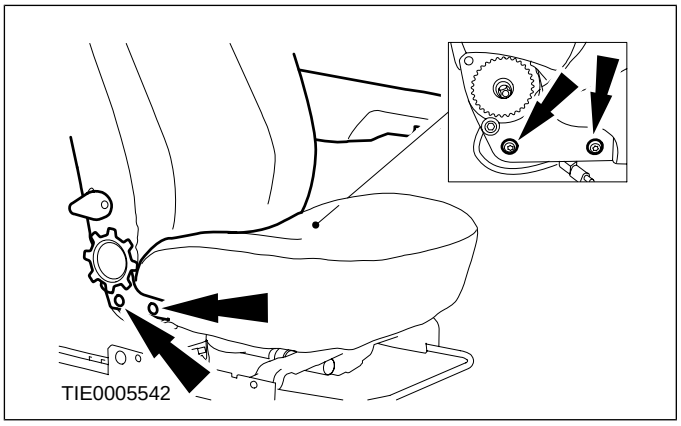
2. **Detach the cushion cover retaining strips from the seat track.**



3. **Detach the backrest heater mat electrical connector from the seat track (if equipped).**

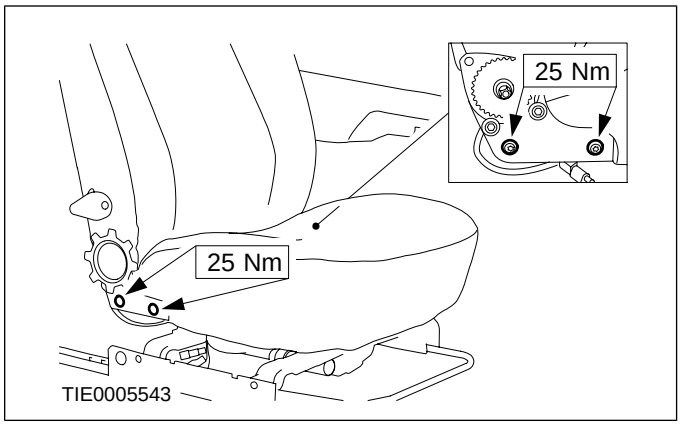


4. **Remove the front seat backrest.**



Installation

1. **To install, reverse the removal procedure.**

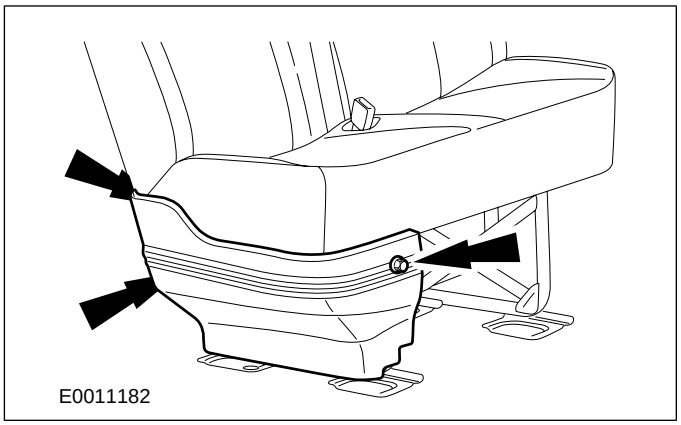


REMOVAL AND INSTALLATION

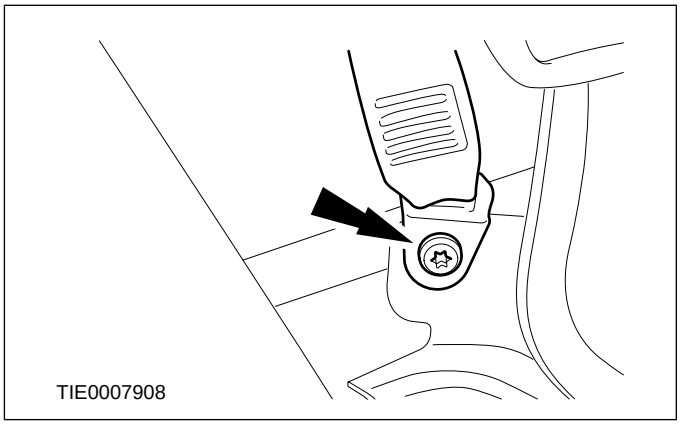
Double Passenger Seat

Removal

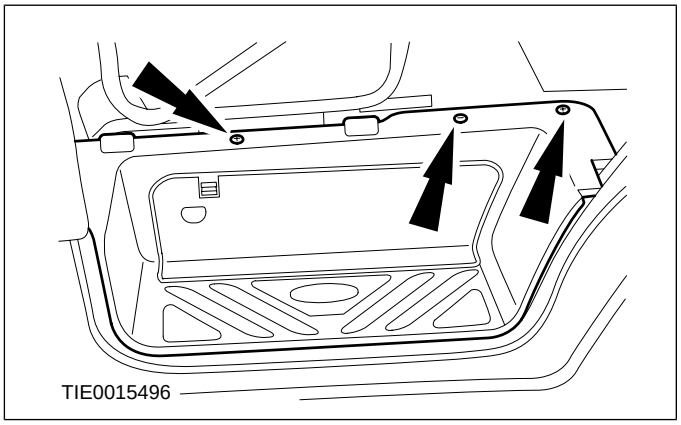
1. **Remove the seat outer trim panel.**



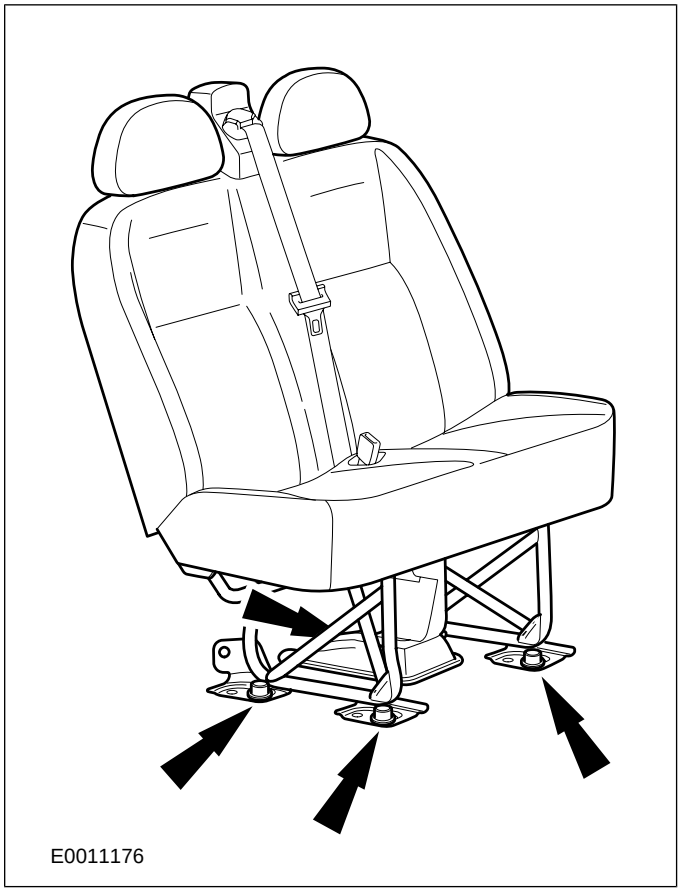
2. **Detach the safety belt lower anchor from the seat.**



3. **Remove the step well.**



4. **Remove the seat.**

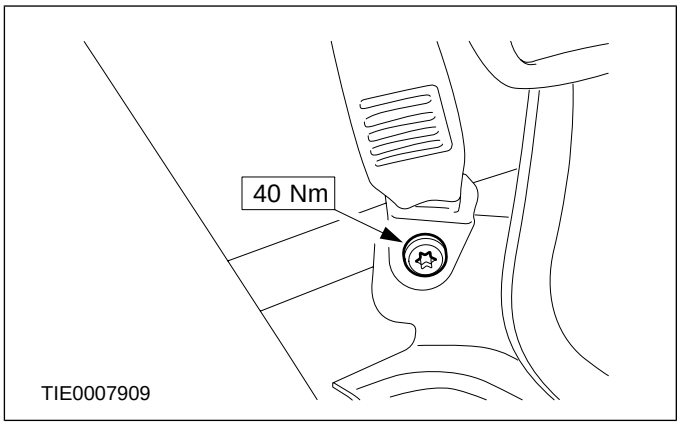


REMOVAL AND INSTALLATION

Installation

1. To install, reverse the removal procedure.





REMOVAL AND INSTALLATION

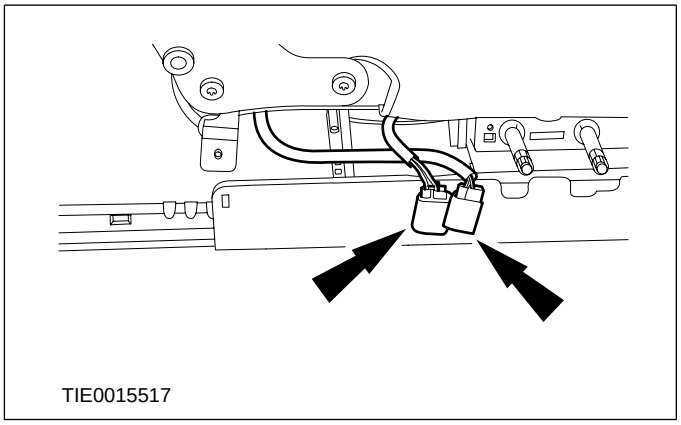
Seat Track

Removal

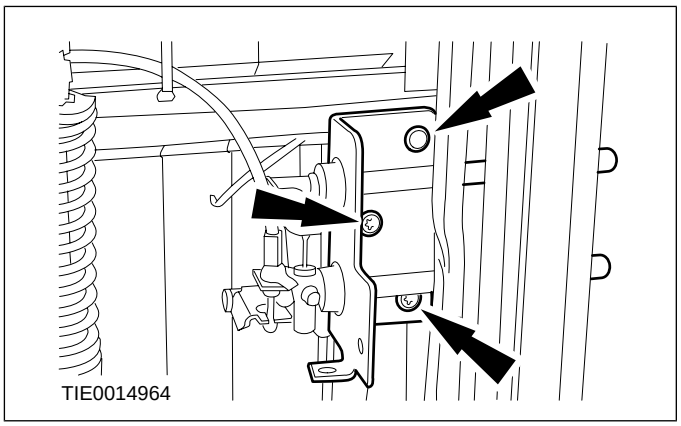
1. **Remove the front seat.**

   For additional information, refer to:Front Seat (501-10 Seating, Removal and Installation).

2. **Detach the heated seat electrical connectors (if equipped).**

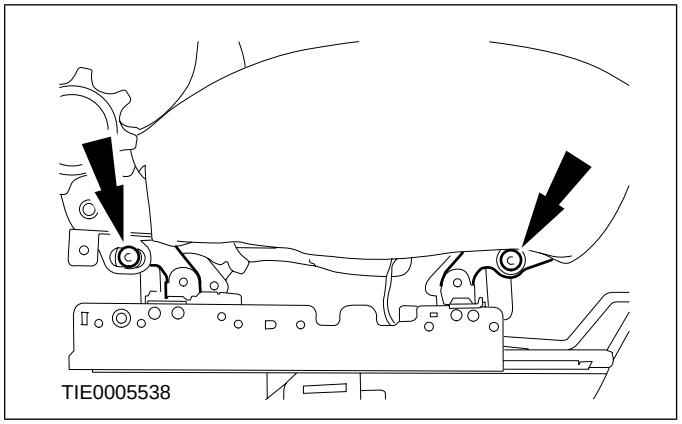


3. **Detach the seat adjuster bracket from the seat cushion.**



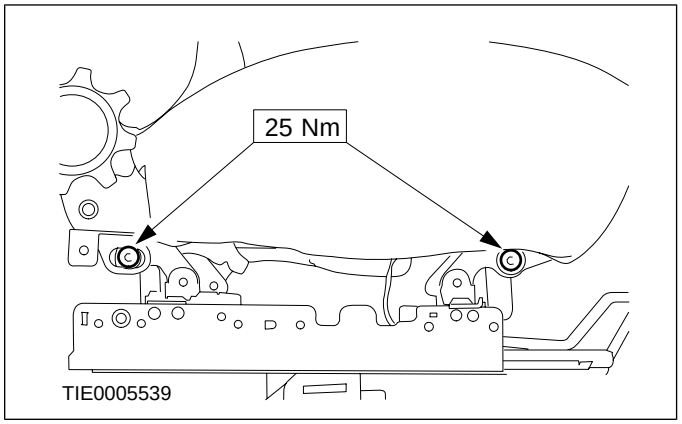
4. **NOTE:Mark the position of both rear retaining bolt spacers to aid installation.**

Remove the seat track (four bolts).



Installation

1. **To install, reverse the removal procedure.**



REMOVAL AND INSTALLATION

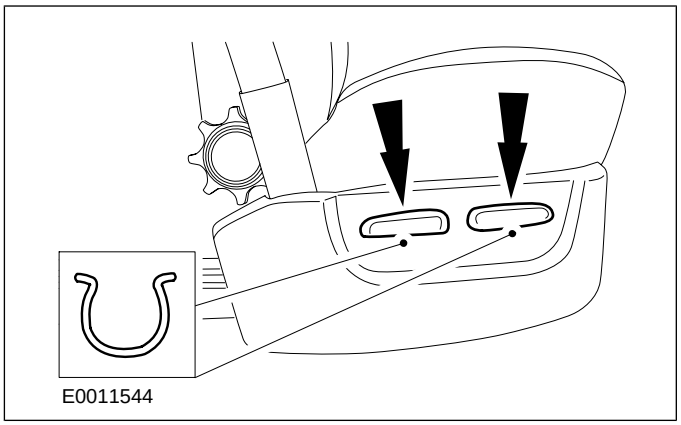
Front Seat (40 100 0)

Removal

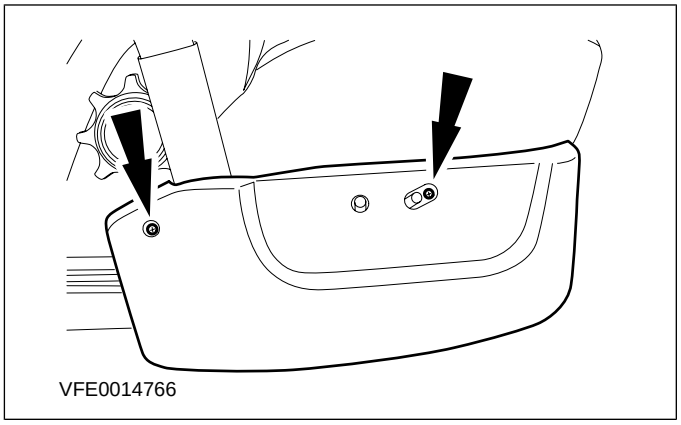
1. Disconnect the battery ground cable.

   For additional information, refer to: Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

2. Remove the seat height adjust levers.



3. Remove the seat outer trim panel.



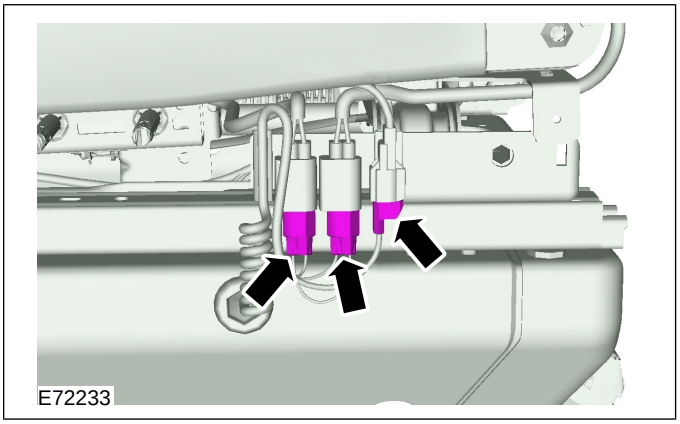
4. WARNINGS:

   The supplemental restraint system (SRS) is active for a certain length of time after the power supply has been disconnected. Wait 3 minutes before disconnecting or removing any SRS components.

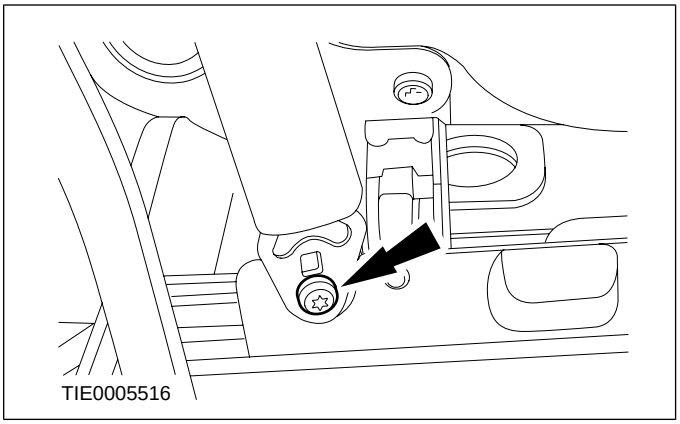
   Do not probe supplemental restraint system (SRS) electrical connectors.

   Always carry a live air bag module away from the body with the air bag or trim cover pointed away from the body.

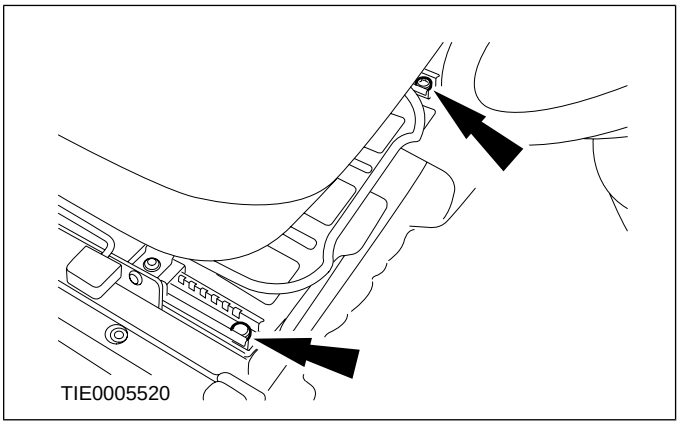
   Disconnect the heated seat and side air bag module electrical connectors (if equipped).



5. Detach the safety belt lower anchor from the seat.



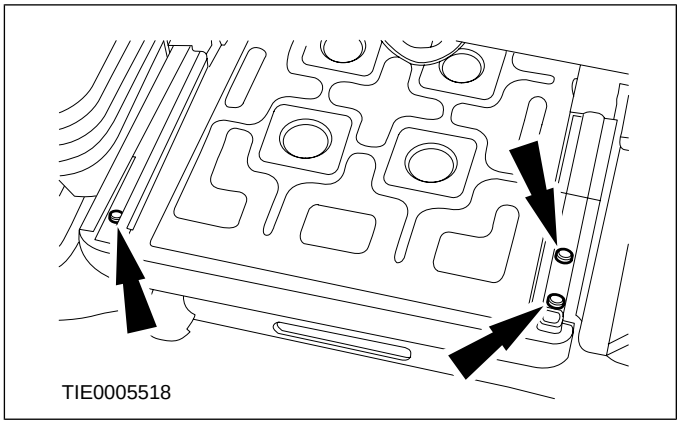
6. Move the seat fully rearwards.
7. Remove the seat front retaining bolts.

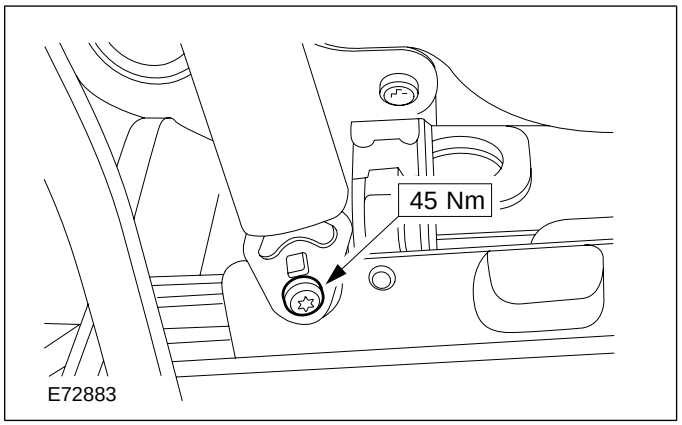


8. Move the seat fully forwards.

REMOVAL AND INSTALLATION

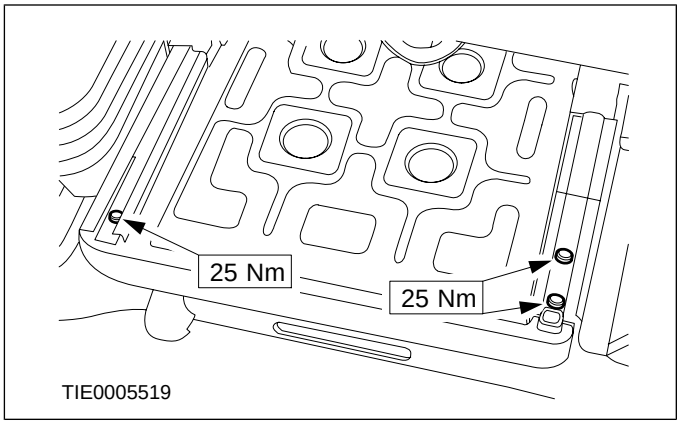
9. Remove the rear retaining bolts and remove the seat.

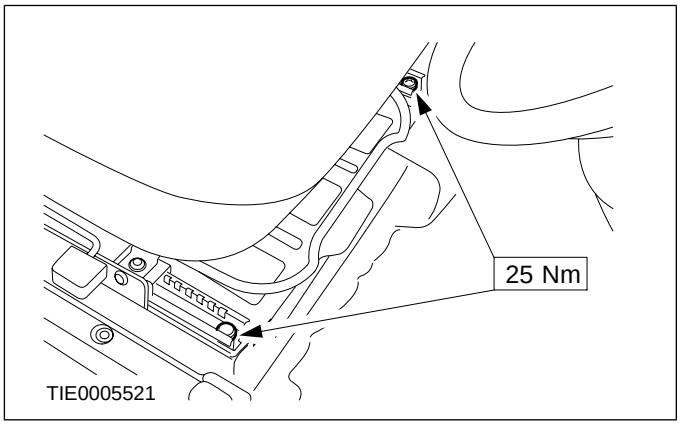




Installation

1. To install, reverse the removal procedure.





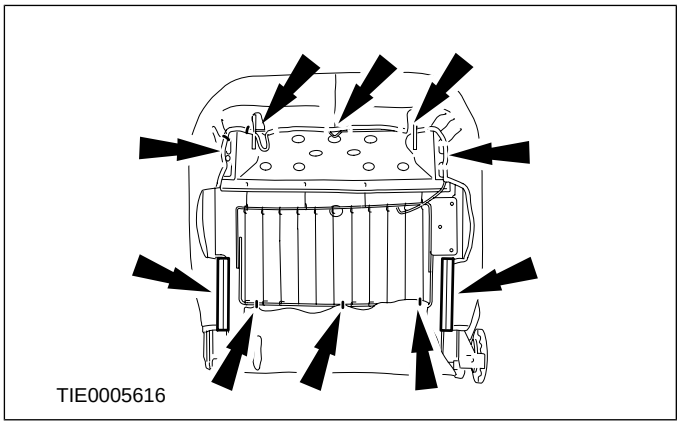
DISASSEMBLY AND ASSEMBLY

Front Seat Cushion (40 104 0)

Disassembly

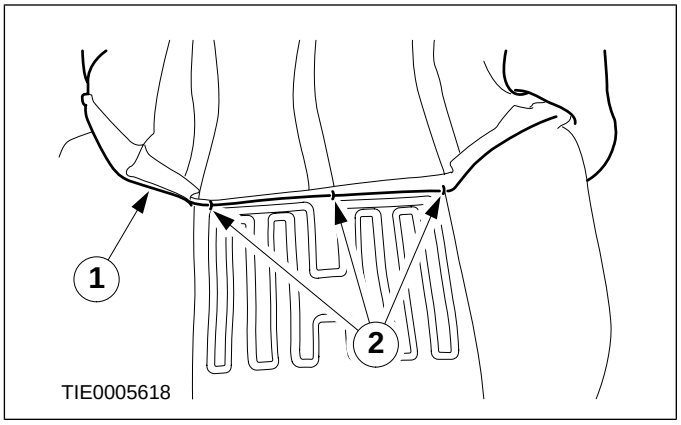
1. Detach the cushion cover from the underside of the seat.

- Cut the hog rings.
- Detach the retaining strips.


TIE0005616

2. Remove the cushion cover.

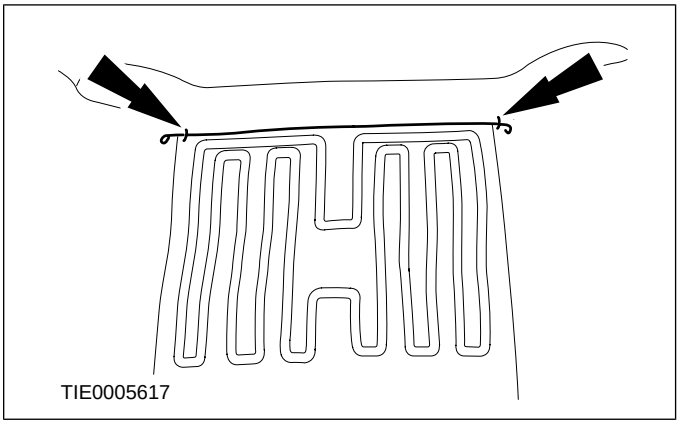
1. Roll the cushion cover back to access the pleating hog rings.
2. Cut the hog rings.



TIE0005618

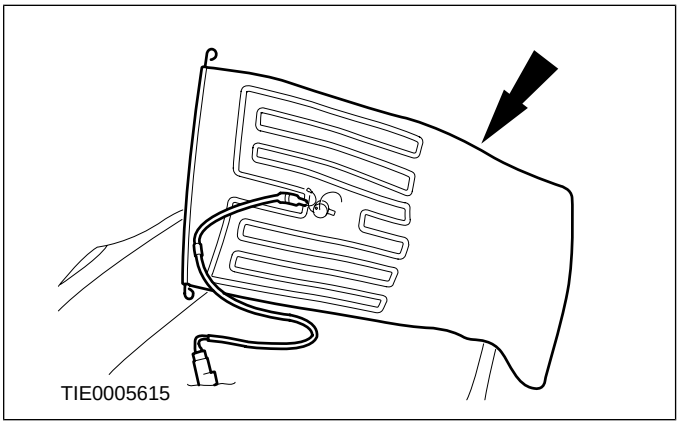
3. Detach the heated seat mat from the cushion (if equipped).

- Cut the hog rings.


TIE0005617

4. Remove the heated seat mat (if equipped).

- Feed the heated seat mat wiring harness through the cushion.


TIE0005615

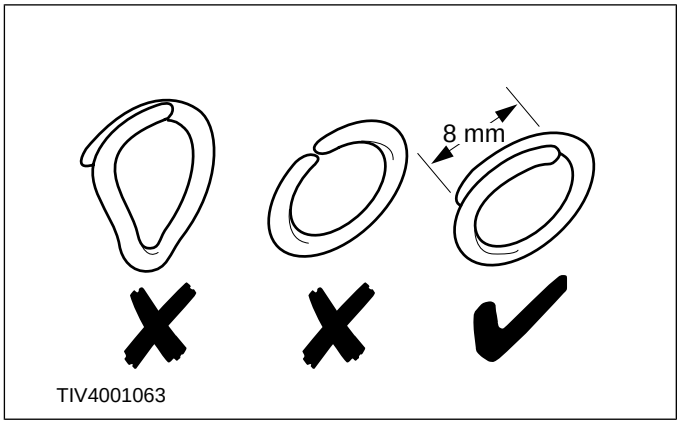
5. Remove the front seat cushion.

Assembly

1. NOTE:Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

DISASSEMBLY AND ASSEMBLY

To assemble, reverse the disassemble procedure.



DISASSEMBLY AND ASSEMBLY

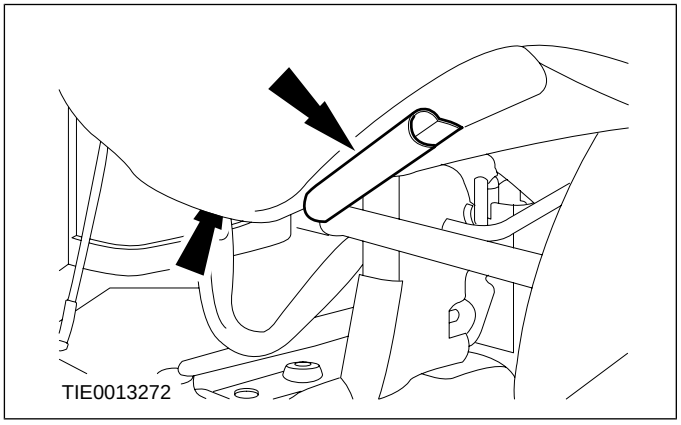
Double Passenger Seat Cushion

Disassembly

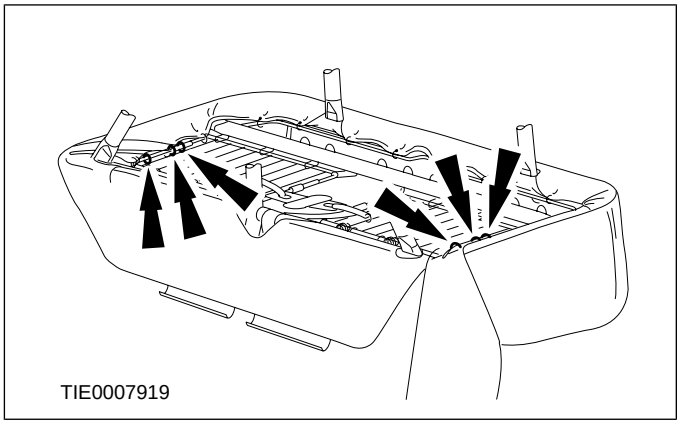
1. **Remove the passenger seat.**

   For additional information, refer to:Double Passenger Seat (501-10 Seating, Removal and Installation).

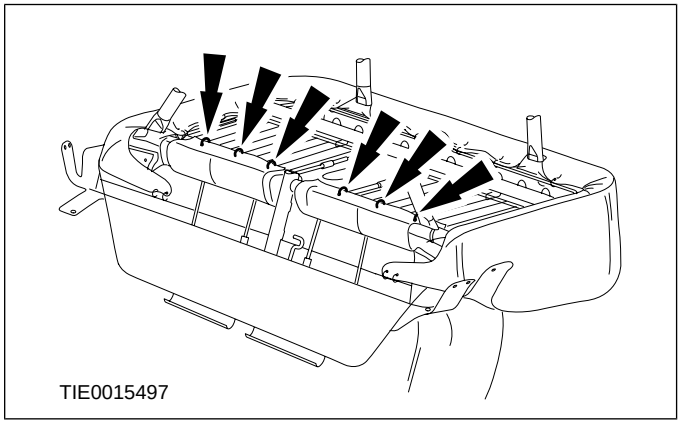
2. **Detach the rear of the backrest cover from the underside of the seat.**



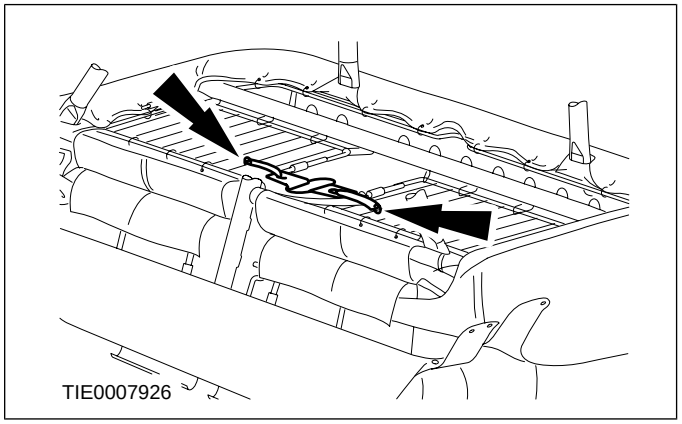
3. **Detach the backrest cover side panels from the underside of the seat.**
   - Cut the hog rings.



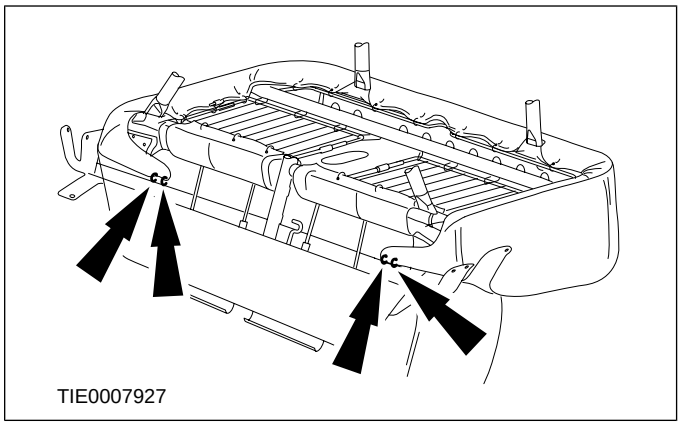
4. **Detach the front of the backrest cover from the underside of the seat.**
   - Cut the hog rings.



5. **Remove the safety belt guide (if equipped).**
   - Cut the hog rings.



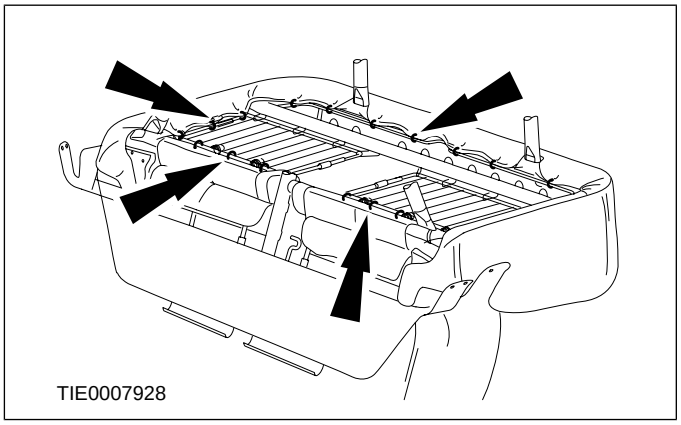
6. **Detach the rear of the cushion cover from the rear of the backrest.**
   - Cut the hog rings.



7. **Detach the cushion cover from the underside of the seat.**

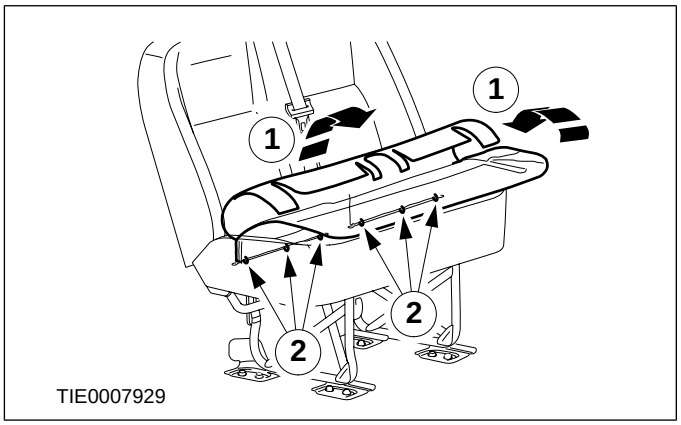
DISASSEMBLY AND ASSEMBLY

- Cut the hog rings.



8. Remove the cushion cover.

1. Roll the cushion cover towards the center to access the pleating hog rings.
2. Cut the hog rings.

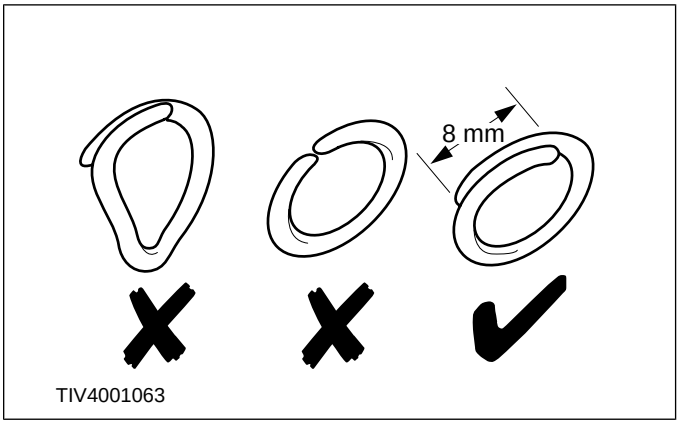


9. Remove the seat cushion.

Assembly

1. NOTE:Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

To assemble, reverse the disassembly procedure.

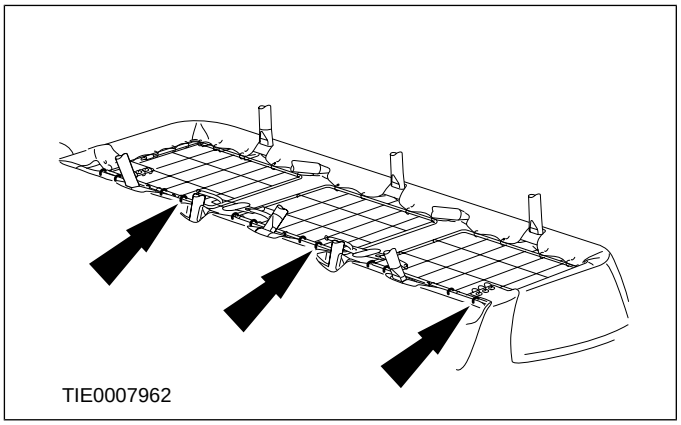


DISASSEMBLY AND ASSEMBLY

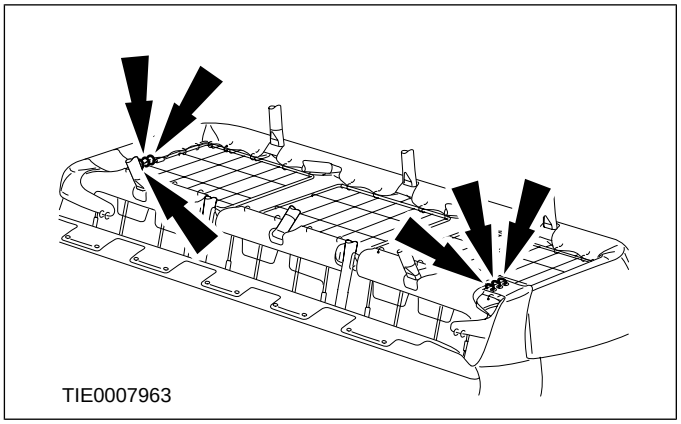
Rear Seat Cushion — Chassis Double Cab

Disassembly

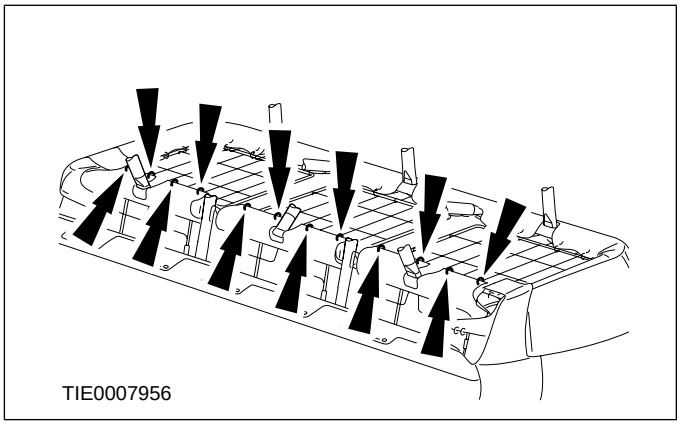
1. **Detach the rear of the backrest cover from the underside of the seat.**
   - Cut the hog rings.



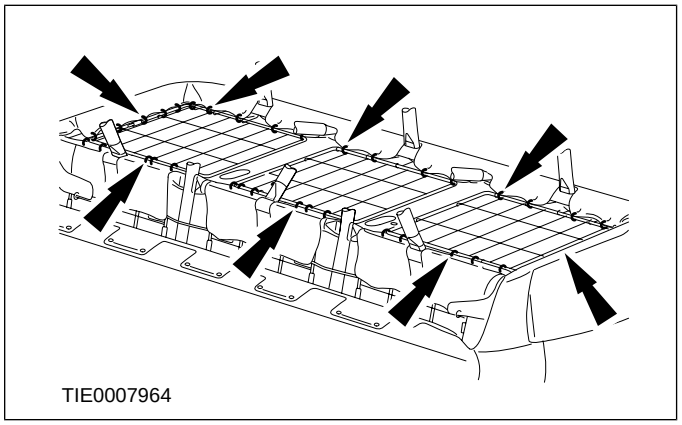
2. **Detach the backrest cover side panels from the underside of the seat.**
   - Cut the hog rings.



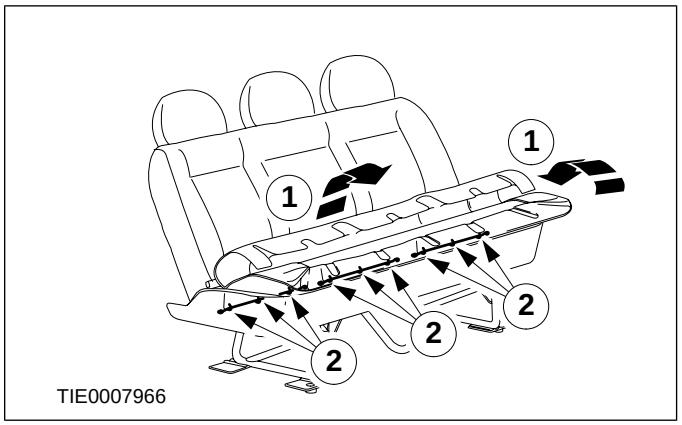
3. **Detach the front of the backrest cover from the underside of the seat.**
   - Cut the hog rings.



4. **Detach the cushion cover from the underside of the seat.**
   - Cut the hog rings.



5. **Remove the cushion cover.**
   1. Roll the cushion cover back to access the pleating hog rings.
   2. Cut the hog rings.



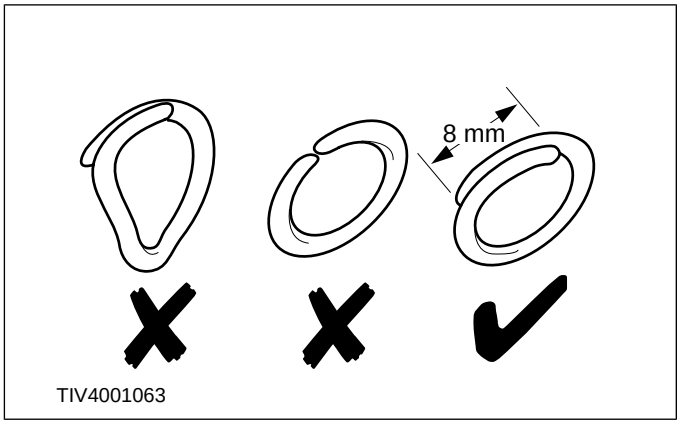
6. **Remove the rear seat cushion.**

Assembly

1. **NOTE:Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.**

DISASSEMBLY AND ASSEMBLY

To assemble, reverse the disassembly procedure.



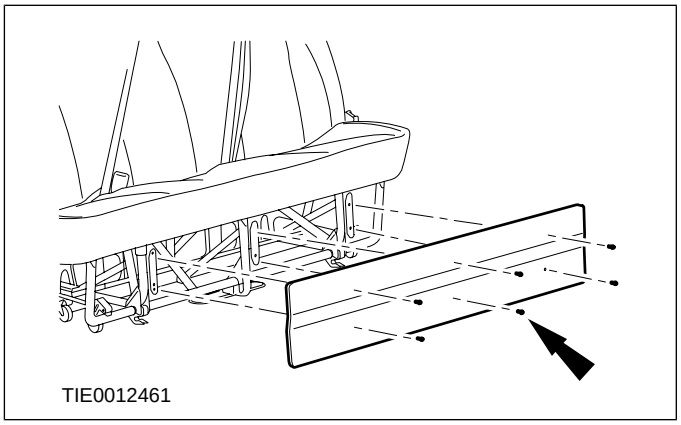
TIV4001063

DISASSEMBLY AND ASSEMBLY

Treble Second Row Seat Cushion

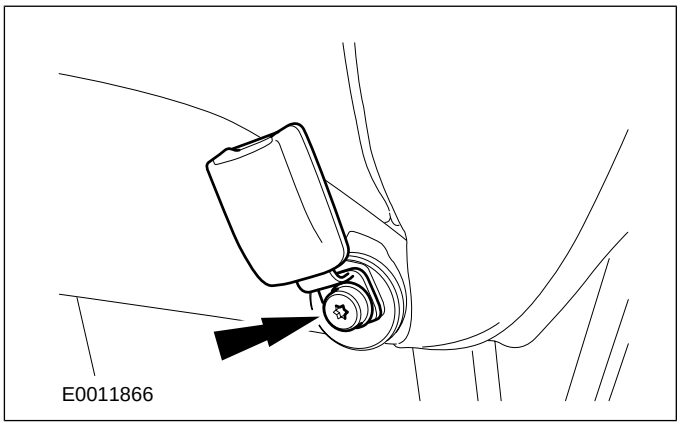
Disassembly

1. **Remove the seat front trim panel (if equipped).**



2. **CAUTION:The bolt securing the safety belt buckle is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt buckle at all times when the safety belt buckle is detached or removed.**

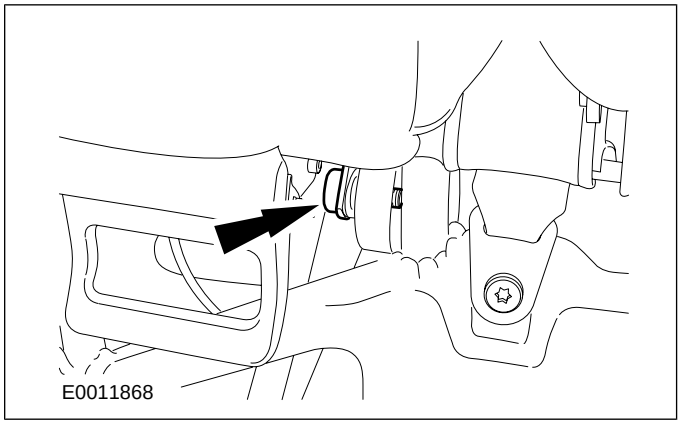
   Remove the outer safety belt buckle.



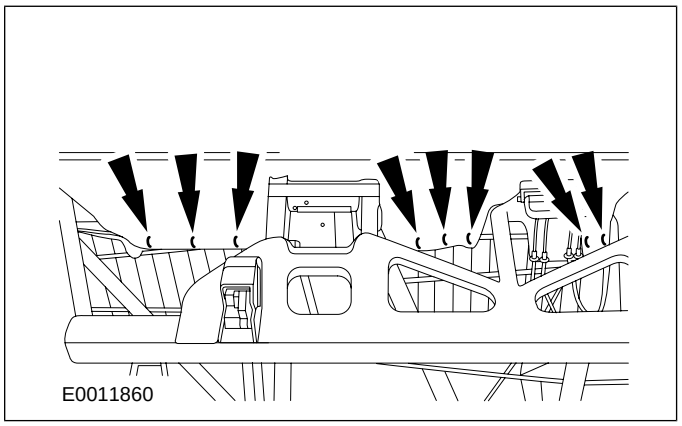
3. **Remove the seat base rear trim panel (if equipped).**

4. **CAUTION:The bolt securing the safety belt buckle is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt buckle at all times when the safety belt buckle is detached or removed.**

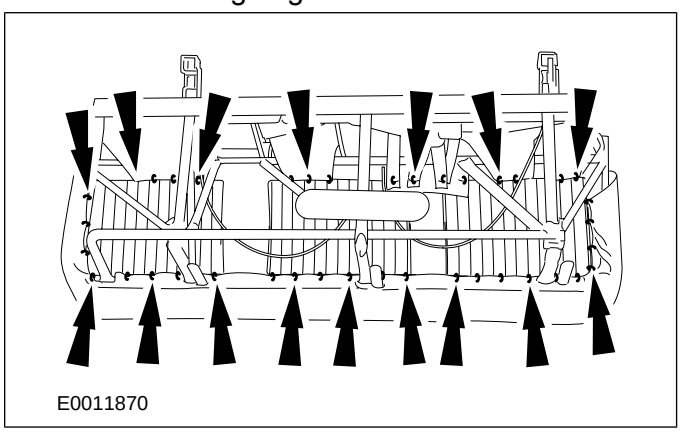
   Remove the center safety belt buckle.



5. **Detach the rear of the backrest cover from the underside of the seat.**
   - Cut the hog rings.



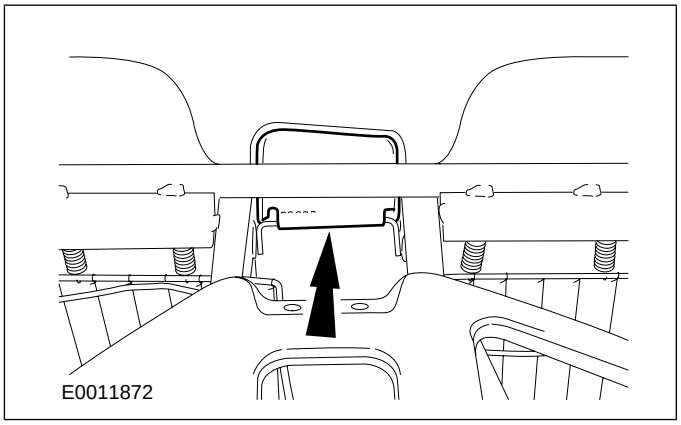
6. **Detach the cushion cover from the underside of the seat.**
   - Cut the hog rings.



7. **Detach the cushion cover.**

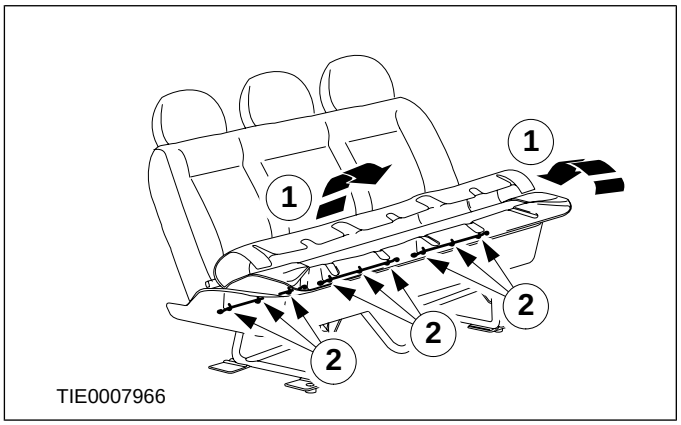
DISASSEMBLY AND ASSEMBLY

- Detach the retaining strip.



8. Remove the cushion cover.

1. Roll the cushion cover towards the center to access the pleating hog rings.
2. Cut the hog rings.

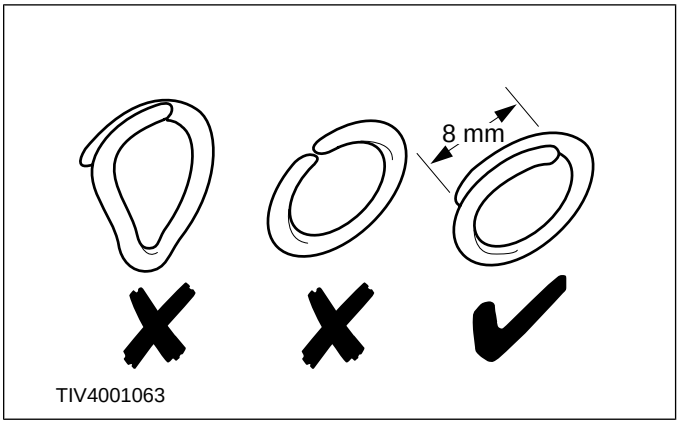


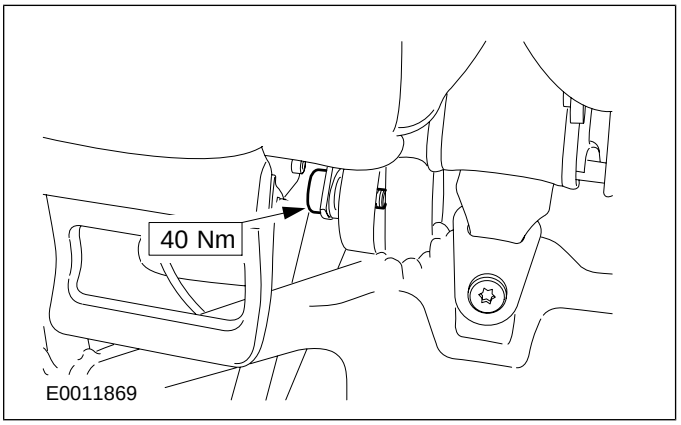
9. Remove the seat cushion.

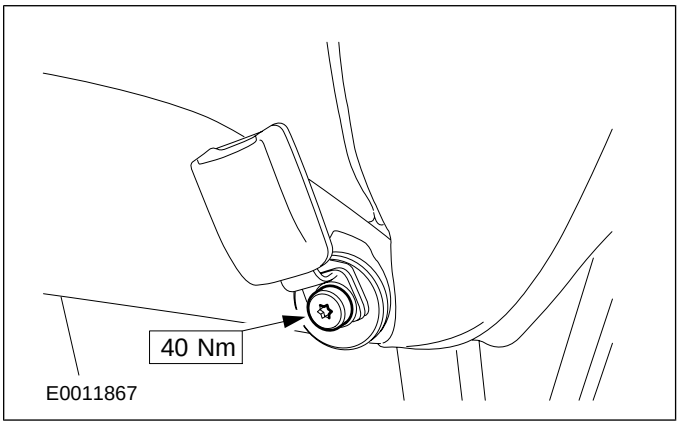
Assembly

1. NOTE:Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

To assemble, reverse the disassembly procedure.





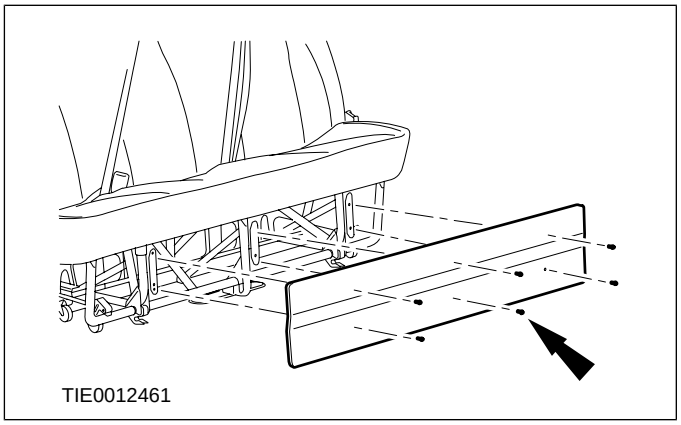


DISASSEMBLY AND ASSEMBLY

Treble Third Row Seat Cushion

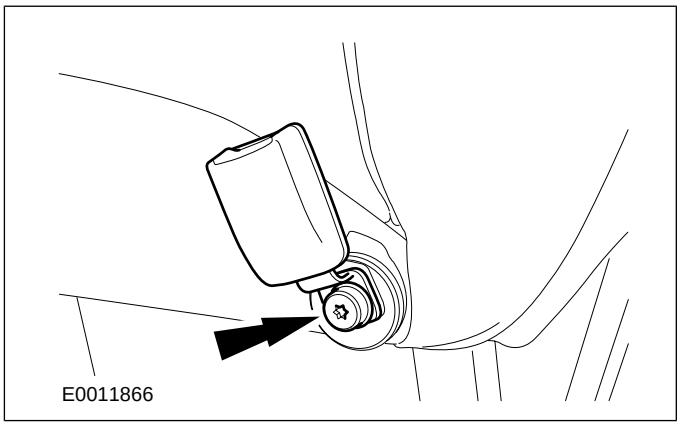
Disassembly

1. **Remove the seat front trim panel (if equipped).**

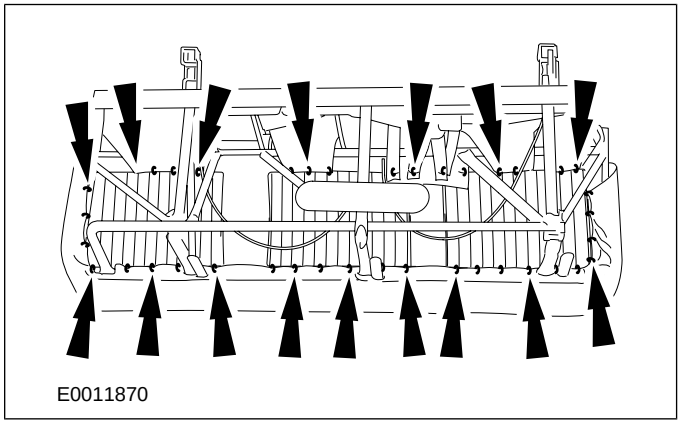

TIE0012461

2. **CAUTION:The bolt securing the safety belt buckle is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt buckle at all times when the safety belt buckle is detached or removed.**

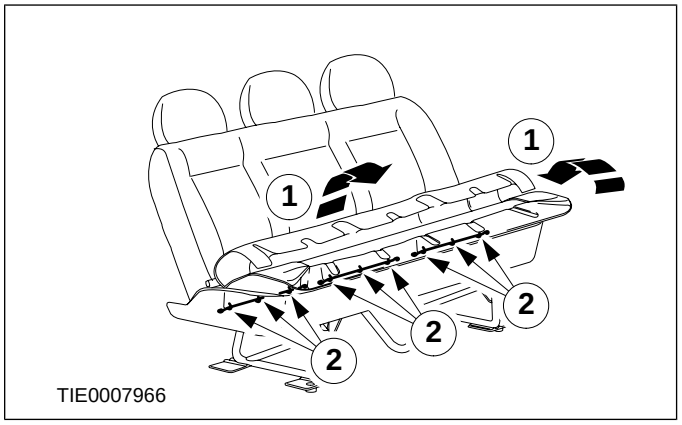
   Remove the outer safety belt buckle.


E0011866

3. **Remove the seat rear trim panel (if equipped).**
4. **Detach the cushion cover from the underside of the seat.**
   - Cut the hog rings.


E0011870

5. **Remove the cushion cover.**
   1. Roll the cover towards the center to access the pleating hog rings.
   2. Cut the hog rings.



TIE0007966

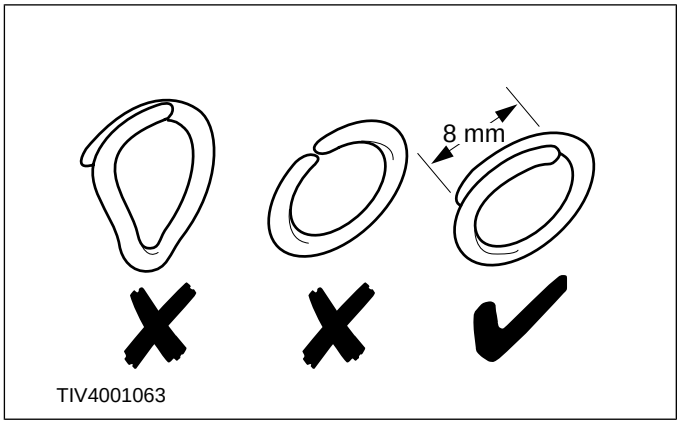
6. **Remove the seat cushion.**

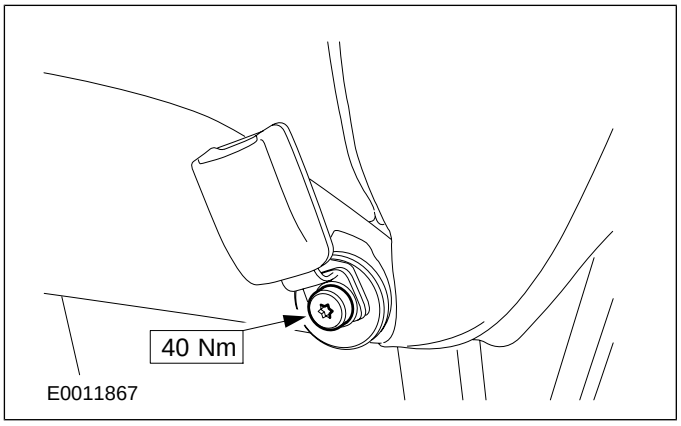
Assembly

1. **NOTE:Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.**

DISASSEMBLY AND ASSEMBLY

To assemble, reverse the disassembly procedure.



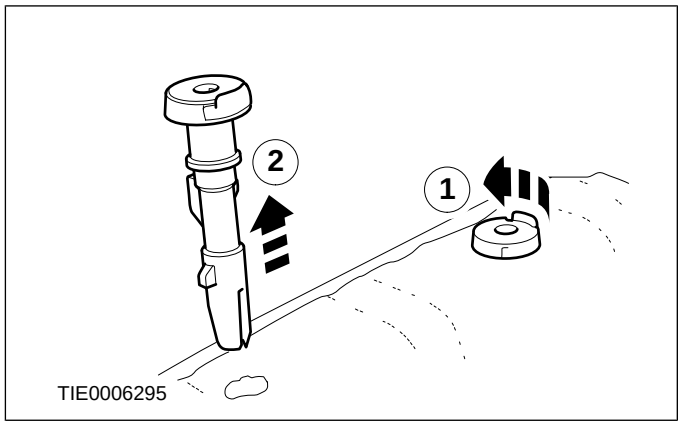


DISASSEMBLY AND ASSEMBLY

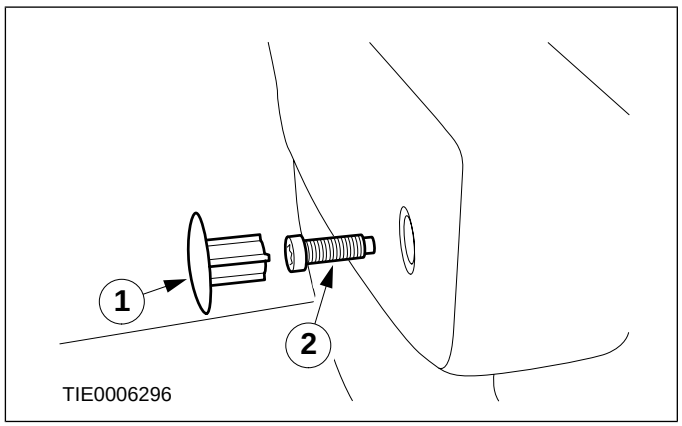
Front Seat Backrest (40 106 0)

Disassembly

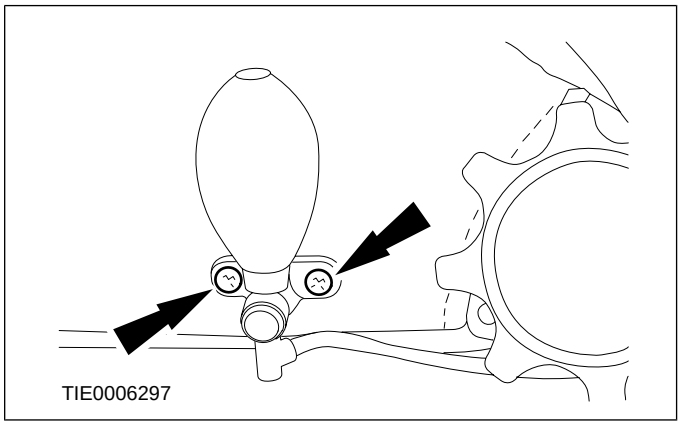
1. **Remove the head restraint.**
2. **Remove the head restraint guides.**
   1. Turn the guides one-fourth turn counterclockwise.
   2. Remove the guides.



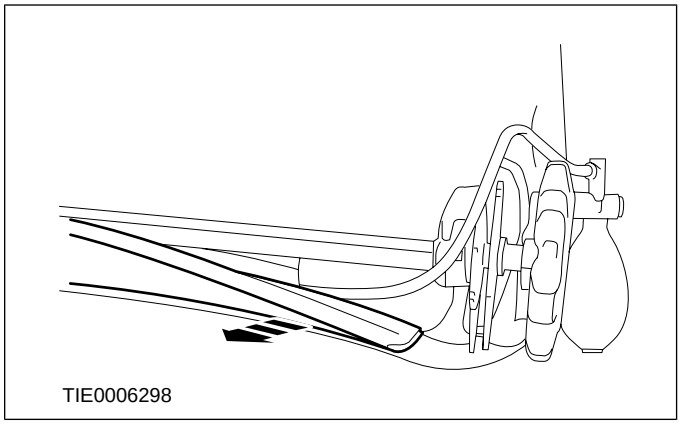
3. **Remove the armrest.**
   1. Remove the bolt cover.
   2. Remove the bolt.



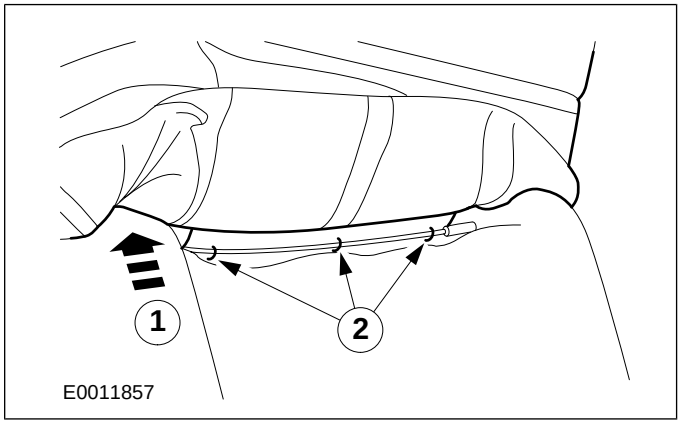
4. **Detach the lumbar pump from the backrest (if equipped).**



5. **Detach the backrest cover from the underside of the seat.**
   - Detach the retaining strip.



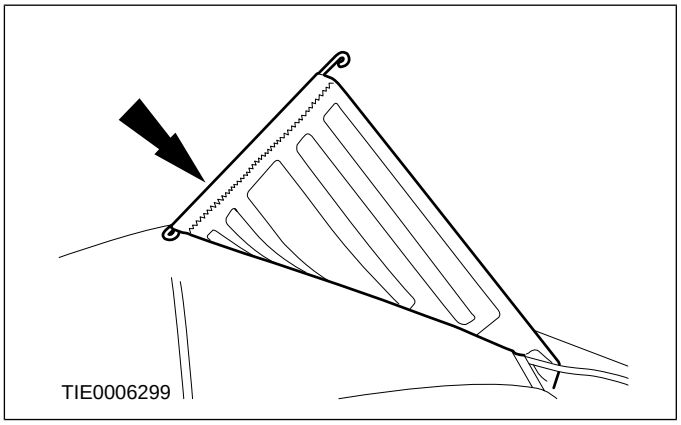
6. **Remove the backrest cover.**
   1. Roll the backrest cover upwards to access the pleating hog rings.
   2. Cut the hog rings.



7. **Remove the heated seat mat (if equipped).**

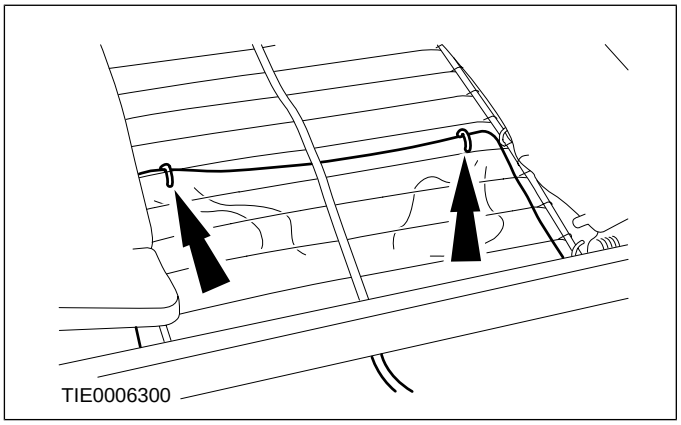
DISASSEMBLY AND ASSEMBLY

- Cut the hog rings.



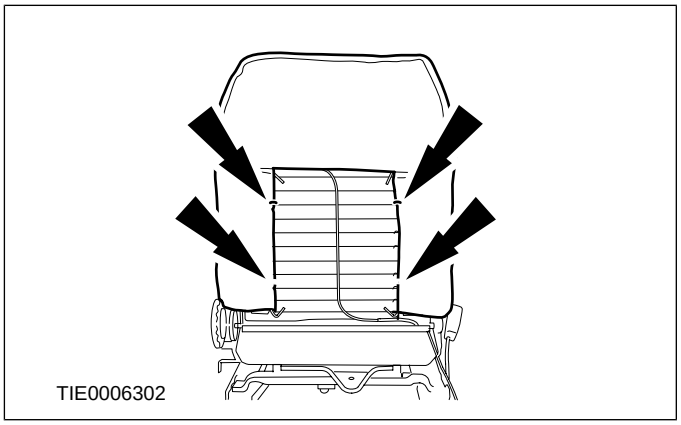
8. Remove the lumbar bag (if equipped).

- Cut the hog rings.



9. Remove the front seat backrest.

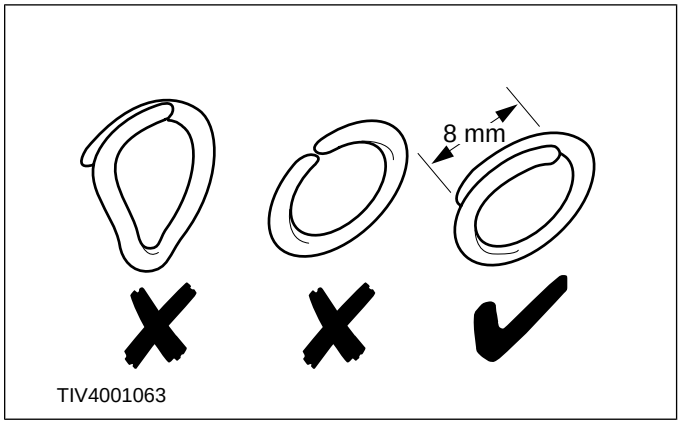
- Cut the hog rings.

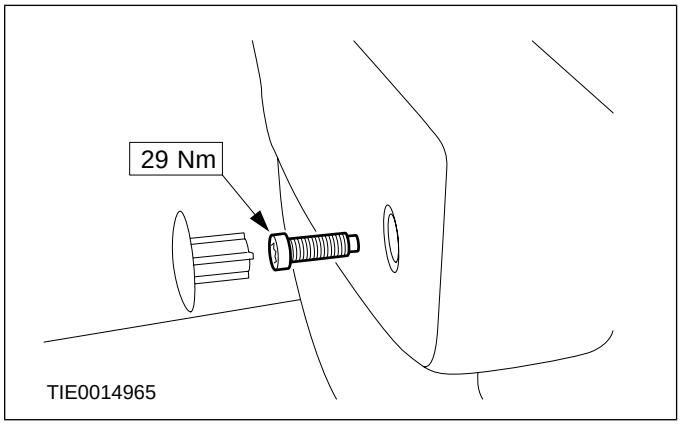


Assembly

1. NOTE:Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

To assemble, reverse the disassembly procedure.





DISASSEMBLY AND ASSEMBLY

Double Passenger Seat Backrest

Disassembly

All vehicles

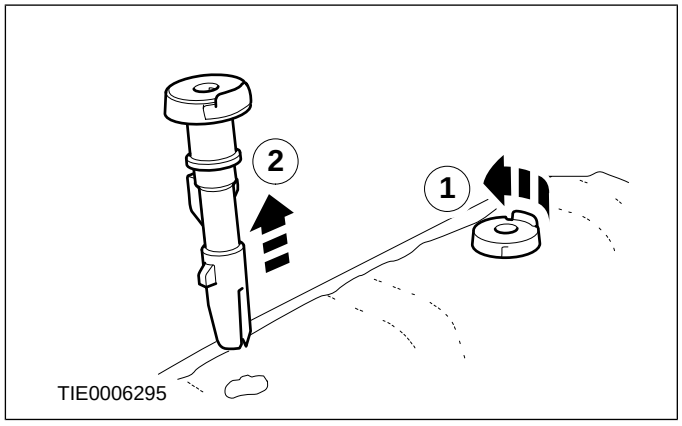
1. **Remove the double passenger seat.**

   For additional information, refer to:Double Passenger Seat (501-10 Seating, Removal and Installation).

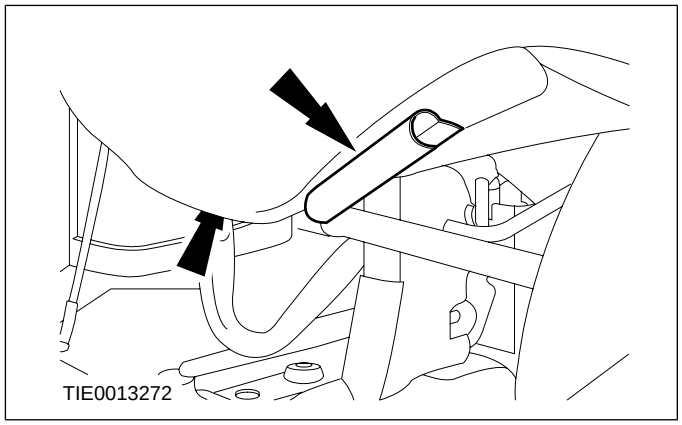
2. **Remove the head restraints.**

3. **Remove the head restraint guides.**

   1. Turn the guides one-fourth turn counterclockwise.
   2. Remove the guides.



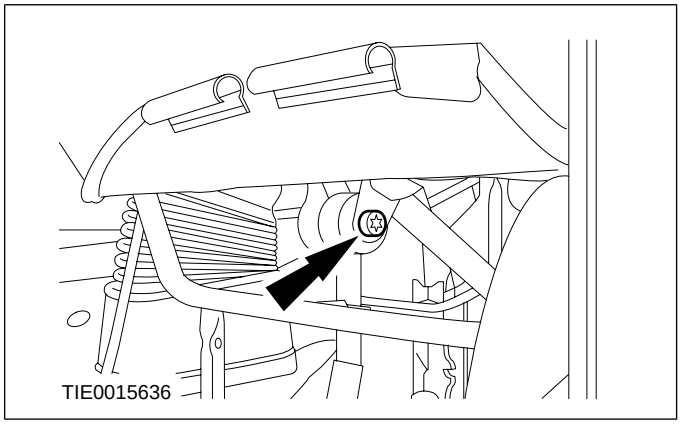
4. **Detach the rear of the backrest cover from the underside of the seat.**



Vehicles with seat mounted safety belt retractors

5. **⚠CAUTION:The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt at all times when the safety belt is detached or removed.**

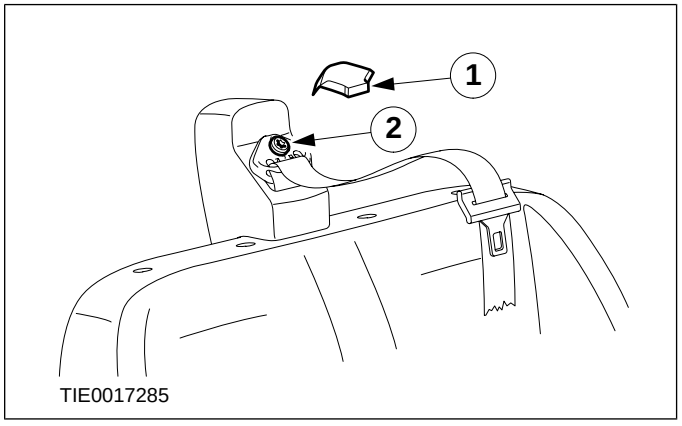
   Detach the centre belt safety belt lower anchor from the underside of the seat.



6. **⚠CAUTION:The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt at all times when the safety belt is detached or removed.**

   Detach the safety belt upper anchor.

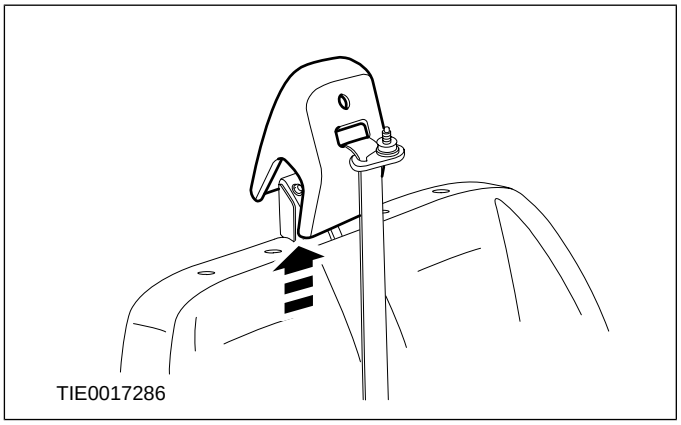
   1. Remove the cover.
   2. Remove the bolt.



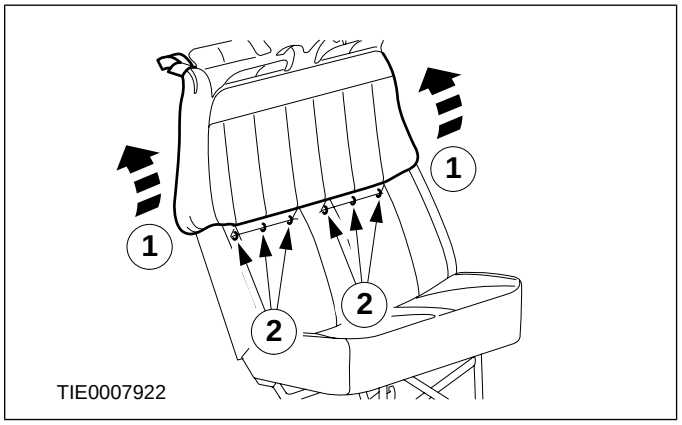
7. **Remove the safety belt upper anchor cover.**

DISASSEMBLY AND ASSEMBLY

- Feed the safety belt through the cover.



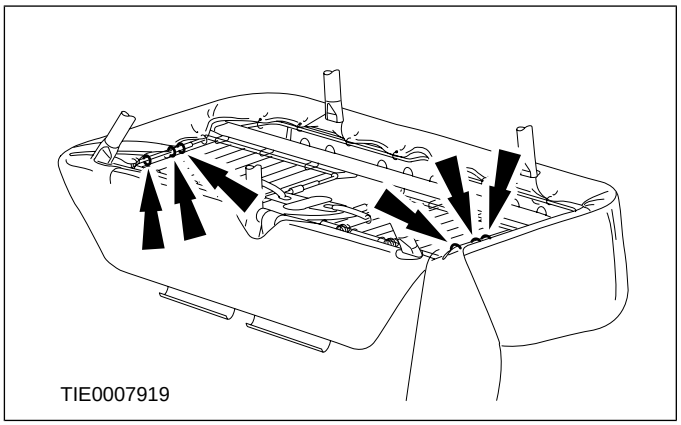
2. Cut the hog rings.



All vehicles

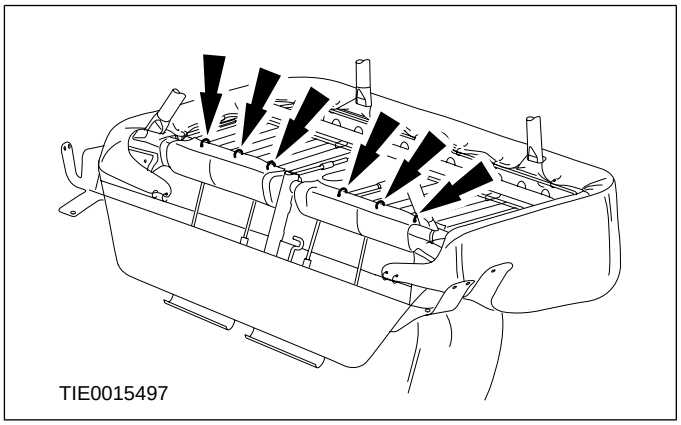
8. Detach the backrest cover side panels from the underside of the seat.

- Cut the hog rings.



9. Detach the front of the backrest cover from the underside of the seat.

- Cut the hog rings.

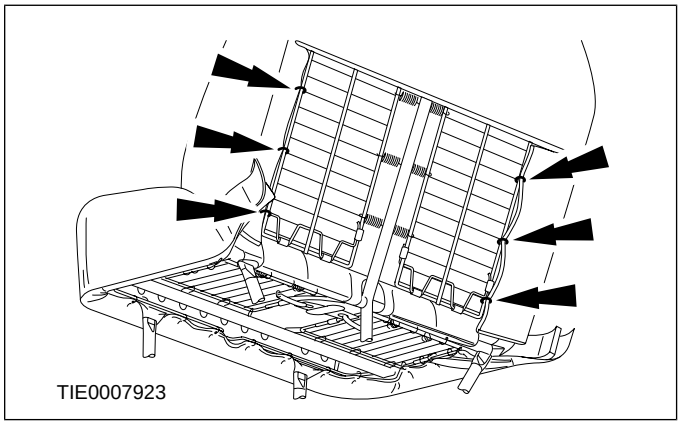


10. Remove the backrest cover.

1. Roll the backrest cover upwards to access the pleating hog rings.

11. Remove the passenger seat backrest.

- Cut the hog rings.

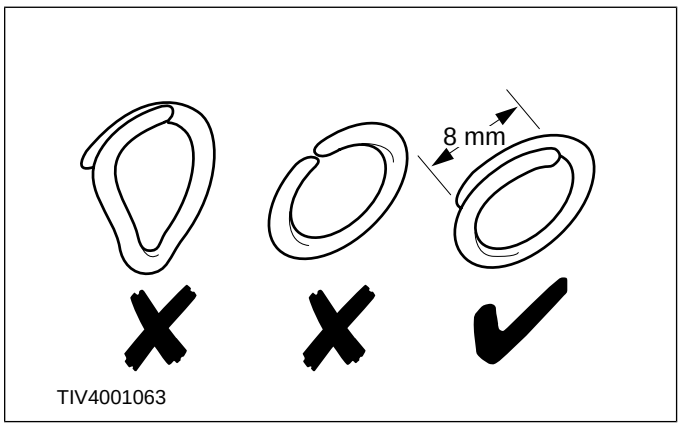


Assembly

All Vehicles

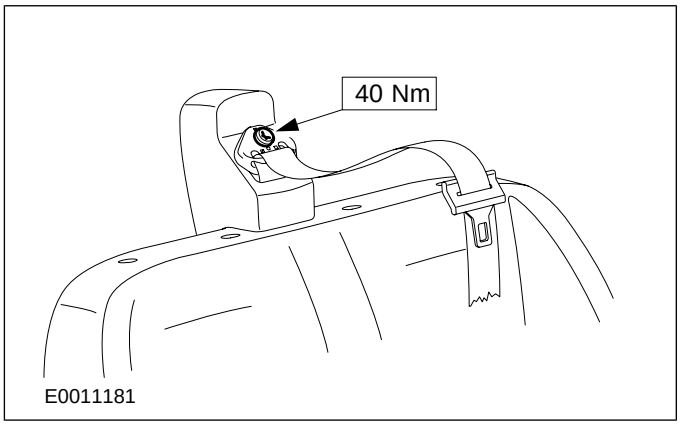
1. NOTE:Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

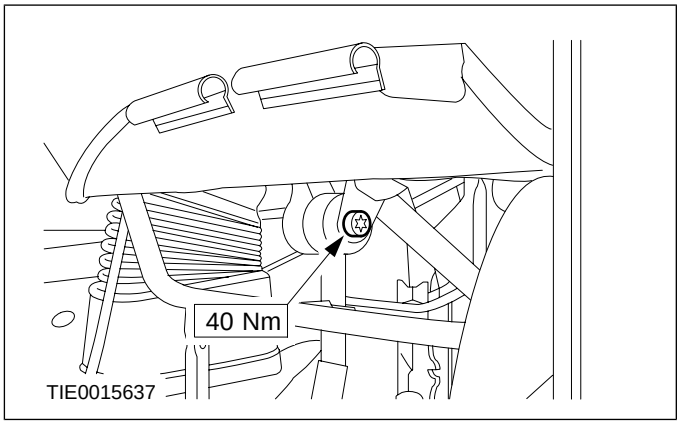
To assemble, reverse the disassembly procedure.



DISASSEMBLY AND ASSEMBLY

Vehicles with seat mounted safety belt retractors



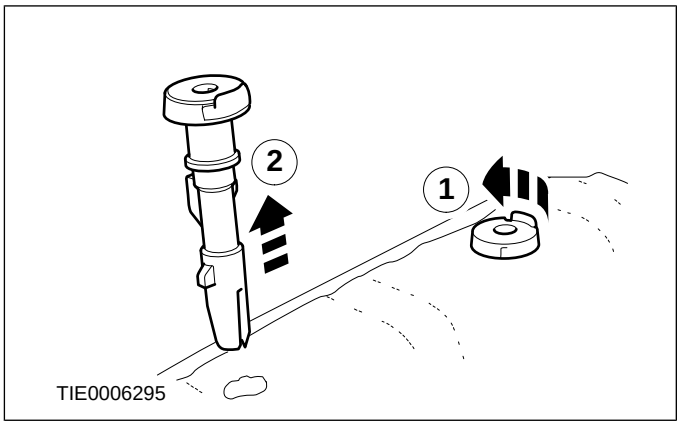


DISASSEMBLY AND ASSEMBLY

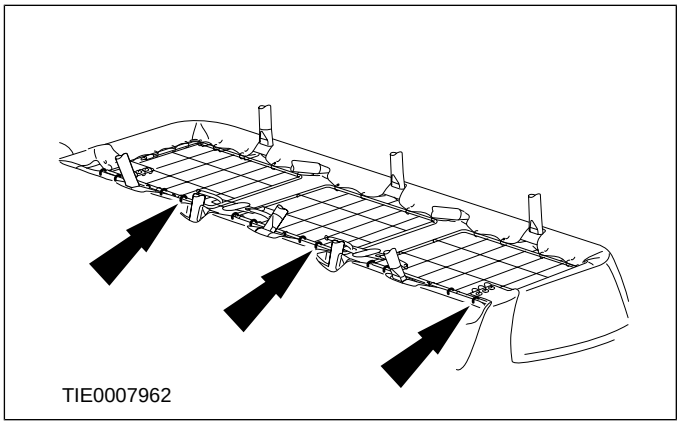
Rear Seat Backrest — Chassis Double Cab (40 127 0)

Disassembly

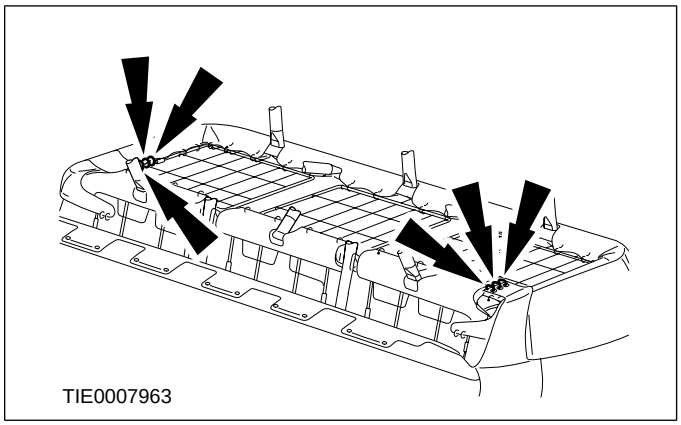
1. **Remove the head restraints.**
2. **Remove the head restraint guides.**
   1. Turn the guides one - fourth turn counterclockwise.
   2. Remove the guides.



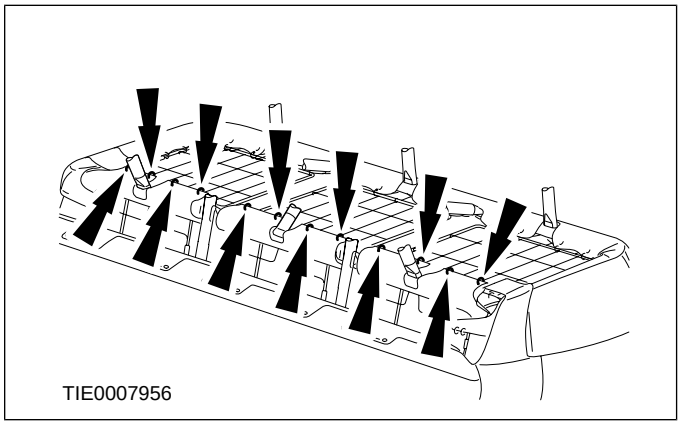
3. **Detach the rear of the backrest cover from the underside of the seat.**
   - Cut the hog rings.



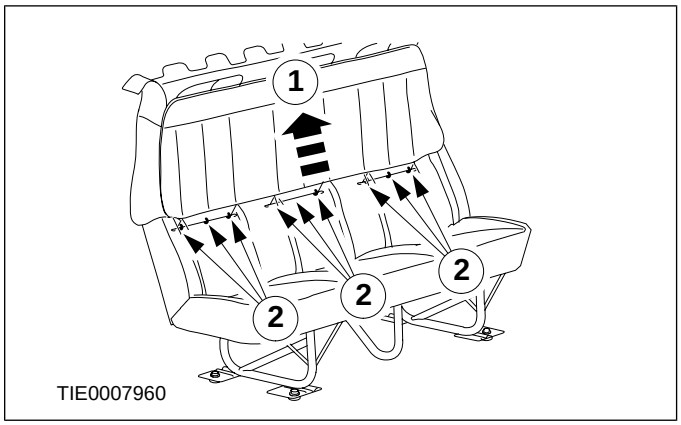
4. **Detach the backrest cover side panels from the underside of the seat.**
   - Cut the hog rings.



5. **Detach the front of the backrest cover from the underside of the seat.**
   - Cut the hog rings.



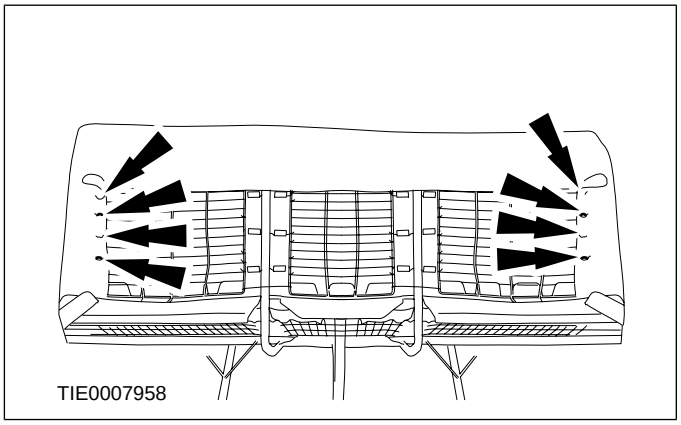
6. **Remove the backrest cover.**
   1. Roll the backrest cover upwards to access the pleating hog rings.
   2. Cut the hog rings.



7. **Remove the rear seat backrest.**

DISASSEMBLY AND ASSEMBLY

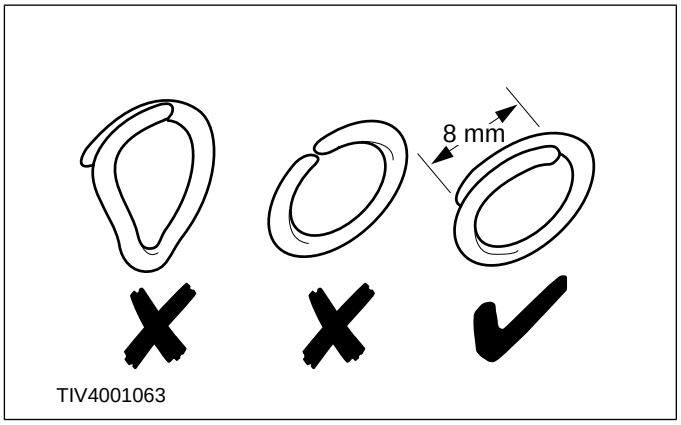
- Cut the hog rings.


TIE0007958

Assembly

1. **NOTE:Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.**

   To assemble, reverse the disassembly procedure.



TIV4001063

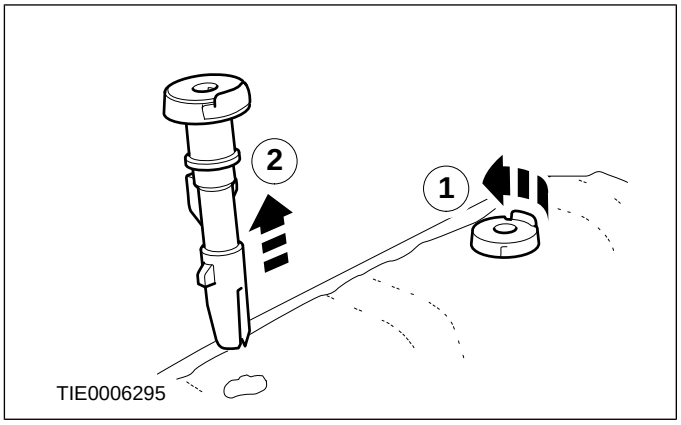
DISASSEMBLY AND ASSEMBLY

Treble Second Row Seat Backrest

Disassembly

All vehicles

1. **Remove the head restraints.**
2. **Remove the head restraint guides.**
   1. Turn the guides one-fourth turn counterclockwise.
   2. Remove the guides.

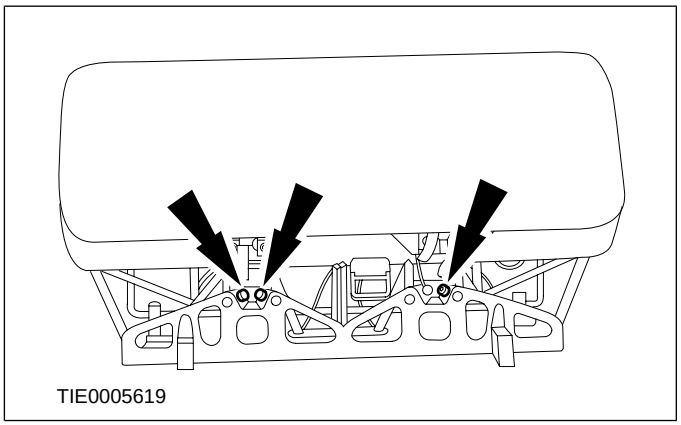


3. **Remove the seat rear trim panel (if equipped).**

Vehicles with seat mounted safety belt retractors

4. **CAUTION:The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt at all times when the safety belt is detached or removed.**

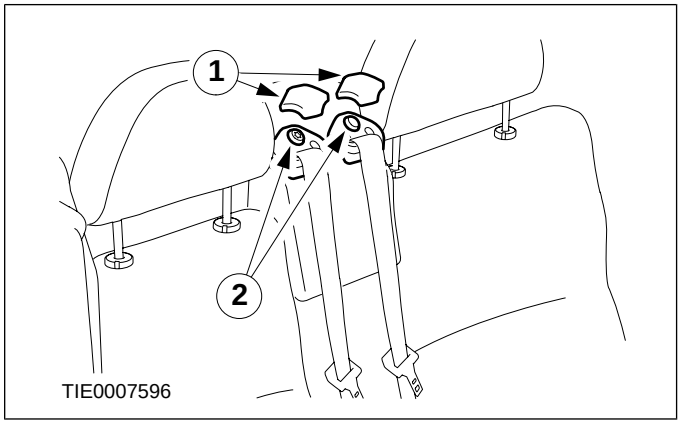
   Detach the safety belt lower anchors from the underside of the seat.



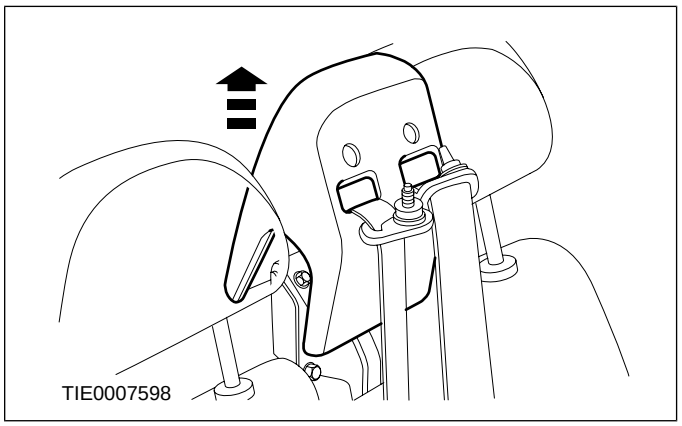
5. **CAUTION:The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt at all times when the safety belt is detached or removed.**

   Detach the safety belt upper anchors (dual retractor mounting shown).

   1. Remove the covers.
   2. Remove the bolts.



6. **Remove the safety belt retractor covers (dual retractor mounting shown).**
   - Feed the safety belts through the retractor covers.

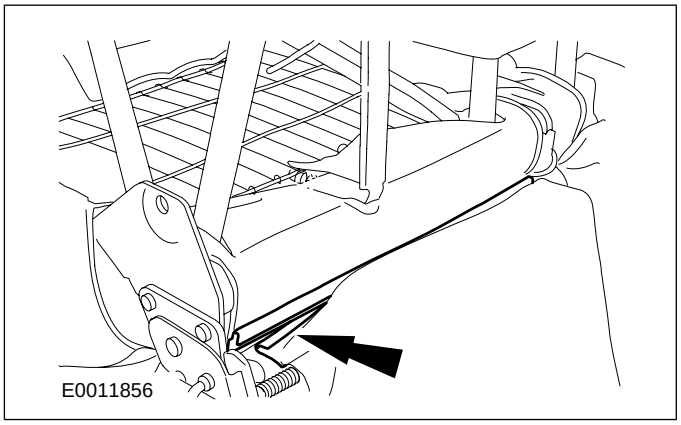


All Vehicles

7. **Detach the folding backrest from the underside of the seat.**

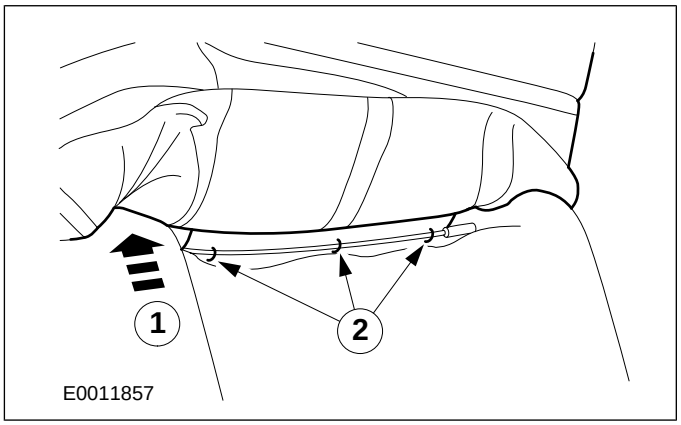
DISASSEMBLY AND ASSEMBLY

- Detach the retaining strip.



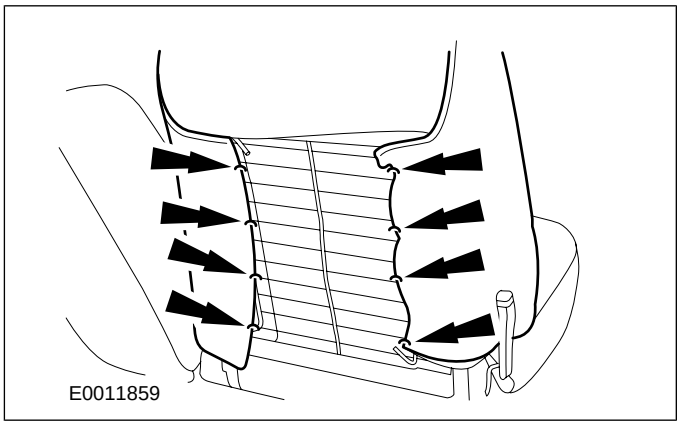
8. Remove the folding backrest cover.

1. Roll the backrest cover upwards to access the pleating hog rings.
2. Cut the hog rings.



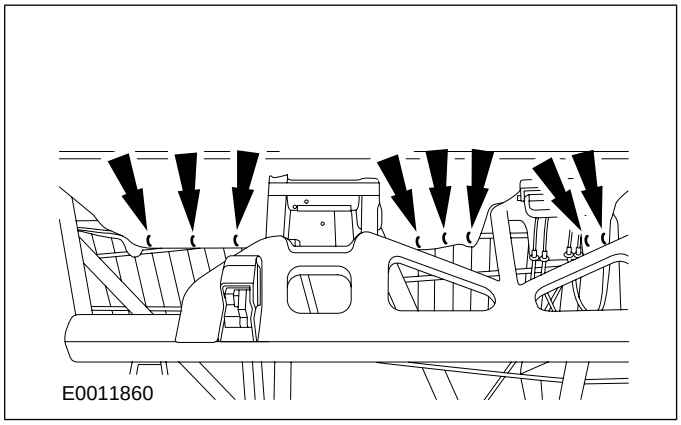
9. Remove the folding seat backrest.

- Cut the hog rings.



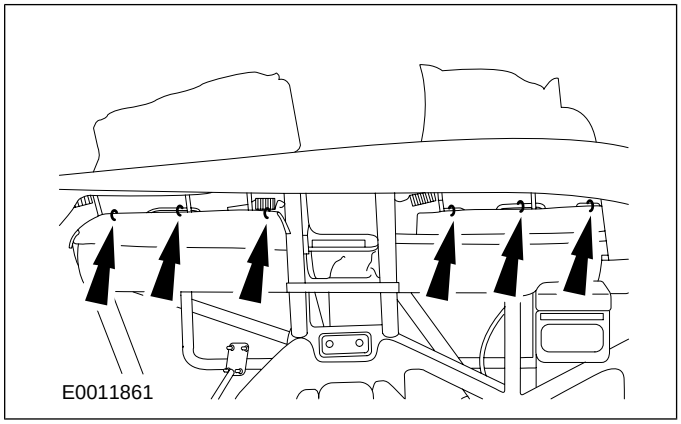
10. Detach the rear of the fixed backrest cover from the underside of the seat.

- Cut the hog rings.



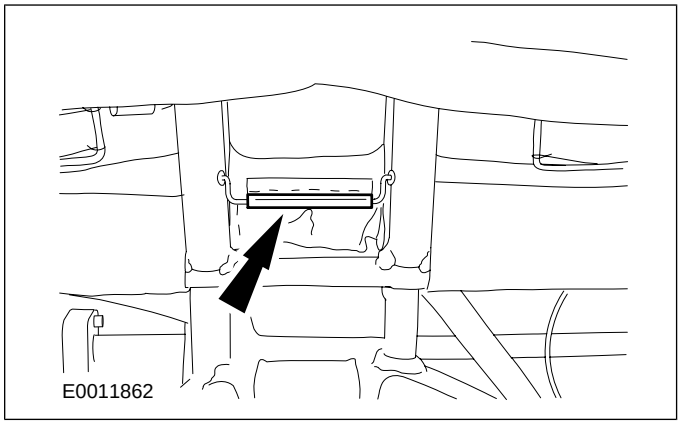
11. Detach the front of the fixed backrest cover from the underside of the seat.

- Cut the hog rings.



12. Detach the backrest cover from the underside of the seat.

- Detach the retaining strip.

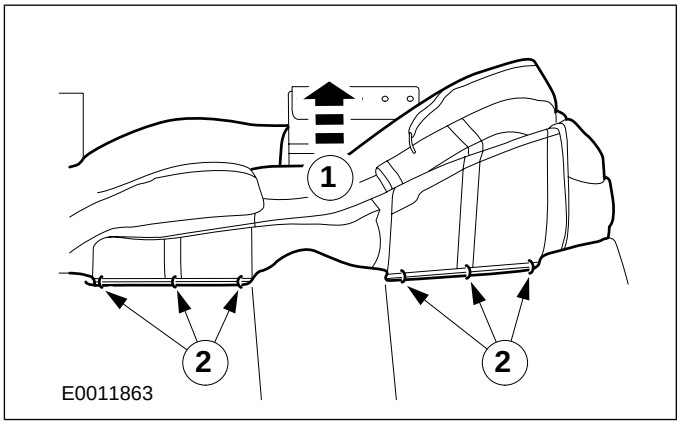


13. Remove the fixed backrest cover.

1. Roll the backrest cover upwards to access the pleating hog rings.

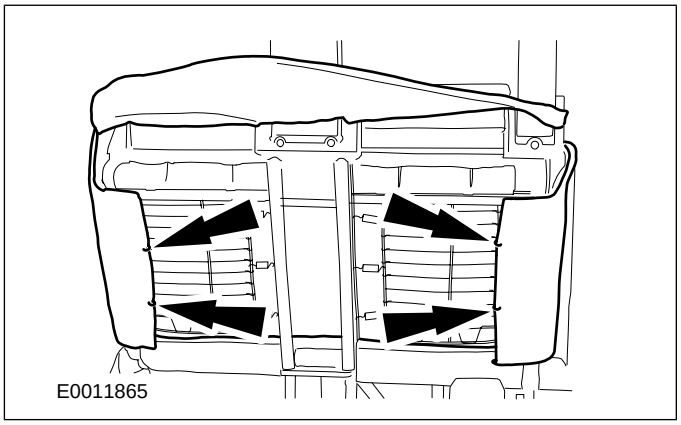
DISASSEMBLY AND ASSEMBLY

2. Cut the hog rings.

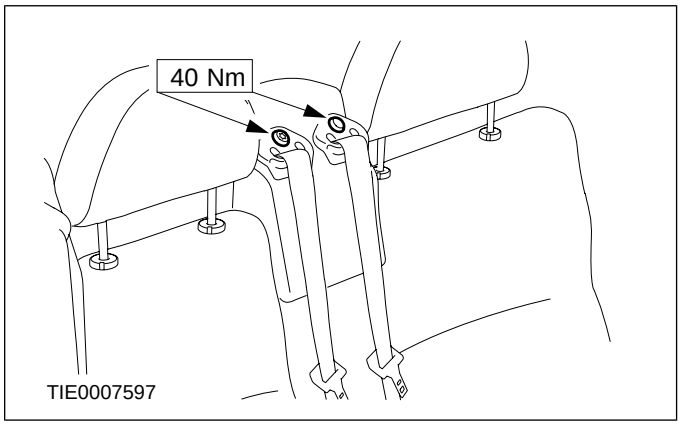


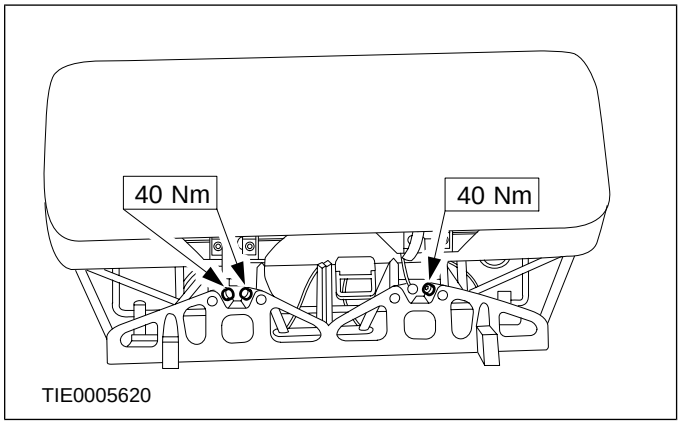
14. Remove the fixed seat backrest.

- Cut the hog rings.



Vehicles with seat mounted safety belt retractors



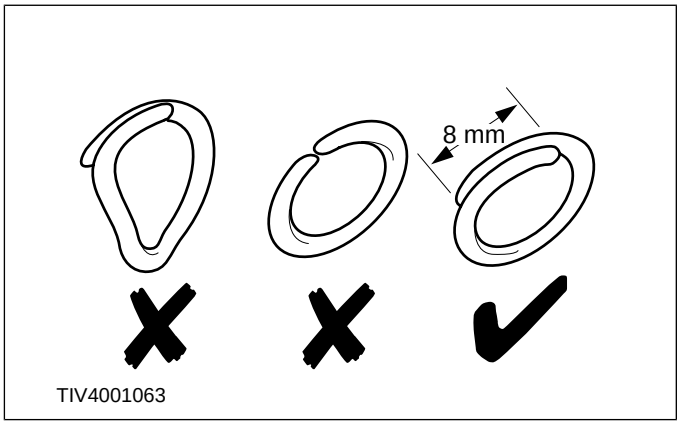


Assembly

All vehicles

1. NOTE:Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

To assemble, reverse the disassembly procedure.



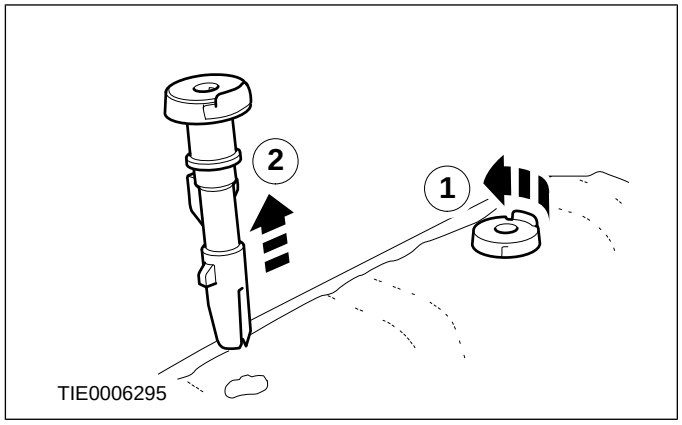
DISASSEMBLY AND ASSEMBLY

Treble Third Row Seat Backrest

Disassembly

All vehicles

1. **Remove the head restraints.**
2. **Remove the head restraint guides.**
   1. Turn the guides one - fourth turn counterclockwise.
   2. Remove the guides.

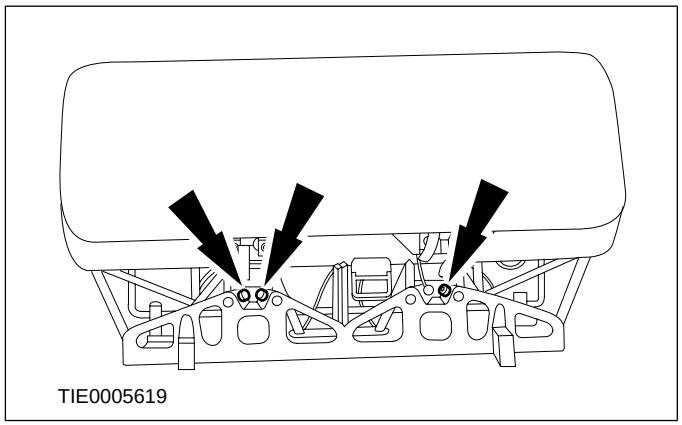


3. **Remove the seat rear trim panel (if equipped).**

Vehicles with seat mounted safety belt retractors

4. **CAUTION:The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt at all times when the safety belt is detached or removed.**

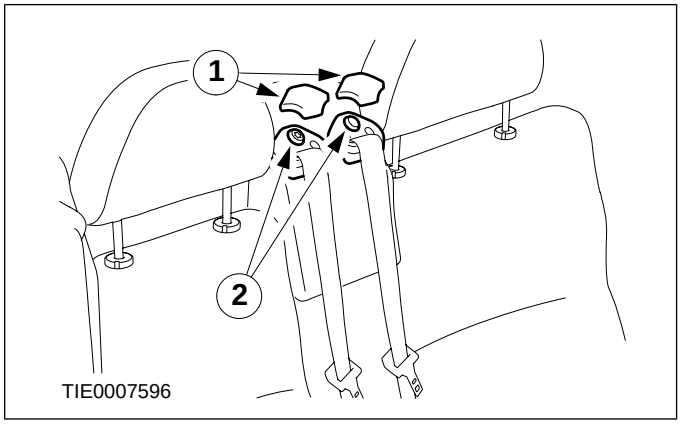
   Detach the safety belt lower anchors from the underside of the seat.



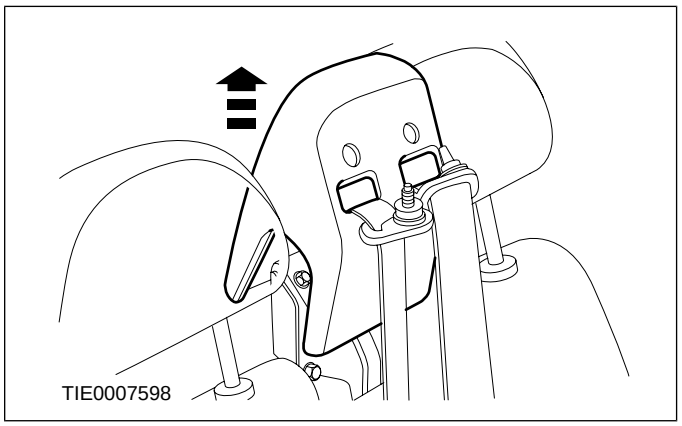
5. **CAUTION:The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer should remain on the safety belt at all times when the safety belt is detached or removed.**

   Detach the safety belt upper anchors (dual retractor mounting shown).

   1. Remove the covers.
   2. Detach the bolts.



6. **Remove the safety belt retractor covers (dual retractor mounting shown).**
   - Feed the safety belts through the retractor covers.

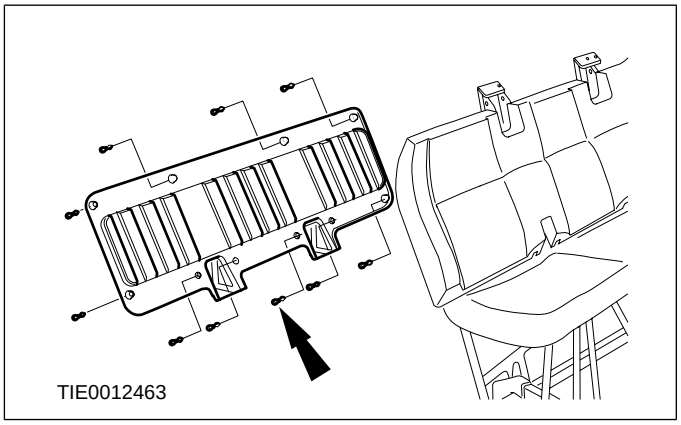


All Vehicles

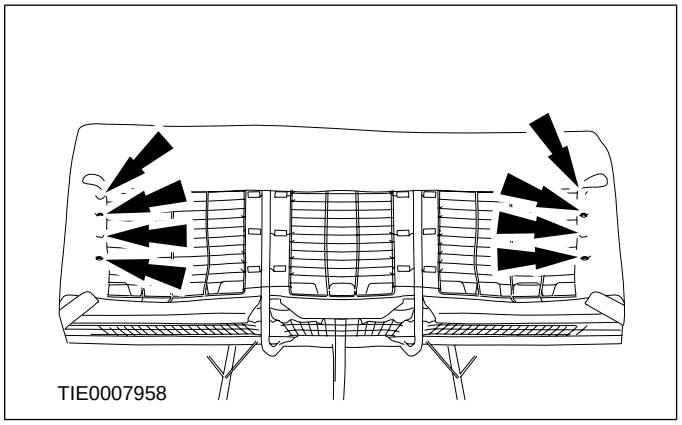
7. **Remove the backrest rear trim panel (if equipped).**

DISASSEMBLY AND ASSEMBLY

- Detach the clips.

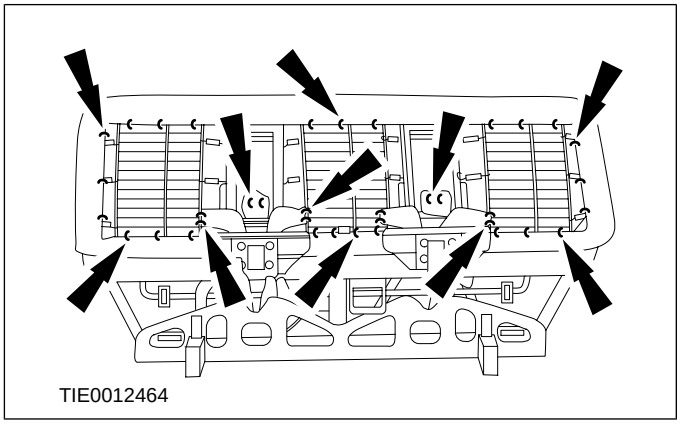


- Cut the hog rings



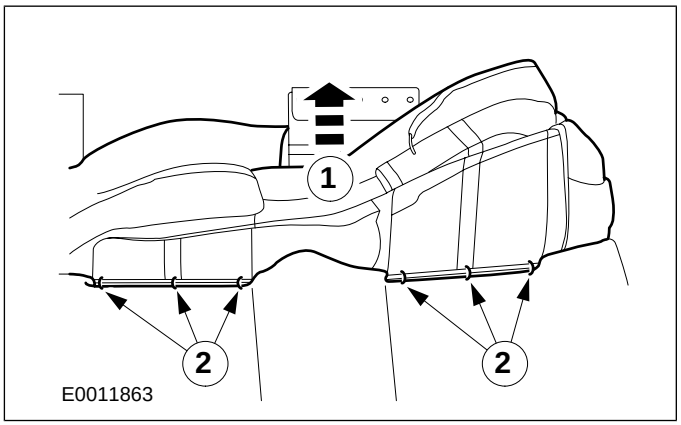
8. Detach the backrest cover from the rear of the backrest.

- Cut the hog rings.



9. Remove the backrest cover.

1. Roll the backrest cover up the backrest to access the pleating hog rings.
2. Cut the hog rings.



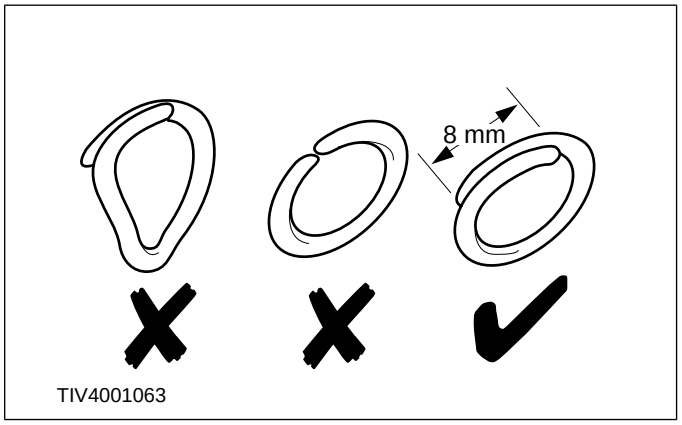
10. Remove the backrest

Assembly

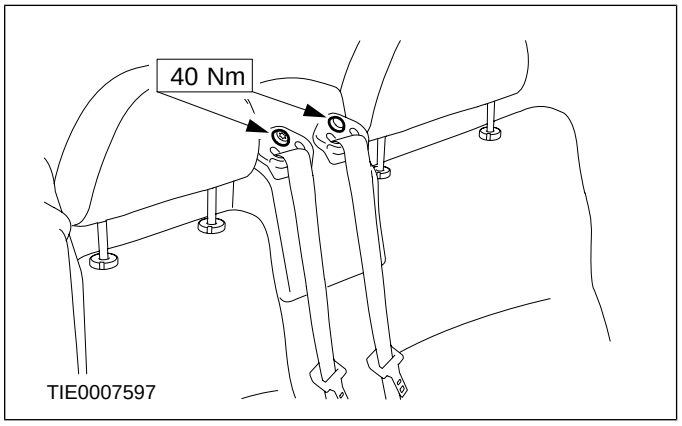
All Vehicles

1. NOTE:Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

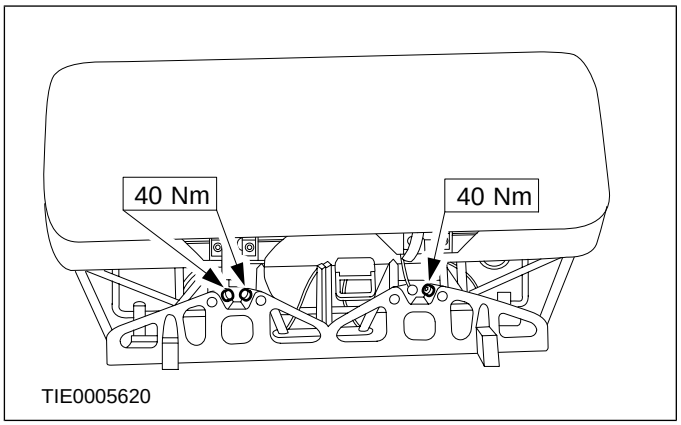
To assemble, reverse the disassemble procedure.



Vehicles with seat mounted safety belt retractors



DISASSEMBLY AND ASSEMBLY



TIE0005620

SECTION 501-11 Glass, Frames and Mechanisms

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 501-11-2

DESCRIPTION AND OPERATION

Glass, Frames and Mechanisms 501-11-3
Opening Windows 501-11-3
Fixed/Direct Glazed Windows 501-11-3

DIAGNOSIS AND TESTING

Glass, Frames and Mechanisms 501-11-4
Inspection and Verification 501-11-4
Pinpoint Tests 501-11-6
Component Tests 501-11-36

REMOVAL AND INSTALLATION

Front Door Window Glass ..... (42 314 0) 501-11-38
Front Quarter Window Glass 501-11-42
Second Row Side Window Glass 501-11-43
Sliding Door Window Glass 501-11-45
Third Row Side Window Glass 501-11-48
Rear Door Window Glass ..... (42 315 0) 501-11-51
Rear Door Window Glass — Chassis Double Cab ..... (42 315 0) 501-11-56
Rear Window Glass — Chassis Double Cab 501-11-59
Liftgate Window Glass 501-11-62
Front Door Window Regulator ..... (42 338 0) 501-11-65
Front Door Window Regulator and Motor ..... (42 338 0) 501-11-67
Windshield Glass ..... (42 115 0) 501-11-69
Front Door Glass Top Run ..... (42 333 0) 501-11-77

SPECIFICATIONS

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Cleaner	WSK-M2G342-A
Primer	WSK-M2G343-A
Winshield Adhesive Kit	WSK-M11P57-A1

Torque Specifications

Description	Nm	lb-ft	lb-in
Windshield wiper arm retaining nut	22	16	-
Rear window wiper arm retaining nut	15	11	-
Front door glass top run left-hand bracket retaining bolts	10	-	89
Front door glass top run right-hand bracket retaining bolt	10	-	89
Headerboard to float floor retaining bolts	48	35	-
Headerboard to float stanchion retaining bolts	25	18	-

DESCRIPTION AND OPERATION

Glass, Frames and Mechanisms

Opening Windows

Manually operated front door windows are standard. There is a market option for front power windows, which are activated by switches located in the door trim panels. The driver switch also incorporates a one-touch down function. There is a market option for opening rear quarter windows.

Fixed/Direct Glazed Windows

The front door quarter window glass is secured in a rubber weatherstrip and retained by a flange in the door panel.

The windshield, side and rear windows are directly glazed to the window opening flange by means of a polyurethane (PU) adhesive bead. In addition to fixing the glass to the opening flange, the PU adhesive bead also forms a watertight seal around the inner edge of the glass.

The glass is held in the correct position, during the curing period of the PU adhesive, by locating pegs in the top corners. There is a market option for sliding rear windows which are fitted into a cassette and secured in the same manner.

All new glass, including the sliding cassettes, is supplied in service with the locating pegs attached.

It is essential for good adhesion and sealing of the direct glazed windows and sliding rear window cassettes that the correct materials are used and that the PU adhesive is allowed to cure.

NOTE: If the ambient temperature falls below 10°C, warming of the PU adhesive using a hot air gun should be employed. The curing time depends not only on temperature, but also on the relative humidity of the air. The cure time for a warm humid environment will be shorter than a cool, dry atmosphere.

NOTE:A surface film of water on the bond line of the glass or on the window opening flange will prevent the PU adhesive correctly bonding the two surfaces.

Any moisture on the bond line of the glass or on the window opening flange must be removed using a hot air gun before applying the PU adhesive bead.

To carry out direct glazing operations an oscillating cutter, an assortment of special cutting blades, a cartridge gun and two glaziers suction cups will be required (in addition to the contents supplied with the Ford repair kit).

DIAGNOSIS AND TESTING

Glass, Frames and Mechanisms

Refer to Wiring Diagrams Section 501-11,for schematic and connector information.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical and electrical damage.

Visual Inspection Chart

Electrical
– Fuse(s) – Electrical connector(s) – Switch(es) – Circuit(s)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Symptom Chart

Symptom	Possible Sources	Action
• All power windows are inoperative	• Circuit(s).	• GO to Pinpoint Test A.
• A single power window is inoperative - driver side	• Driver side power window switch.	• CARRY OUT the Power Window Switch Component Test. REFER to the Wiring Diagrams.
	• Driver side front door window regulator motor. • One-touch down relay (if equipped). • Circuit(s).	• GO to Pinpoint Test B.
• A single power window is inoperative - passenger side	• Driver side, passenger power window switch.	• CARRY OUT the Power Window Switch Component Test. REFER to the Wiring Diagrams.
	• Passenger side power window switch.	• CARRY OUT the Power Window Switch Component Test. REFER to the Wiring Diagrams.
	• Passenger side front door window regulator motor. • Circuit(s).	• GO to Pinpoint Test C.
• The one-touch down feature is inoperative	• Driver side power window switch.	• CARRY OUT the Power Window Switch Component Test. REFER to the Wiring Diagrams.
	• One-touch down relay. • Circuit(s).	• GO to Pinpoint Test D.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• The defrost system is inoperative	• Heated windshield glass switch.	• CARRY OUT the Heated Windshield Glass Switch component test. REFER to the Wiring Diagrams.
	• Heated rear window glass switch.	• CARRY OUT the Heated Rear Window Glass Switch component test. REFER to the Wiring Diagrams.
	• Heated windshield glass relay.	• CARRY OUT the Heated Windshield Glass Relay component test. REFER to the Wiring Diagrams.
	• Heated rear window glass relay.	• CARRY OUT the Heated Rear Window Glass Relay component test. REFER to the Wiring Diagrams.
	• Central junction box (CJB).	• For additional information, REFER to WDS.
	• Heated rear window grid wire.	• Carry out the Heated Rear Window Grid Wire Component Test in this procedure.
	• Heated windshield grid wire. • Circuit(s).	• GO to Pinpoint Test E.
• The defrost system will not shut off automatically	• Heated windshield glass relay.	• CARRY OUT the Heated Windshield Glass Relay component test. REFER to the Wiring Diagrams.
	• Heated rear window glass relay.	• CARRY OUT the Heated Rear Window Glass Relay component test. REFER to the Wiring Diagrams.
	• Central junction box (CJB).	• For additional information, REFER to WDS.
	• Circuit(s).	• GO to Pinpoint Test F.

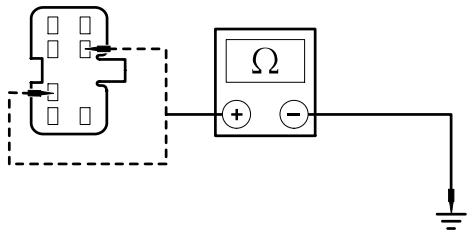
DIAGNOSIS AND TESTING

Pinpoint Tests

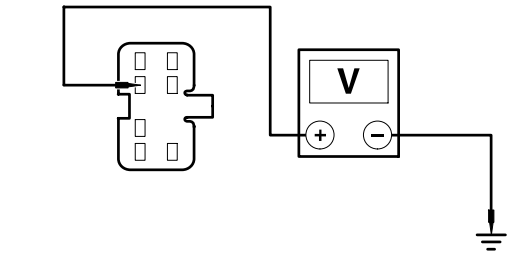
PINPOINT TEST A : ALL POWER WINDOWS ARE INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
A1: CHECK THE DRIVER SIDE POWER WINDOW SWITCH CIRCUIT	
	1 Ignition switch in position II. • Does the driver side power window switch LED illuminate? → **Yes** VERIFY the customer concern. → **No** GO to A2.
A2: CHECK FOR CONTINUITY BETWEEN THE DRIVER SIDE POWER WINDOW SWITCH AND GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Driver Side Power Window Switch CPW10B.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0013518	3 Measure the resistance between the: Left-hand drive vehicles with one-touch down • Driver power window switch CPW10B pin 3, circuit A_GD133Z (BK), harness side and ground. • Driver power window switch CPW10B pin 6, circuit A_GD133Y (BK), harness side and ground. Right-hand drive vehicles with one-touch down • Driver power window switch CPW10B pin 3, circuit B_GD138Z (BK/WH), harness side and ground. • Driver power window switch CPW10B pin 6, circuit B_GD138Y (BK/WH), harness side and ground. Left-hand drive vehicles without one-touch down • Driver power window switch CPW10B pin 3, circuit A_GD133AC (BK), harness side and ground. • Driver power window switch CPW10B pin 6, circuit A_GD133AG (BK), harness side and ground. Right-hand drive vehicles without one-touch down • Driver power window switch CPW10B pin 3, circuit B_GD138Z (BK/WH), harness side and ground. • Driver power window switch CPW10B pin 6, circuit B_GD138Y (BK/WH), harness side and ground. • Are the resistances less than 5 ohms? → **Yes** GO to A3. → **No** Left-hand drive vehicles with one-touch down - REPAIR circuit A_GD133Y (BK) or circuit A_GD133Z (BK). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit B_GD138Y (BK/WH) or circuit B_GD138Z (BK/WH). TEST the system for normal operation. Left-hand drive vehicles without one-touch down - REPAIR circuit A_GD133AC (BK) or circuit A_GD133AG (BK). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit B_GD138Y (BK/WH) or circuit B_GD138Z (BK/WH). TEST the system for normal operation.

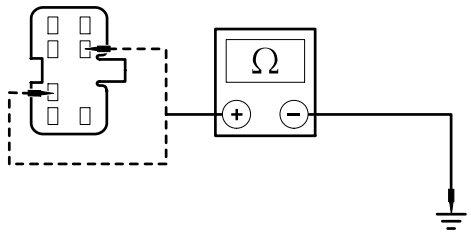
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A3: CHECK FOR VOLTAGE TO THE DRIVER SIDE POWER WINDOW SWITCH	
	1 Ignition switch in position II.
 TIE0013078	2 Measure the voltage between the: Left-hand drive vehicles with one-touch down • Driver power window switch CPW10B pin 2, circuit CB156G (BU/GN), harness side and ground. Right-hand drive vehicles with one-touch down • Driver power window switch CPW10B pin 2, circuit CB156F (BU/GN), harness side and ground. Left-hand drive vehicles without one-touch down • Driver power window switch CPW10B pin 2, circuit CB156F (BU/GN), harness side and ground. Right-hand drive vehicles without one-touch down • Driver power window switch CPW10B pin 2, circuit CB156G (BU/GN), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** VERIFY the customer concern. → **No** Left-hand drive vehicles with one-touch down - REPAIR circuit CB156G (BU/GN). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit CB156F (BU/GN). TEST the system for normal operation. Left-hand drive vehicles without one-touch down - REPAIR circuit CB156F (BU/GN). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit CB156G (BU/GN). TEST the system for normal operation.

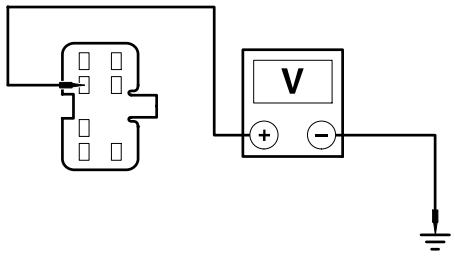
PINPOINT TEST B : A SINGLE POWER WINDOW IS INOPERATIVE - DRIVER SIDE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: CHECK FOR CONTINUITY BETWEEN THE DRIVER SIDE POWER WINDOW SWITCH AND GROUND	
NOTE: Use a digital multimeter for all electrical measurements.	
	1 Disconnect Driver Side Power Window Switch CPW10B.

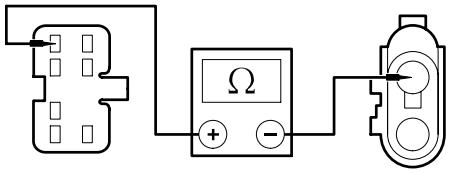
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0013518	2 Measure the resistance between the: Left-hand drive vehicles with one-touch down • Driver power window switch CPW10B pin 3, circuit A_GD133Z (BK), harness side and ground. • Driver power window switch CPW10B pin 6, circuit A_GD133Y (BK), harness side and ground. Right-hand drive vehicles with one-touch down • Driver power window switch CPW10B pin 3, circuit B_GD138Z (BK/WH), harness side and ground. • Driver power window switch CPW10B pin 6, circuit B_GD138Y (BK/WH), harness side and ground. Left-hand drive vehicles without one-touch down • Driver power window switch CPW10B pin 3, circuit A_GD133AC (BK), harness side and ground. • Driver power window switch CPW10B pin 6, circuit A_GD133AG (BK), harness side and ground. Right-hand drive vehicles without one-touch down • Driver power window switch CPW10B pin 3, circuit B_GD138Z (BK/WH), harness side and ground. • Driver power window switch CPW10B pin 6, circuit B_GD138Y (BK/WH), harness side and ground. • Are the resistances less than 5 ohms? → **Yes** GO to B2. → **No** Left-hand drive vehicles with one-touch down - REPAIR circuit A_GD133Y (BK) or circuit A_GD133Z (BK). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit A_GD138Y (BK/WH), or circuit A_GD138Z (BK/WH). TEST the system for normal operation. Left-hand drive vehicles without one-touch down - REPAIR circuit A_GD133AC (BK) or circuit A_GD133AG (BK). TEST the system for normal operation. Right-hand drive vehicles without one-touch down - REPAIR circuit B_GD138Y (BK/WH), or circuit B_GD138Z (BK/WH). TEST the system for normal operation.

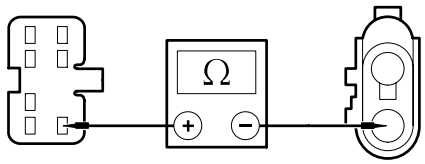
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B2: CHECK FOR VOLTAGE TO THE DRIVER SIDE POWER WINDOW SWITCH	
	1 Ignition switch in position II.
 TIE0013078	2 Measure the voltage between the: Left-hand drive vehicles with one-touch down • Driver power window switch CPW10B pin 2, circuit CB156G (BU/GN), harness side and ground. Right-hand drive vehicles with one-touch down • Driver power window switch CPW10B pin 2, circuit CB156F (BU/GN), harness side and ground. Left-hand drive vehicles without one-touch down • Driver power window switch CPW10B pin 2, circuit CB156F (BU/GN), harness side and ground. Right-hand drive vehicles without one-touch down • Driver power window switch CPW10B pin 2, circuit CB156G (BU/GN), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to B3. → **No** Left-hand drive vehicles with one-touch down - REPAIR circuit CB156G (BU/GN). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit CB156F (BU/GN). TEST the system for normal operation. Left-hand drive vehicles without one-touch down - REPAIR circuit CB156F (BU/GN). TEST the system for normal operation. Right-hand drive vehicles without one-touch down - REPAIR circuit CB156G (BU/GN). TEST the system for normal operation.
B3: CHECK FOR CONTINUITY BETWEEN THE DRIVER POWER WINDOW SWITCH AND THE DRIVER SIDE FRONT DOOR WINDOW REGULATOR MOTOR DOWN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Driver Side Front Door Window Regulator Motor CPW10B.

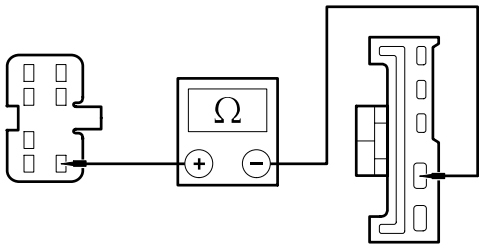
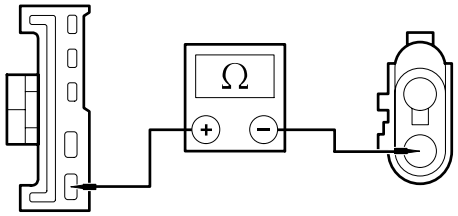
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0017679	3 Measure the resistance between the: Left-hand drive vehicles with one-touch down • Driver side power window switch CPW10B pin 1, circuit CPW35B (GN), harness side and the driver side front door window regulator motor CPW11 pin 1, circuit CPW35A (GN), harness side. Right-hand drive vehicles with one-touch down • Driver side power window switch CPW10B pin 1, circuit CPW35A (GN), harness side and the driver side front door window regulator motor CPW11 pin 1, circuit CPW35C (GN), harness side. Left-hand drive vehicles without one-touch down • Driver side power window switch CPW10B pin 1, circuit CPW35A (GN), harness side and the driver side front door window regulator motor CPW11 pin 1, circuit CPW35A (GN), harness side. Right-hand drive vehicles without one-touch down • Driver side power window switch CPW10B pin 1, circuit CPW35A (GN), harness side and the driver side front door window regulator motor CPW11 pin 1, circuit CPW35A (GN), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B4. → **No** Left-hand drive vehicles with one-touch down - REPAIR circuit CPW35A (GN) or circuit CPW35B (GN). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit CPW35A (GN) or circuit CPW35C (GN). TEST the system for normal operation. Left-hand drive vehicles without one-touch down - REPAIR circuit CPW35A (GN). TEST the system for normal operation. Right-hand drive vehicles without one-touch down - REPAIR circuit CPW35A (GN). TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B4: CHECK FOR CONTINUITY BETWEEN THE DRIVER POWER WINDOW SWITCH AND THE DRIVER SIDE FRONT DOOR WINDOW REGULATOR MOTOR UP CIRCUIT	
 TIE0017680	1 Measure the resistance between the: Left-hand drive vehicles with one-touch down • Driver side power window switch CPW10B pin 7, circuit CPW29A (VT/GY), harness side and the driver side front door window regulator motor CPW11 pin 2, circuit CPW34A (BU), harness side. Right-hand drive vehicles with one-touch down • Driver side power window switch CPW10B pin 7, circuit CPW29A (VT/GY), harness side and the driver side front door window regulator motor CPW11 pin 2, circuit CPW34A (BU), harness side. Left-hand drive vehicles without one-touch down • Driver side power window switch CPW10B pin 7, circuit CPW34A (BU), harness side and the driver side front door window regulator motor CPW11 pin 2, circuit CPW34A (BU), harness side. Right-hand drive vehicles without one-touch down • Driver side power window switch CPW10B pin 7, circuit CPW34A (BU), harness side and the driver side front door window regulator motor CPW11 pin 2, circuit CPW34A (BU), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new front door window regulator and motor. REFER to:Front Door Window Regulator and Motor (501-11 Glass, Frames and Mechanisms, Removal and Installation). TEST the system for normal operation. → **No** Vehicles with one-touch down - GO to B5. Vehicles without one-touch down - REPAIR circuit CPW29A (VT/GY) or circuit CPW34A (BU). TEST the system for normal operation.

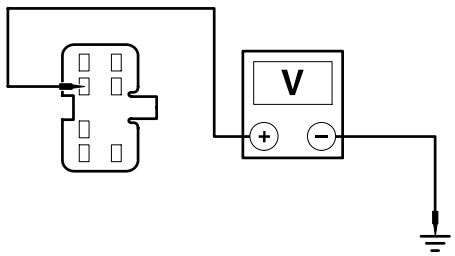
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B5: CHECK FOR CONTINUITY BETWEEN THE DRIVER SIDE POWER WINDOW SWITCH AND THE ONE-TOUCH DOWN RELAY	
 TIE0013523	1 Measure the resistance between the driver side power window switch CPW10B pin 7, circuit CPW29A (VT/GY), harness side and the one-touch down relay CPW29 pin 4, circuit CPW29A (VT/GY), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to B6. → **No** REPAIR circuit CPW29A (VT/GY). TEST the system for normal operation.
B6: CHECK FOR CONTINUITY BETWEEN THE ONE-TOUCH DOWN RELAY AND THE DRIVER SIDE FRONT DOOR WINDOW REGULATOR MOTOR	
 TIE0013524	1 Measure the resistance between the one-touch down relay CPW29 pin 1, circuit CPW34A (BU), harness side and the driver side front door window regulator motor CPW11 pin 2, circuit CPW34A (BU), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new one-touch down relay. TEST the system for normal operation. → **No** REPAIR circuit CPW34A (BU). TEST the system for normal operation.

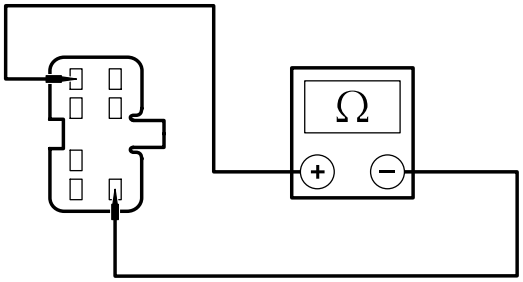
PINPOINT TEST C : A SINGLE POWER WINDOW IS INOPERATIVE - PASSENGER SIDE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
C1: DOES THE PASSENGER WINDOW OPERATE FROM THE DRIVER SIDE POWER WINDOW SWITCH	
	1 Ignition switch in position II.
	2 Operate the passenger power window from the driver side power window switch. • Does the passenger power window operate? → **Yes** GO to C2. → **No** GO to C3.

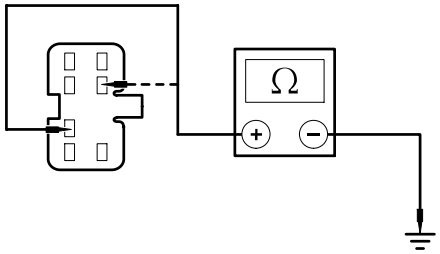
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C2: CHECK FOR VOLTAGE TO THE PASSENGER POWER WINDOW SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Passenger Side Power Window Switch CPW19.
	3 Ignition switch in position II.
 TIE0013078	4 Measure the voltage between the: Left-hand drive vehicles with one-touch down • Passenger side power window switch CPW19 pin 2, circuit CB156D (BU/GN), harness side and ground. Right-hand drive vehicles with one-touch down • Passenger side power window switch CPW19 pin 2, circuit CB156H (BU/GN), harness side and ground. Left-hand drive vehicles without one-touch down • Passenger side power window switch CPW19 pin 2, circuit CB156H (BU/GN), harness side and ground. Right-hand drive vehicles without one-touch down • Passenger side power window switch CPW19 pin 2, circuit CB156F (BU/GN), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** INSTALL a new passenger side power window switch. TEST the system for normal operation. → **No** Left-hand drive vehicles with one-touch down - REPAIR circuit CB156D (BU/GN). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit CB156H (BU/GN). TEST the system for normal operation. Left-hand drive vehicles without one-touch down - REPAIR circuit CB156H (BU/GN). TEST the system for normal operation. Right-hand drive vehicles without one-touch down - REPAIR circuit CB156F (BU/GN). TEST the system for normal operation.
C3: CHECK THE PASSENGER SIDE FRONT DOOR POWER WINDOW REGULATOR MOTOR CIRCUIT FOR CONTINUITY	
	1 Ignition switch in position 0.
	2 Disconnect Passenger Side Power Window Switch CPW19.

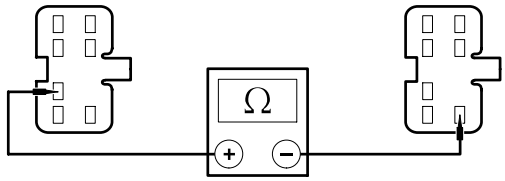
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E59364	3 Measure the resistance between the: Left-hand drive vehicles with one-touch down • Passenger side power window switch CPW19 pin 1, circuit CPW41A (GY/YE), harness side and the passenger side power window switch CPW19 pin 7, circuit CPW40A (WH), harness side. Right-hand drive vehicles with one-touch down • Passenger side power window switch CPW19 pin 1, circuit CPW41A (GY/YE), harness side and the passenger side power window switch CPW19 pin 7, circuit CPW40A (GN/BK), harness side. Left-hand drive vehicles without one-touch down • Passenger side power window switch CPW19 pin 1, circuit CPW41A (GY/YE), harness side and the passenger side power window switch CPW19 pin 7, circuit CPW40A (GN/BK), harness side. Right-hand drive vehicles without one-touch down • Passenger side power window switch CPW19 pin 1, circuit CPW41A (GY/YE), harness side and the passenger side power window switch CPW19 pin 7, circuit CPW40A (WH), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to C4. → **No** GO to C7.
C4: CHECK FOR CONTINUITY BETWEEN THE DRIVER SIDE PASSENGER POWER WINDOW SWITCH AND GROUND	
	1 Disconnect Driver Side Passenger Power Window Switch CPW10B.

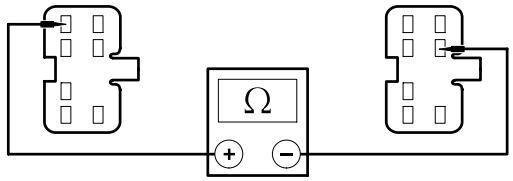
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0014346	2 Measure the resistance between the: Left-hand drive vehicles with one-touch down • Driver side passenger power window switch CPW10B pin 3, circuit A_GD133AC (BK), harness side and ground. • Driver side passenger power window switch CPW10B pin 6, circuit A_GD133AD (BK), harness side and ground. Right-hand drive vehicles with one-touch down • Driver side passenger power window switch CPW10B pin 3, circuit B_GD138AC (BK/WH), harness side and ground. • Driver side passenger power window switch CPW10B pin 6, circuit B_GD138AD (BK/WH), harness side and ground. Left-hand drive vehicles without one-touch down • Driver side passenger power window switch CPW10B pin 3, circuit A_GD133AD (BK), harness side and ground. • Driver side passenger power window switch CPW10B pin 6, circuit A_GD133AF (BK), harness side and ground. Right-hand drive vehicles without one-touch down • Driver side passenger power window switch CPW10B pin 3, circuit B_GD138AC (BK/WH), harness side and ground. • Driver side passenger power window switch CPW10B pin 6, circuit B_GD138AB (BK/WH), harness side and ground. • Are the resistances less than 5 ohms? → **Yes** GO to C5. → **No** Left-hand drive vehicles with one-touch down - REPAIR circuit A_GD133AC (BK) or circuit A_GD133AD (BK). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit B_GD138AC (BK/WH), or circuit B_GD138AD (BK/WH). TEST the system for normal operation. Left-hand drive vehicles without one-touch down - REPAIR circuit A_GD133AD (BK) or circuit A_GD133AF (BK). TEST the system for normal operation. Right-hand drive vehicles without one-touch down - REPAIR circuit B_GD138AB (BK/WH), or circuit B_GD138AC (BK/WH). TEST the system for normal operation.

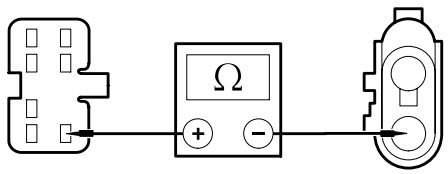
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C5: CHECK THE UP CIRCUIT FOR CONTINUITY BETWEEN THE DRIVER SIDE PASSENGER POWER WINDOW SWITCH AND PASSENGER SIDE POWER WINDOW SWITCH	
 TIE0013579	1 Measure the resistance between the: Left-hand drive vehicles with one-touch down • Driver side passenger power window switch CPW10B pin 7, circuit CPW13A (BN/YE), harness side and the passenger side power window switch CPW19 pin 3, circuit CPW13C (BN/YE), harness side. Right-hand drive vehicles with one-touch down • Driver side passenger power window switch CPW10B pin 7, circuit CPW13A (GY/RD), harness side and the passenger side power window switch CPW19 pin 3, circuit CPW13C (GY/RD), harness side. Right-hand drive vehicles without one-touch down • Driver side passenger power window switch CPW10B pin 7, circuit CPW13A (GY/RD), harness side and the passenger side power window switch CPW19 pin 3, circuit CPW13C (GY/RD), harness side. Left-hand drive vehicles without one-touch down • Driver side passenger power window switch CPW10B pin 7, circuit CPW13A (BN/YE), harness side and the passenger side power window switch CPW19 pin 3, circuit CPW13C (BN/YE), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to C6. → **No** Left-hand drive vehicles with one-touch down - REPAIR circuit CPW13A (BN/YE) or circuit CPW13C (BN/YE). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit CPW13A (GY/RD) or circuit CPW13C (GY/RD). TEST the system for normal operation. Left-hand drive vehicles without one-touch down - REPAIR circuit CPW13A (GY/RD) or circuit CPW13C (GY/RD). TEST the system for normal operation. Right-hand drive vehicles without one-touch down - REPAIR circuit CPW13A (BN/YE) or circuit CPW13C (BN/YE). TEST the system for normal operation.

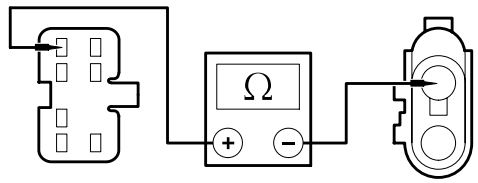
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C6: CHECK THE DOWN CIRCUIT FOR CONTINUITY BETWEEN THE DRIVER SIDE PASSENGER POWER WINDOW SWITCH AND PASSENGER SIDE POWER WINDOW SWITCH	
 TIE0013580	1 Measure the resistance between the: Left-hand drive vehicles with one-touch down • Driver side passenger power window switch CPW10B pin 1, circuit CPW12A (GN/OG), harness side and the passenger side power window switch CPW19 pin 6, circuit CPW12C (GN/OG0), harness side. Right-hand drive vehicles with one-touch down • Driver side passenger power window switch CPW10B pin 1, circuit CPW12A (GN/OG), harness side and the passenger side power window switch CPW19 pin 6, circuit CPW12C (GN/OG), harness side. Right-hand drive vehicles without one-touch down • Driver side passenger power window switch CPW10B pin 1, circuit CPW12A (GN/OG), harness side and the passenger side power window switch CPW19 pin 6, circuit CPW12C (GN/OG), harness side. Left-hand drive vehicles without one-touch down • Driver side passenger power window switch CPW10B pin 1, circuit CPW12A (GN/OG), harness side and the passenger side power window switch CPW19 pin 6, circuit CPW12C (GN/OG), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new passenger side power window switch. TEST the system for normal operation. → **No** REPAIR circuit CPW12A (GN/OG) or circuit CPW12C (GN/OG). TEST the system for normal operation.
C7: CHECK THE UP CIRCUIT FOR CONTINUITY BETWEEN THE PASSENGER POWER WINDOW SWITCH AND THE PASSENGER POWER WINDOW MOTOR	
	1 Disconnect Passenger Side Front Door Window Regulator Motor CPW20.

DIAGNOSIS AND TESTING

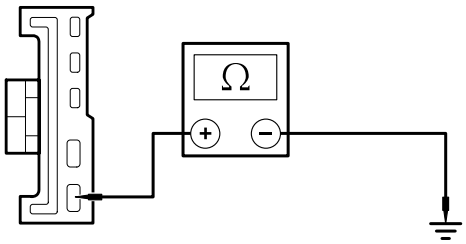
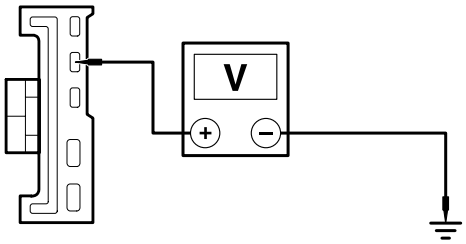
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E69436	2 Measure the resistance between the: Left-hand drive vehicles with one-touch down • Passenger side power window switch CPW19 pin 7, circuit CPW40A (WH), harness side and the passenger side front door window regulator motor CPW20 pin 2, circuit CPW40A (WH), harness side. Right-hand drive vehicles with one-touch down • Passenger side power window switch CPW19 pin 7, circuit CPW40A (GN/BK), harness side and the passenger side front door window regulator motor CPW20 pin 2, circuit CPW40A (GN/BK), harness side. Right-hand drive vehicles without one-touch down • Passenger side power window switch CPW19 pin 7, circuit CPW40A (GN/BK), harness side and the passenger side front door window regulator motor CPW20 pin 2, circuit CPW40A (GN/BK), harness side. Left-hand drive vehicles without one-touch down • Passenger side power window switch CPW19 pin 7, circuit CPW40A (WH), harness side and the passenger side front door window regulator motor CPW20 pin 2, circuit CPW40A (WH), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to C8. → **No** Left-hand drive vehicles with one-touch down - REPAIR circuit CPW40A (WH). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit CPW40A (GN/BK). TEST the system for normal operation. Left-hand drive vehicles without one-touch down - REPAIR circuit CPW40A (GN/BK). TEST the system for normal operation. Right-hand drive vehicles without one-touch down - REPAIR circuit CPW40A (WH). TEST the system for normal operation.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C8: CHECK FOR CONTINUITY BETWEEN THE PASSENGER POWER WINDOW SWITCH DOWN CIRCUIT AND THE PASSENGER POWER WINDOW MOTOR	
 E69437	1 Measure the resistance between the: Left-hand drive vehicles with one-touch down • Passenger side power window switch CPW19 pin 1, circuit CPW41A (GN/YE), harness side and the passenger side front door window regulator motor CPW20 pin 1, circuit CPW41A (GN/YE), harness side. Right-hand drive vehicles with one-touch down • Passenger side power window switch CPW19 pin 1, circuit CPW41A (GN/YE), harness side and the passenger side front door window regulator motor CPW20 pin 1, circuit CPW41A (GN/YE), harness side. Right-hand drive vehicles without one-touch down • Passenger side power window switch CPW19 pin 1, circuit CPW41A (GN/YE), harness side and the passenger side front door window regulator motor CPW20 pin 1, circuit CPW41A (GN/YE), harness side. Left-hand drive vehicles without one-touch down • Passenger side power window switch CPW19 pin 1, circuit CPW41A (GN/YE), harness side and the passenger side front door window regulator motor CPW20 pin 1, circuit CPW41A (GN/YE), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new passenger side front door window regulator and motor. REFER to:Front Door Window Regulator and Motor (501-11 Glass, Frames and Mechanisms, Removal and Installation). TEST the system for normal operation. → **No** REPAIR circuit CPW41A (GN/YE). TEST the system for normal operation.

DIAGNOSIS AND TESTING

PINPOINT TEST D : THE ONE-TOUCH DOWN FEATURE IS INOPERATIVE

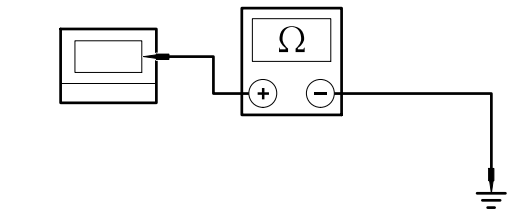
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
D1: CHECK THE ONE-TOUCH DOWN RELAY GROUND CIRCUIT	
	1 Measure the resistance between the: Left-hand drive vehicles with one-touch down • One-touch down relay CPW29 pin 5, circuit A_GD133AE (BK), harness side and ground. Right-hand drive vehicles with one-touch down • One-touch down relay CPW29 pin 5, circuit B_GD138AE (BK/WH), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** GO to D2. → **No** Left-hand drive vehicles with one-touch down - REPAIR circuit A_GD133AE (BK). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit B_GD138AE (BK/WH). TEST the system for normal operation.
D2: CHECK FOR SWITCH VOLTAGE TO THE ONE-TOUCH DOWN RELAY	
	1 Disconnect One-touch Down Relay CPW29.
	2 Ignition switch in position II.
	3 Operate the driver power window switch to the DOWN position.
 E72606	4 Measure the voltage between the: Left-hand drive vehicles with one-touch down • One-touch down relay CPW29 pin 2, circuit CPW35C (GN), harness side and ground. Right-hand drive vehicles with one-touch down • One-touch down relay CPW29 pin 2, circuit CPW35B (GN), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** INSTALL a new one-touch down relay. TEST the system for normal operation. → **No** Left-hand drive vehicles with one-touch down - REPAIR circuit CPW35C (GN). TEST the system for normal operation. Right-hand drive vehicles with one-touch down - REPAIR circuit CPW35B (GN). TEST the system for normal operation.

DIAGNOSIS AND TESTING

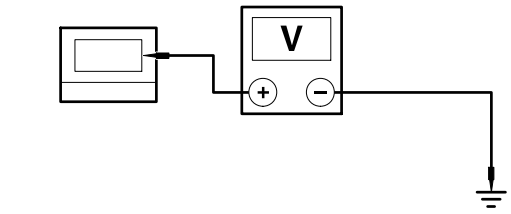
PINPOINT TEST E : THE DEFROST SYSTEM IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
E1: CHECK THE OPERATION OF THE HEATED REAR WINDOW	
	1 Ignition switch in position III.
	2 Ignition switch in position II.
	3 Operate the heated rear window glass switch. • Does the heated rear window function correctly? → **Yes** GO to E2. → **No** GO to E3.
E2: CHECK THE OPERATION OF THE HEATED WINDSHIELD	
	1 Ignition switch in position III.
	2 Ignition switch in position II.
	3 Operate the heated windshield glass switch. • Does the heated windshield glass operate correctly? → **Yes** VERIFY the customer concern. → **No** GO to E7.
E3: CHECK THE OPERATION OF THE HEATED REAR WINDOW SWITCH LED	
	1 Operate the heated rear window glass switch. • Does the heated rear window glass switch LED illuminate? → **Yes** GO to E4. → **No** GO to E10.

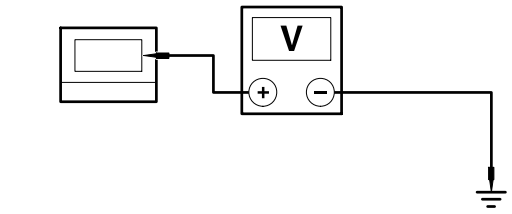
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E4: CHECK THE OPERATION OF THE HEATED EXTERIOR MIRRORS	
	1 Operate the heated rear window switch. • Do the heated exterior mirrors operate correctly? → **Yes** GO to E5. → **No** GO to E14.
E5: CHECK THE HEATED REAR WINDOW GLASS GRID GROUND CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Heated Rear Window Glass CRD02B or CRD02D or CRD02F.
 TIE0005283	3 Measure the resistance between the: Vehicles with rear doors • Left-hand heated rear window glass CRD02D pin 1, circuit A_GD149B (BK/GY), harness side and ground. • Right-hand heated rear window glass CRD02B pin 1, circuit A_GD151D (BK/GN), harness side and ground. Vehicles with liftgate • Liftgate heated rear window glass CRD02F pin 1, circuit A_GD149K (BK/GY), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** GO to E6. → **No** Vehicles with rear doors - REPAIR circuit A_GD149B (BK/GY) or circuit A_GD151D (BK/GN). TEST the system for normal operation. Vehicles with liftgate - REPAIR circuit A_GD149K (BK/GY). TEST the system for normal operation.
E6: CHECK FOR VOLTAGE TO THE HEATED REAR WINDOW GLASS GRID WIRES	
	1 Disconnect Heated Rear Window Glass CRD02A or CRD02C or CRD02E.
	2 Ignition switch in position II.

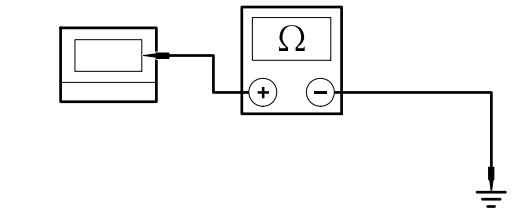
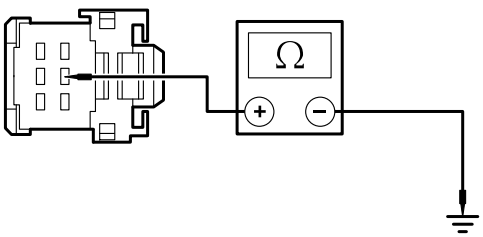
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0005282	3 Measure the voltage between the: Vehicles with rear doors • Left-hand heated rear window glass CRD02C pin 1, circuit L_CB159B (BN/WH), harness side and ground. • Right-hand heated rear window glass CRD02A pin 1, circuit R_CB159E (BN/WH), harness side and ground. Vehicles with liftgate • Liftgate heated rear window glass CRD02E pin 1, circuit L_CB159G (BN/WH), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** CARRY OUT the Heated Rear Window Glass Grid Wire Component Test in this procedure. TEST the system for normal operation. → **No** Vehicles with rear doors - REPAIR circuit L_CB159B (BN/WH) or circuit R_CB159E (BN/WH). TEST the system for normal operation. Vehicles with liftgate - REPAIR circuit L_CB159G (BN/WH). TEST the system for normal operation.
E7: CHECK THE OPERATION OF THE HEATED WINDSHIELD GLASS ON BOTH SIDES	
	1 Operate the heated windshield glass control switch. • Does the heated windshield glass operate correctly on either side? → **Yes** GO to E8. → **No** GO to E16.
E8: CHECK FOR VOLTAGE TO THE INOPERATIVE HEATED WINDSHIELD GLASS GRID WIRE	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand Heated Windshield Glass Grid Wire CRD03A or Right-hand Heated Windshield Glass Grid Wire CRD04A.
	3 Ignition switch in position III.
	4 Ignition switch in position II.
	5 Operate the heated windshield glass switch.

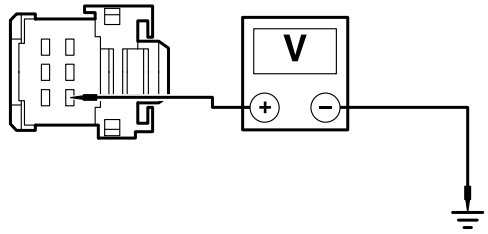
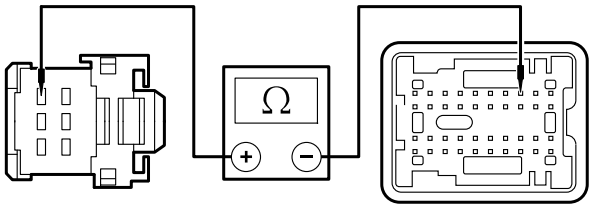
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0005282	6 Measure the voltage between the: Chassis Cab • Left-hand heated windshield glass grid wire CRD03A pin 1, circuit CRD10C (VT/RD), harness side and ground. • Right-hand heated windshield glass grid wire CRD04A pin 1, circuit CRD11B (YE/VT), harness side and ground. Van, Bus, Kombi • Left-hand heated windshield glass grid wire CRD04A pin 1, circuit CRD10B (BN/WH), harness side and ground. • Right-hand heated windshield glass grid wire CRD04C pin 1, circuit CRD11B (YE/VT), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to E9. → **No** GO to E18.
E9: CHECK THE INOPERATIVE HEATED WINDSHIELD GLASS GRID WIRE GROUND CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Left-hand Heated Windshield Glass Grid Wire CRD03B or Right-hand Heated Windshield Glass Grid Wire CRD04B.

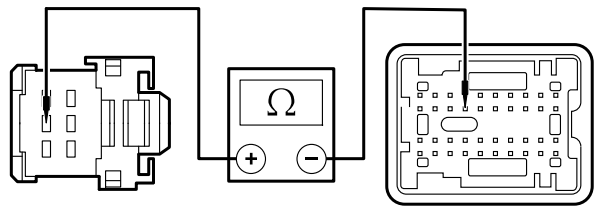
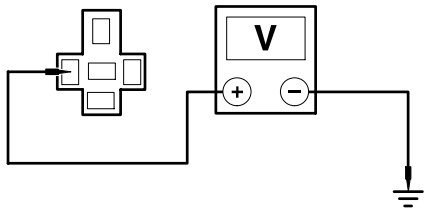
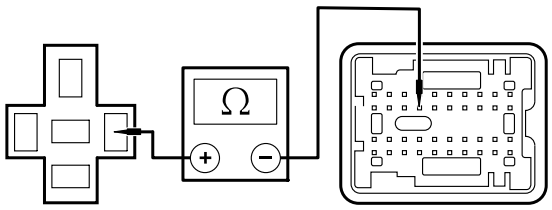
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0005283	3 Measure the resistance between the: Chassis Cab • Left-hand heated windshield glass grid wire CRD03B pin 1, circuit A_GD133J (BK), harness side and ground. • Right-hand heated windshield glass grid wire CRD04B pin 1, circuit A_GD138J (BK/WH), harness side and ground. Van, Bus, Kombi • Left-hand heated windshield glass grid wire CRD04B pin 1, circuit A_GD133E (BK), harness side and ground. • Right-hand heated windshield glass grid wire CRD04C pin 1, circuit A_GD138M (BK/WH), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new windshield glass. REFER to:Windshield Glass (501-11 Glass, Frames and Mechanisms, Removal and Installation). TEST the system for normal operation. → **No** Chassis Cab - REPAIR circuit A_GD133J (BK) or circuit A_GD138J (BK/WH). TEST the system for normal operation. Van, Bus, Kombi - REPAIR circuit A_GD133E (BK) or circuit A_GD138M (BK/WH). TEST the system for normal operation.
E10: CHECK THE HEATED REAR WINDOW CONTROL SWITCH GROUND CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Heated Rear Window Switch CRD09.
	3 Measure the resistance between the heated rear window switch CRD09 pin 2, circuit B_GD115G (BK/GY), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** GO to E11. → **No** REPAIR circuit B_GD115G (BK/GY). TEST the system for normal operation.

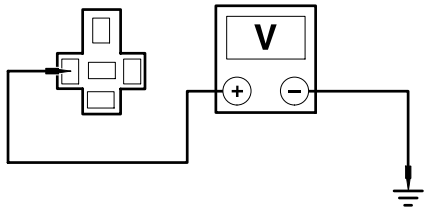
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E11: CHECK FOR VOLTAGE TO THE HEATED REAR WINDOW CONTROL SWITCH	
	1 Ignition switch in position II.
	2 Measure the voltage between the heated rear window switch CRD09 pin 1, circuit SBP66F (YE/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to E12. → **No** REPAIR circuit SBP66F (YE/RD). TEST the system for normal operation.
E12: CHECK FOR CONTINUITY BETWEEN THE HEATED REAR WINDOW SWITCH AND THE CENTRAL JUNCTION BOX (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect CJB CBP02F.
	3 Measure the resistance between the heated rear window control switch CRD09 pin 6, circuit CRD09A (BU/GY), harness side and the CJB CBP02F pin 3, circuit CRD09A (BU/GY), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to E13. → **No** REPAIR circuit CRD09A (BU/GY). TEST the system for normal operation.
E13: CHECK FOR CONTINUITY BETWEEN THE HEATED REAR WINDOW SWITCH AND THE CJB GROUND CIRCUIT	
	1 Disconnect CJB CBP02D.

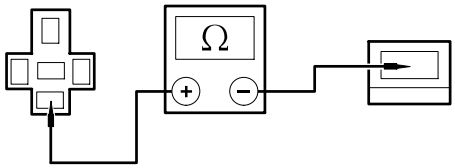
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E71765	2 Measure the resistance between the heated rear window control switch CRD09 pin 5, circuit CRD06D (BN/YE), harness side and the CJB CBP02D pin 17, circuit CRD06D (BN/YE), harness side . • Is the resistance less than 5 ohms? → **Yes** CARRY OUT the CJB self-test. REFER to WDS. → **No** REPAIR circuit CRD06D (BN/YE). TEST the system for normal operation.
E14: CHECK FOR VOLTAGE TO THE HEATED REAR WINDOW RELAY	
	1 Ignition switch in position 0.
	2 Disconnect Heated Rear Window Relay R17.
 TIE0035307	3 Measure the voltage between the heated rear window relay R17 pin 1, harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to E15. → **No** INSTALL a new auxiliary junction box. TEST the system for normal operation.
E15: CHECK FOR CONTINUITY BETWEEN THE HEATED REAR WINDOW RELAY AND THE CENTRAL JUNCTION BOX (CJB)	
	1 Disconnect CJB CBP02D.
 E71766	2 Measure the resistance between the heated rear window relay R17 pin 2, circuit CRD06B (BN/YE), harness side and the CJB CBP02D pin 17, circuit CRD06B (BN/YE), harness side. • Is the resistance less than 5 ohms? → **Yes** VERIFY the customer concern. → **No** REPAIR circuit CRD06B (BN/YE). TEST the system for normal operation.

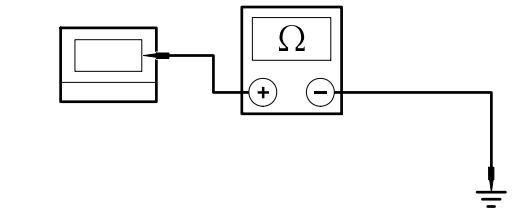
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E16: CHECK THE OPERATION OF THE HEATED WINDSHIELD SWITCH LED	
	1 Operate the heated rear window switch. • Does the heated rear window switch LED illuminate? → **Yes** GO to E17. → **No** GO to E20.
E17: CHECK OPERATION OF THE HEATED WINDSHIELD GLASS RELAY	
	1 Operate the heated windshield glass switch. • Does the heated windshield glass relay click? → **Yes** VERIFY the customer concern. → **No** GO to E24.
E18: CHECK FOR VOLTAGE TO THE HEATED WINDSHIELD GLASS RELAY	
	1 Disconnect Heated Windshield Glass Relay R22 or Heated Windshield Glass Relay R26.
 TIE0035307	2 Measure the voltage between the: • Left-hand side heated windshield glass relay R26 pin 1, harness side and ground. • Right-hand side heated windshield glass relay R22 pin 1, harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to E19. → **No** INSTALL a new auxiliary junction box. TEST the system for normal operation.
E19: CHECK FOR CONTINUITY BETWEEN THE AUXILIARY JUNCTION BOX AND THE HEATED WINDSHIELD GLASS GRID WIRES	
	1 Ignition switch in position 0.
	2 Disconnect Disconnect Inoperative Heated Windshield Glass Grid Wire CRD03A or CRD04A or CRD04C.

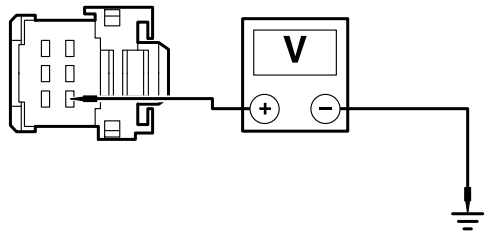
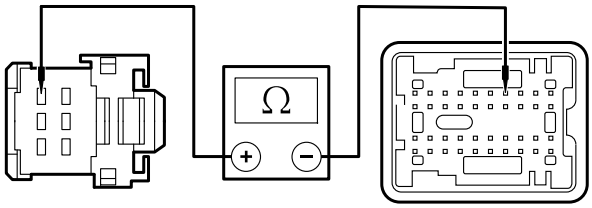
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0035403	3 Measure the resistance between the: Chassis Cab • Left-hand heated windshield glass relay R26 pin 5, circuit CRD10B (VT/RD), harness side and left-hand heated windshield glass grid wire CRD03A pin 1, circuit CRD10C (VT/RD), harness side. • Right-hand heated windshield glass relay R22 pin 5, circuit CRD11A (YE/VT), harness side and right-hand heated windshield glass grid wire CRD04A pin 1, circuit CRD11B (YE/VT), harness side. Van, Bus, Kombi • Left-hand heated windshield glass relay R26 pin 5, circuit CRD10A (BN/WH), harness side and left-hand heated windshield glass grid wire CRD04A pin 1, circuit CRD10B (BN/WH), harness side. • Right-hand heated windshield glass relay R22 pin 5, circuit CRD11A (YE/VT), harness side and right-hand heated windshield glass grid wire CRD04C pin 1, circuit CRD11B (YE/VT), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new heated windshield glass relay. TEST the system for normal operation. → **No** Chassis Cab - Left-hand side - REPAIR circuit CRD10B (VT/RD) or circuit CRD10C (VT/RD). TEST the system for normal operation. Chassis Cab - Right-hand side - REPAIR circuit CRD11A (YE/VT) or circuit CRD11B (YE/VT). TEST the system for normal operation. Van, Bus, Kombi - Left-hand side - REPAIR circuit CRD10B (BN/WH). TEST the system for normal operation. Van, Bus, Kombi - Right-hand side - REPAIR circuit CRD11B (YE/VT). TEST the system for normal operation.
E20: CHECK THE HEATED WINDSHIELD GLASS GRID WIRE GROUND CIRCUITS	
	1 Ignition switch in position 0.
	2 DisconnectLeft-hand Heated Windshield Glass Grid Wire CRD03B or Right-hand Heated Windshield Glass Grid Wire CRD04B.

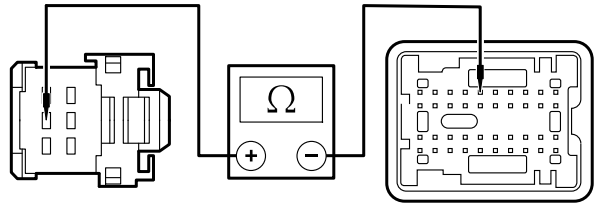
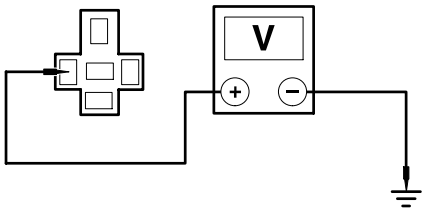
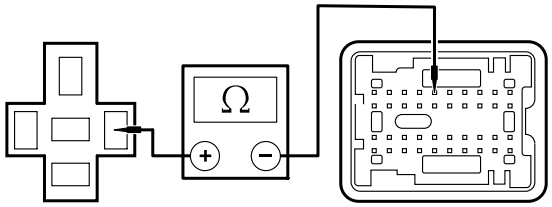
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0005283	3 Measure the resistance between the: Chassis Cab • Left-hand heated windshield glass grid wire CRD03B pin 1, circuit A_GD133J (BK), harness side and ground. • Right-hand heated windshield glass grid wire CRD04B pin 1, circuit A_GD138J (BK/WH), harness side and ground. Van, Bus, Kombi • Left-hand heated windshield glass grid wire CRD04B pin 1, circuit A_GD133E (BK), harness side and ground. • Right-hand heated windshield glass grid wire CRD04C pin 1, circuit A_GD138M (BK/WH), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** GO to E21. → **No** Chassis Cab - Left-hand side - REPAIR circuit A_GD133J (BK). TEST the system for normal operation. Chassis Cab - Right-hand side - REPAIR circuit A_GD138J (BK/WH). TEST the system for normal operation. Van, Bus, Kombi - Left-hand side - REPAIR circuit A_GD133E (BK). TEST the system for normal operation. Van, Bus, Kombi - Right-hand side - REPAIR circuit A_GD138M (BK/WH). TEST the system for normal operation.
E21: CHECK FOR VOLTAGE TO THE HEATED WINDSHIELD GLASS SWITCH	
	1 DisconnectHeated Windshield Glass Switch CRD08.
	2 Ignition switch in position III.
	3 Ignition switch in position II.

DIAGNOSIS AND TESTING

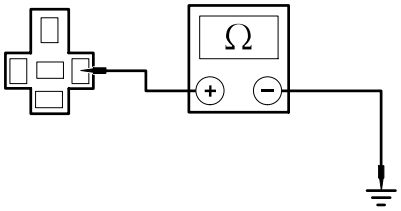
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E70701	4 Measure the voltage between the: Chassis Cab • Heated windshield glass switch CRD08 pin 1, circuit SBP66E (RD/BK), harness side and ground. Van, Bus, Kombi • Heated windshield glass switch CRD08 pin 1, circuit SBP66E (YE/RD), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to E22. → **No** Chassis Cab - REPAIR circuit SBP66E (RD/BK). TEST the system for normal operation. Van, Bus, Kombi - REPAIR circuit SBP66E (YE/RD). TEST the system for normal operation.
E22: CHECK FOR CONTINUITY BETWEEN THE HEATED WINDSHIELD GLASS SWITCH AND THE CENTRAL JUNCTION BOX (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect CJB CBP02F.
	3 Measure the resistance between the heated windshield glass switch CRD08 pin 6, circuit CRD08A (GN/OG), harness side and the CJB CBP02F pin 4, circuit CRD08A (GN/OG), harness side. • Is the resistance less than 5 ohms? → **Yes** GO to E23. → **No** REPAIR circuit CRD08A (GN/OG). TEST the system for normal operation.
E23: CHECK FOR CONTINUITY BETWEEN THE HEATED WINDSHIELD GLASS SWITCH AND THE (CJB) GROUND CIRCUIT	
	1 Disconnect CJB CBP02D.

DIAGNOSIS AND TESTING

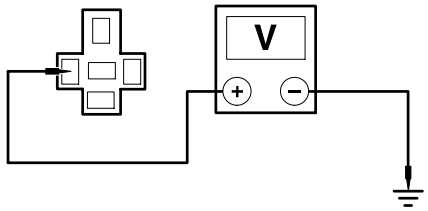
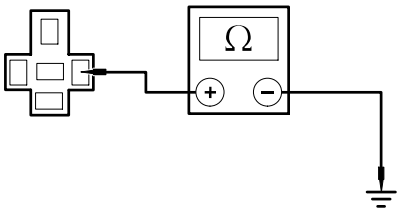
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E71768	2 Measure the resistance between the heated windshield glass switch CRD08 pin 5, circuit CRD01A (VT/OG), harness side and the CJB CBP02D pin 6, circuit CRD01A (VT/OG), harness side. • Is the resistance less than 5 ohms? → **Yes** CARRY OUT the CJB self-test. REFER to WDS. → **No** REPAIR circuit CRD01A (VT/OG). TEST the system for normal operation.
E24: CHECK FOR VOLTAGE TO THE HEATED WINDSHIELD GLASS RELAY	
	1 Ignition switch in position 0.
	2 Disconnect Heated Windshield Glass Relay R22 or R26.
 TIE0035307	3 Measure the voltage between the: • Left-hand side heated windshield glass relay R26 pin 1, harness side and ground. • Right-hand side heated windshield glass relay R22 pin 1, harness side and ground. • Is the voltage greater than 10 volts? → **Yes** GO to E25. → **No** INSTALL a new auxiliary junction box. TEST the system for normal operation.
E25: CHECK FOR CONTINUITY BETWEEN THE HEATED WINDSHIELD GLASS RELAY AND THE CENTRAL JUNCTION BOX (CJB)	
	1 Disconnect CJB CBP02D.
 E71769	2 Measure the resistance between the: • Left-hand side heated windshield glass relay R26 pin 2, harness side and the CJB CBP02D, circuit CRD01A (VT/OG), harness side. • Right-hand side heated windshield glass relay R22 pin 2, harness side and the CJB CBP02D, circuit CRD01A (VT/OG), harness side. • Is the resistance less than 5 ohms? → **Yes** VERIFY the customer concern. → **No** REPAIR circuit CRD01A (VT/OG). TEST the system for normal operation.

DIAGNOSIS AND TESTING

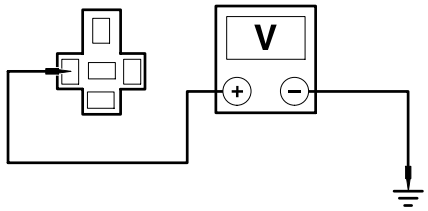
PINPOINT TEST F : THE DEFROST SYSTEM WILL NOT SHUT OFF AUTOMATICALLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
F1: CHECK FOR CONTINUITY BETWEEN THE HEATED REAR WINDOW RELAY AND GROUND	
	1 Disconnect Heated Rear Window Relays R12, R17 and R18.
 TIE0035306	2 Measure the resistance between the: Vehicles with rear doors • Left-hand heated rear window relay R17 pin 2, harness side and ground. • Right-hand heated rear window relay R18 pin 2, harness side and ground. Vehicles with liftgate • Liftgate heated rear window relay R17 pin 2, harness side and ground. • Is the resistance less than 5 ohms? → **Yes** REPAIR circuit CRD06B (BN/YE) or the heated rear window relay auxiliary junction box circuit. TEST the system for normal operation. → **No** GO to F2.
F2: CHECK THE HEATED REAR WINDOW CIRCUIT FOR A SHORT TO POWER	
	1 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0035307	2 Measure the voltage between the: Vehicles with rear doors • Left-hand heated rear window grid wire CRD02C pin 1, circuit L_CB159E (BN/WH), harness side and ground. • Right-hand heated rear window grid wire CRD02A pin 1, circuit R_CB159E (BN/WH), harness side and ground. Vehicles with liftgate • Liftgate heated rear window grid wire CRD02e pin 1, circuit L_CB159G (BN/WH), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** Vehicles with rear doors - REPAIR circuit L_CB159E (BN/WH) or circuit R_CB159E (BN/WH). TEST the system for normal operation. Vehicles with liftgate - REPAIR circuit L_CB159G (BN/WH). TEST the system for normal operation. → **No** GO to F3.
F3: CHECK FOR CONTINUITY BETWEEN THE HEATED WINDSHIELD GLASS RELAY AND GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Heated Windshield Glass Relays R22 and R26.
 TIE0035306	3 Measure the resistance between the: • Left-hand side heated windshield glass relay R26 pin 2, harness side and ground. • Right-hand side heated windshield glass relay R22 pin 2, harness side and ground. • Is the resistance less than 5 ohms? → **Yes** REPAIR circuit CRD01C (VT/OG) or the heated windshield glass relay auxiliary junction box circuit. TEST the system for normal operation. → **No** GO to F4.
F4: CHECK THE HEATED WINDSHIELD GLASS RELAY CIRCUIT FOR A SHORT TO POWER	
	1 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0035307	2 Measure the voltage between the: Chassis Cab • Left-hand side heated windshield glass grid wire CRD03A pin 1, circuit CRD10C (VT/RD), harness side and ground. • Right-hand side heated windshield glass grid wire CRD04A pin 1, circuit CRD11B (YE/VT), harness side and ground. Van, Bus, Kombi • Left-hand side heated windshield glass grid wire CRD04A pin 1, circuit CRD10B (BN/WH), harness side and ground. • Right-hand side heated windshield glass grid wire CRD04C pin 1, circuit CRD11A (YE/VT), harness side and ground. • Is the voltage greater than 10 volts? → **Yes** Chassis Cab - Left-hand side - REPAIR circuit CRD10C (VT/RD). TEST the system for normal operation. Chassis Cab - Right-hand side - REPAIR circuit CRD11B (YE/VT). TEST the system for normal operation. Van, Bus, Kombi - Left-hand side - REPAIR circuit CRD10B (BN/WH). TEST the system for normal operation. Van, Bus, Kombi - Right-hand side - REPAIR circuit CRD11A (YE/VT). TEST the system for normal operation. → **No** VERIFY the customer concern.

Component Tests

Heated Rear Window Grid Wire Test

1. Using a bright lamp inside the vehicle, visually inspect the grid wire from the outside. A broken grid conductor line will appear as a brown spot.
2. Run the engine at idle. Set the heated rear window control switch and lights to ON. The heated rear window indicator light should illuminate.
3. Working inside the vehicle with a multimeter, contact the broad red/brown strips on the heated rear window positive lead to battery side and negative lead to ground side. The meter should read 10-13 volts. A lower voltage reading indicates a loose heated rear window ground wire connection at the heated rear window ground wire screw.
4. Contact a ground point with the negative lead of the multimeter. The voltage reading should not change.
5. With the negative lead of the multimeter grounded, touch each grid line of the heated rear window at its pinpoint with the positive lead. A reading of approximately six volts indicates that the line is OK. A reading of zero volts indicates that the line is broken between the midpoint and the battery side of the grid line. A reading of 12 volts indicates that the circuit is broken between the midpoint of the grid line and ground.

DIAGNOSIS AND TESTING

6. INSTALL a new heated rear window glass. REFER to:(501-11 Glass, Frames and Mechanisms)

   Rear Door Window Glass (Removal and Installation),
   Liftgate Window Glass (Removal and Installation).

REMOVAL AND INSTALLATION

Front Door Window Glass (42 314 0)

Removal

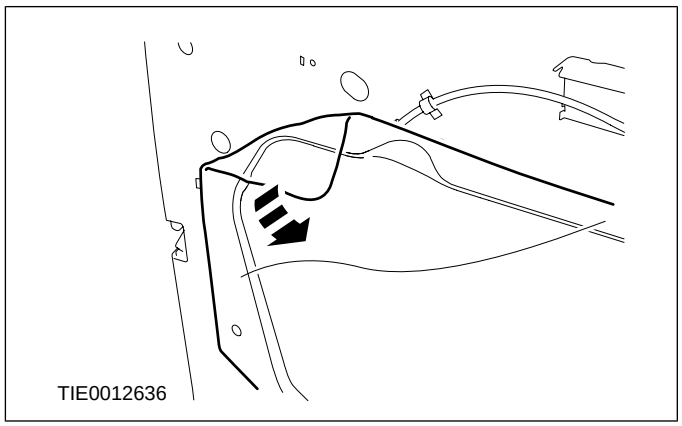
All vehicles

1. **Remove the front door trim panel.**

   For additional information, refer to:Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

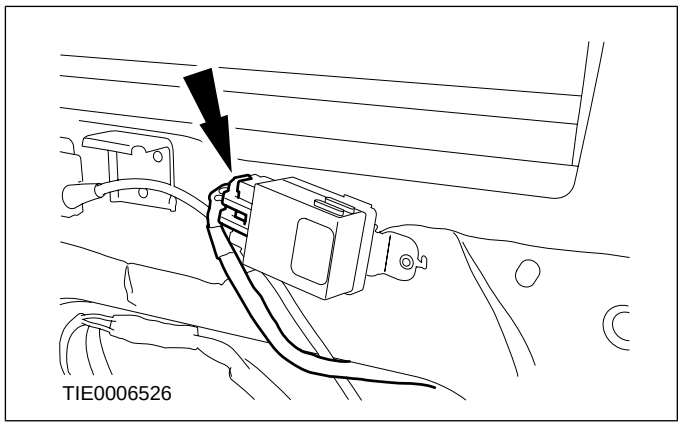
2. **⚠CAUTION:Do not touch the adhesive surface as re-bonding will be impaired.**

   Detach the watershield from the door panel.

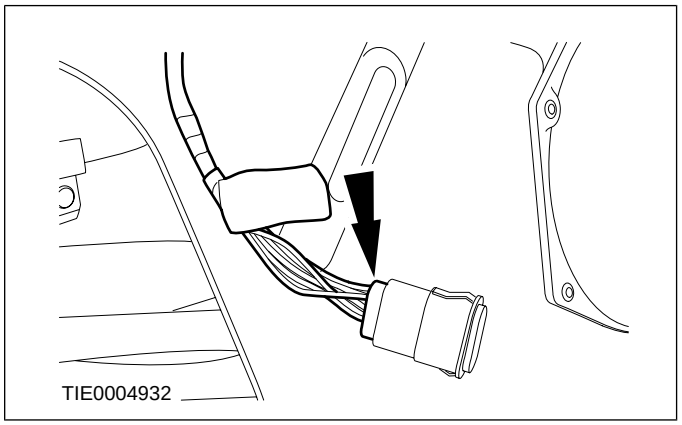


Vehicles with power windows

3. **Disconnect the one-touch down relay electrical connector (if equipped).**

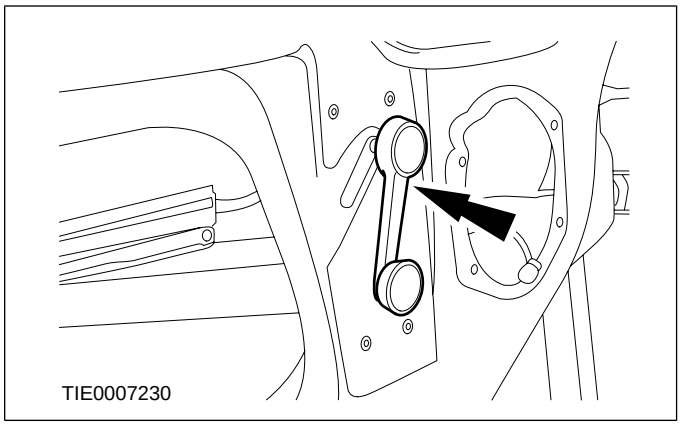


4. **Connect the window control switch electrical connector.**



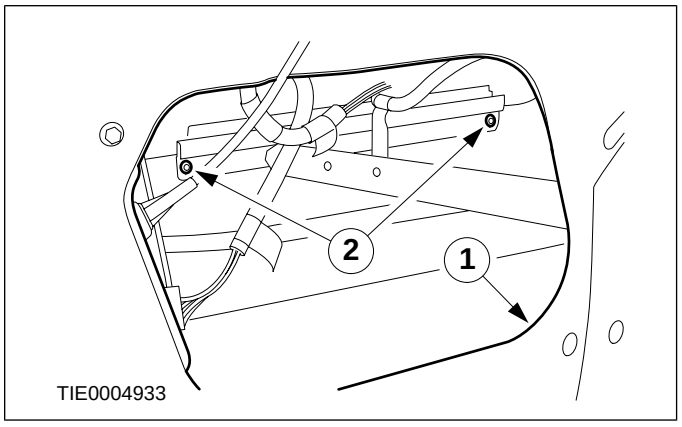
Vehicles with manual windows

5. **Install the window regulator handle.**



All vehicles

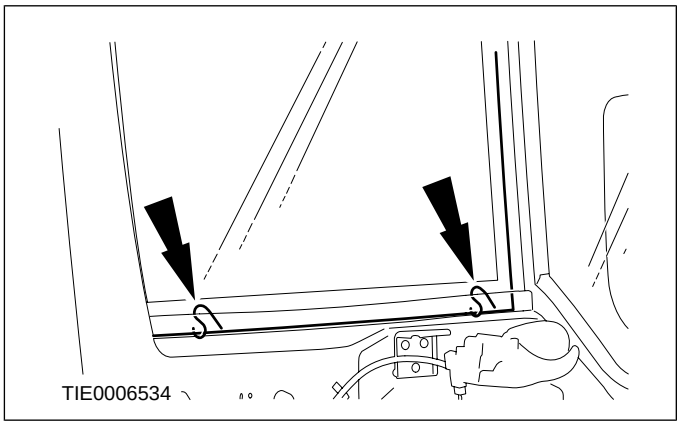
6. **Detach the window glass from the clamp.**
   1. Align the clamp with the access hole.
   2. Remove the rivets.



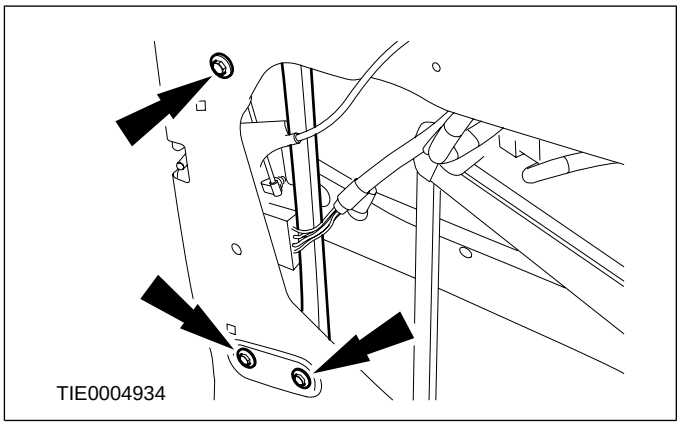
REMOVAL AND INSTALLATION

7. **CAUTION:Make sure the window glass is adequately supported at the top of the window opening.**

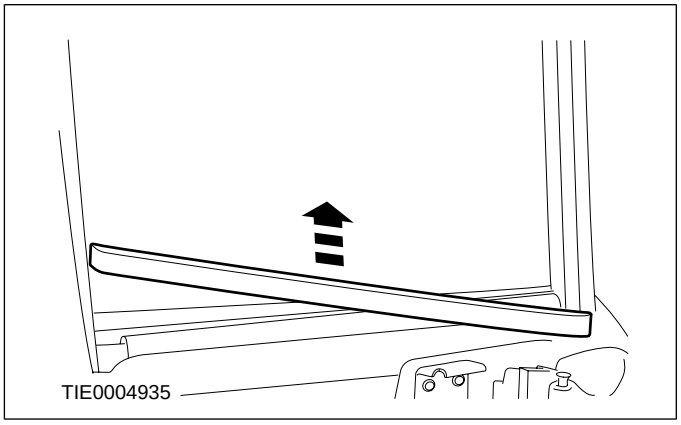
   Raise the window glass and secure using suitable hooks.



8. **Remove the front door glass top run outer retaining bracket.**

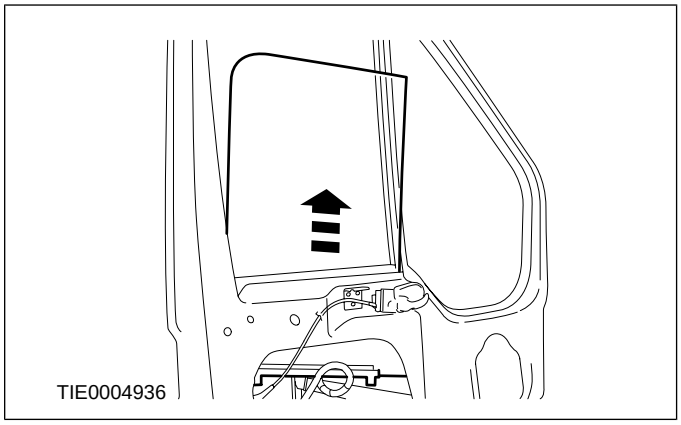


9. **Detach the window glass from the front door glass top run.**
10. **Lower the window glass to the base of the door.**
11. **Remove the window glass weatherstrip.**



12. **NOTE:The front door window glass must be removed towards the inside of the window opening.**

    With the aid of another technician, remove the window glass.

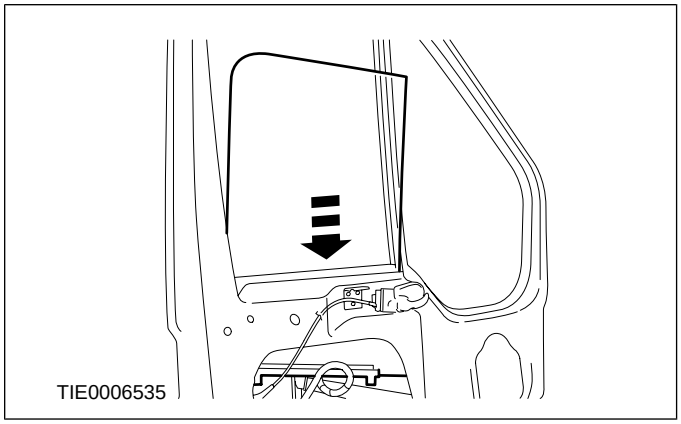


Installation

All vehicles

1. **NOTE:The front door window glass must be installed towards the inside of the window opening.**

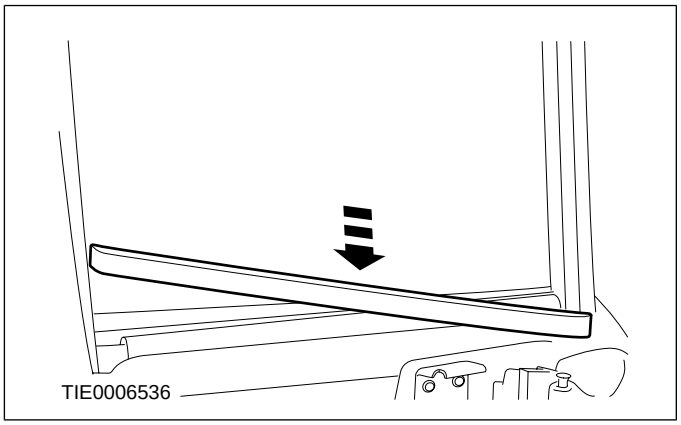
   With the aid of another technician, install the window glass.



2. **Lower the front door window glass to the base of the door.**

REMOVAL AND INSTALLATION

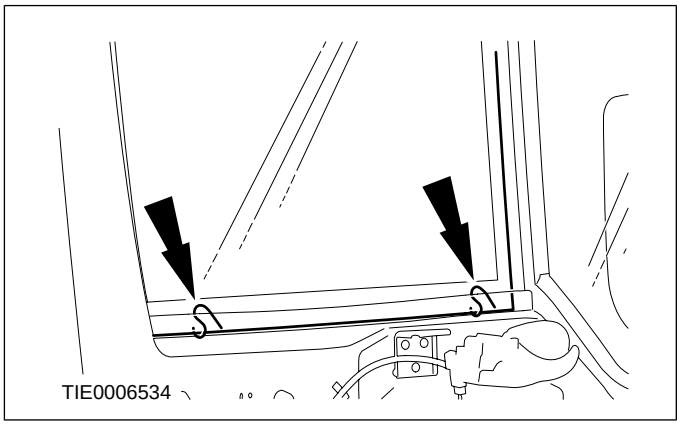
3. Install the window glass weatherstrip.



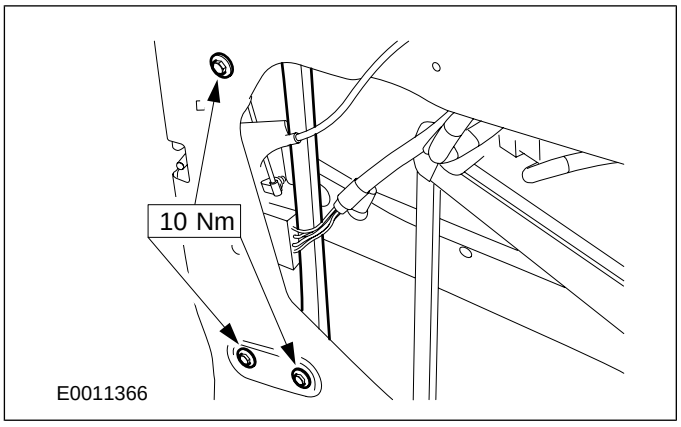
4. Attach the window glass to the front door glass top run.

5. ⚠CAUTION:Make sure that the window glass is adequately supported at the top of the window opening.

Raise the window glass and secure using suitable hooks.

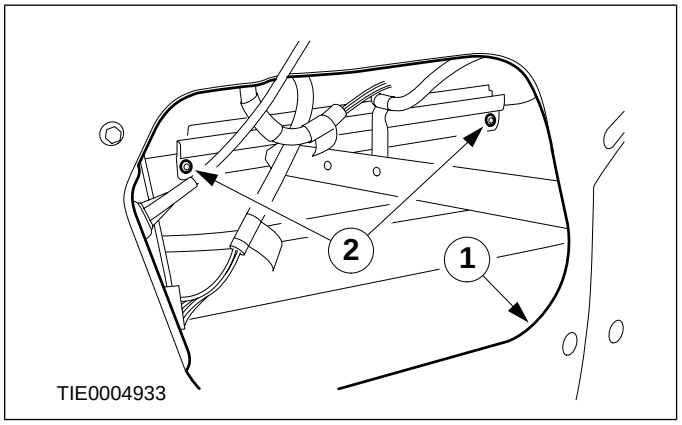


6. Install the front door glass top run outer retaining bracket.



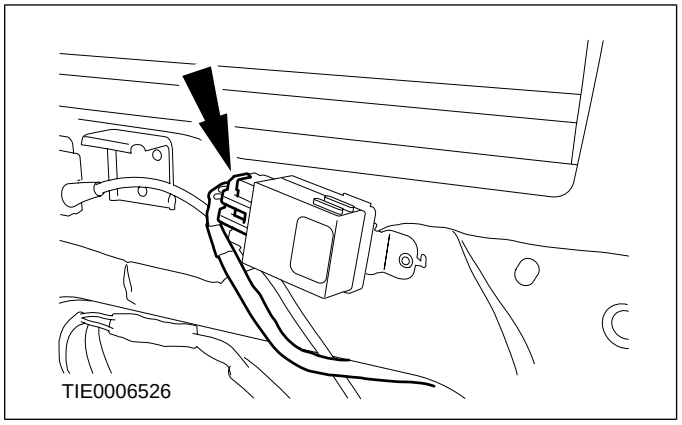
7. Attach the window glass to the clamp.

1. Align the clamp with the access hole.
2. Install the rivets.

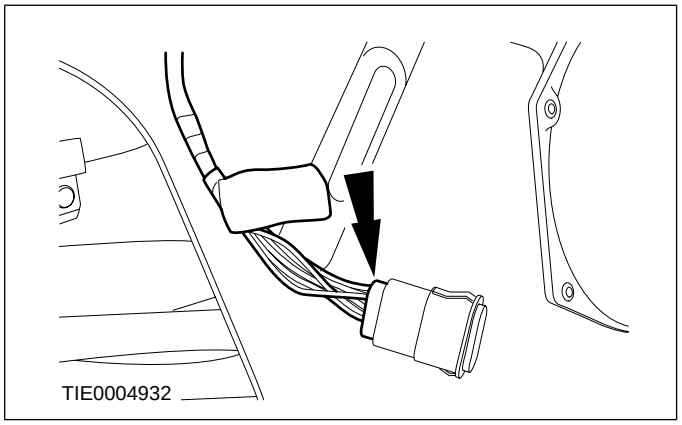


Vehicles with power windows

8. Connect the one-touch down relay electrical connector (if equipped).



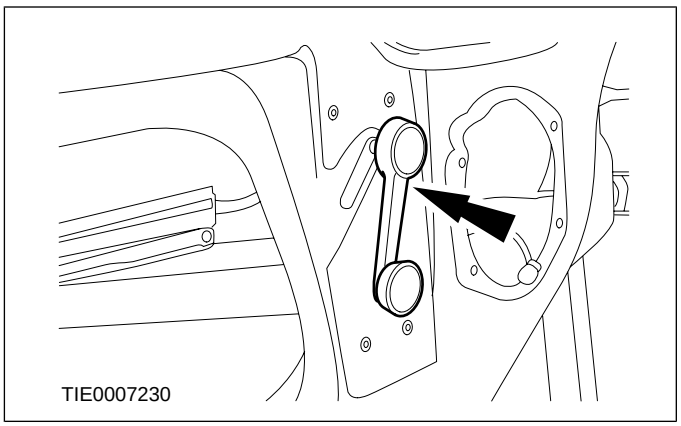
9. Disconnect the window control switch electrical connector.



REMOVAL AND INSTALLATION

Vehicles with manual windows

10. Remove the window regulator handle.



All vehicles

11. Attach the watershield to the door panel.

12. Install the front door trim panel.

For additional information, refer to:Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

REMOVAL AND INSTALLATION

Front Quarter Window Glass

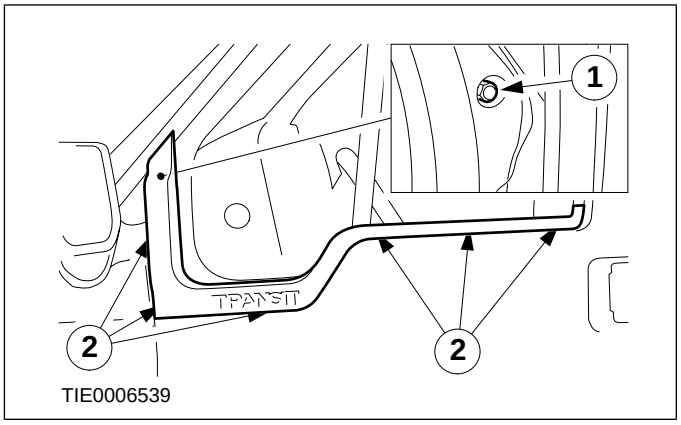
General Equipment

Glazing suction cups
Cord (2 meters in length)

Removal

1. Remove the front door exterior trim panel.

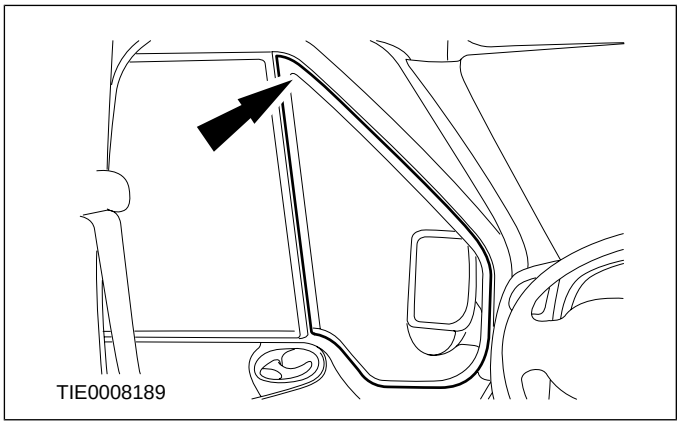
1. Remove the screw.
2. Detach the clips.



TIE0006539

2. With the aid of another technician, use glazing suction cups to remove the front quarter window glass.

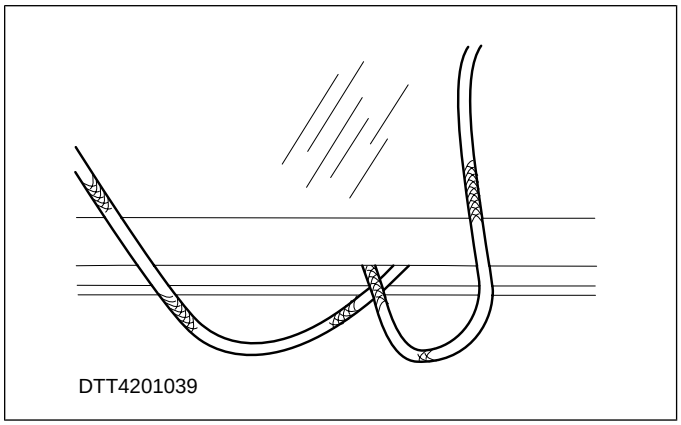
- Starting in the upper corner, apply firm continuous pressure to the glass from inside the vehicle.


TIE0008189

Installation

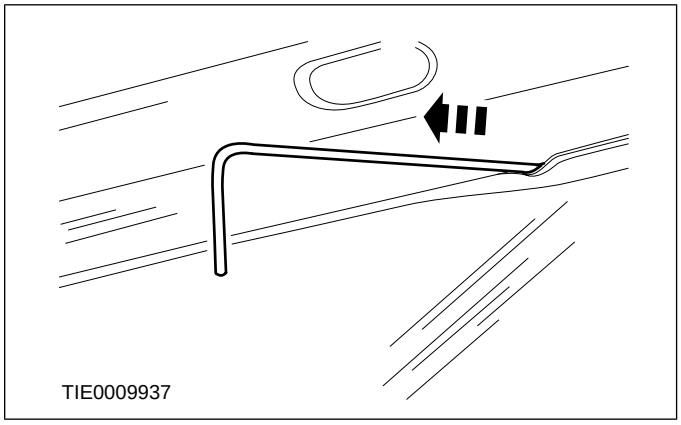
1. NOTE:Position the ends of the cord so that they overlap at one of the lower corners.

Install a length of suitable cord into the front quarter window glass weatherseal channel.


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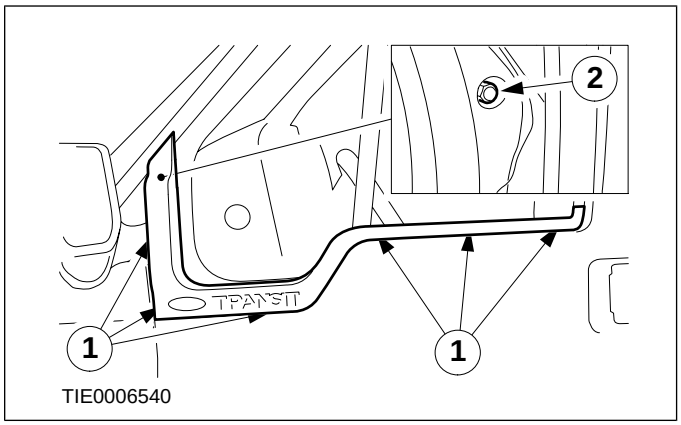
2. With the aid of another technician, use glazing suction cups to install the front quarter window glass.

- Starting in the upper corner, pull the cord from inside the vehicle.


TIE0009937

3. Install the front door exterior trim panel.

1. Attach the clips.
2. Install the screw.



TIE0006540

REMOVAL AND INSTALLATION

Second Row Side Window Glass

General Equipment

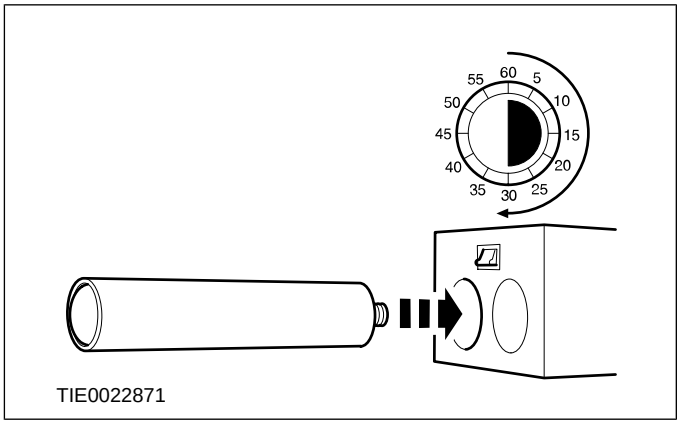
Hot air gun
Direct glazing cutter for bonded glass
Mixing/applicator gun
Direct glazing adhesive oven
Glazing suction cups

Materials

Name	Specification
Windshield Adhesive Kit	WSK-M11P57-A1

Removal

1. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**



2. **WARNING:Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in personal injury.**

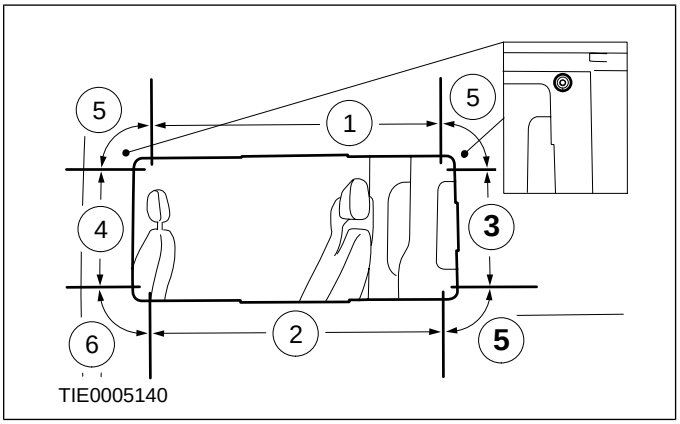
CAUTION:Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

NOTE: Some resistance may be encountered when cutting through the glass locating pegs in the upper corners of the glass.

Using a suitable direct glazing cutter for bonded glass, cut the PU adhesive and, with the aid of another technician, use glazing suction cups to remove the second row side window glass.

- Cut the PU adhesive from inside the vehicle to the given maximum depths.

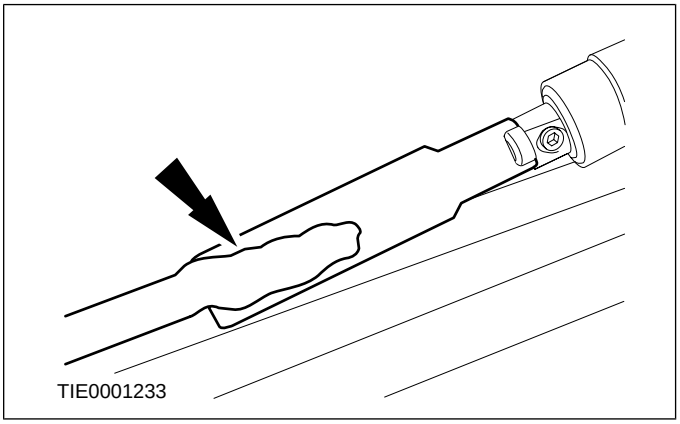
1. 25 mm.
2. 50 mm.
3. 100 mm.
4. 105 mm.
5. 120 mm.
6. 130 mm.



Installation

1. **Carefully remove the remaining part of the glass locating pegs from the second row window glass flange.**
2. **NOTE:Make sure the spacers located at the lower corners of the second row window glass flange are secure.**

   Carefully trim the remaining PU adhesive from the second row window glass flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.



3. **Check the second row side window glass flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.**

REMOVAL AND INSTALLATION

4. **CAUTIONS:**

   ⚠During the curing period of the PU adhesive, the door windows must be left open to avoid a build up of pressure when the doors are opened and closed.

   ⚠Do not touch the adhesive surface as re-bonding will be impaired.

   ⚠To make sure that the PU adhesive cures, it is essential that all bonding surfaces are free of moisture.

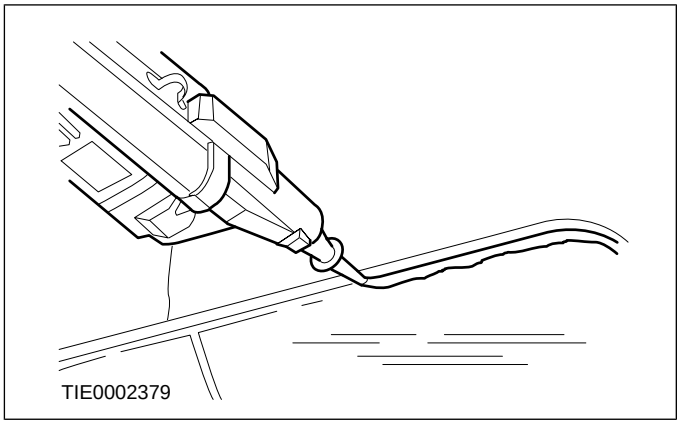
   Using a hot air gun, apply warm air (25°C) to the second row side window glass flange and glass bond line to remove all traces of moisture.

5. **Prepare the glass, second row side window glass flange and trimmed PU adhesive in accordance with the instructions supplied with the adhesive kit.**

6. **NOTE:Discard the first 100 mm of PU adhesive as this may have a reduced working time.**

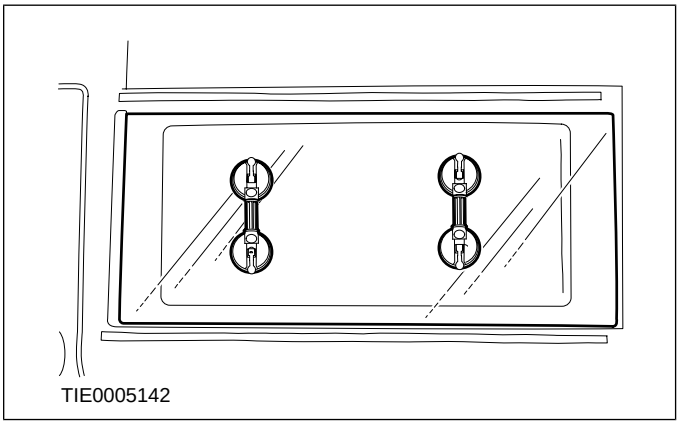
NOTE: To avoid water leaks, any breakage in the continuous bead must be overlapped by 20 mm.

Using the mixing/applicator gun, apply the PU adhesive in a continuous bead of between 8 and 10 mm in height to the second row side window glass flange along the bond line.



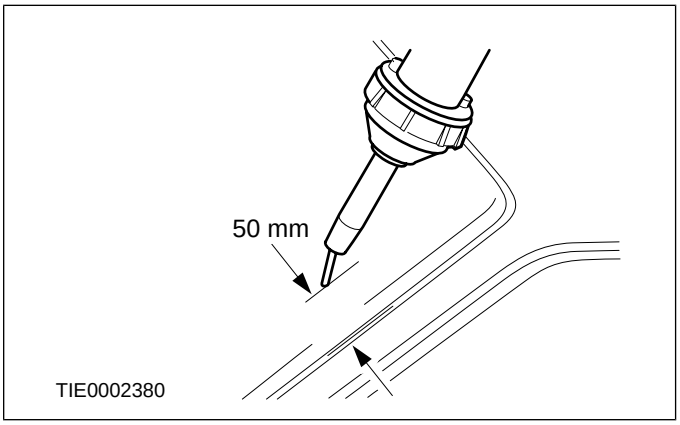
7. **With the aid of another technician, use glazing suction cups to install the second row side window glass.**

- Press firmly and evenly into position.



8. **Using suitable tape, secure the second row side window glass in the correct position until the PU adhesive has cured.**

9. **If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (inside or outside the vehicle).**



REMOVAL AND INSTALLATION

Sliding Door Window Glass

General Equipment

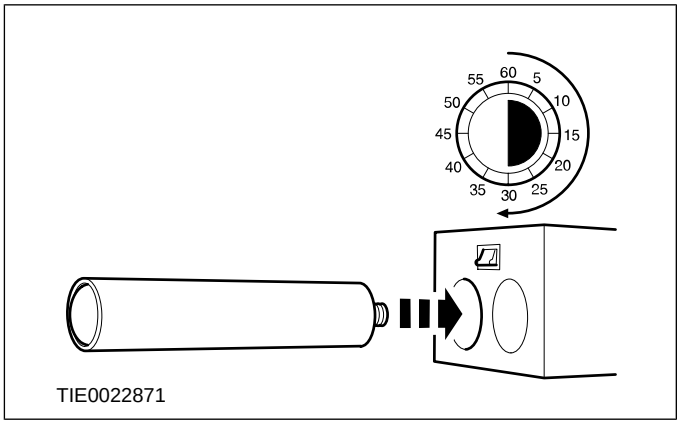
Hot air gun
Direct glazing cutter for bonded glass
Mixing/applicator gun
Direct glazing adhesive oven
Glazing suction cups

Materials

Name	Specification
Windshield Adhesive Kit	WSK-M11P57-A1

Removal

1. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**

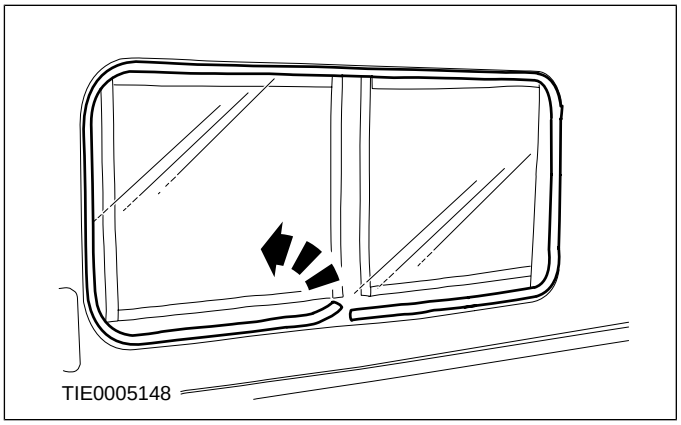


TIE0022871

2. **Remove the sliding door trim panel.**

   For additional information, refer to: Sliding Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

3. **Remove the sliding door window glass weatherstrip.**


TIE0005148

4. **WARNING: Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in personal injury.**

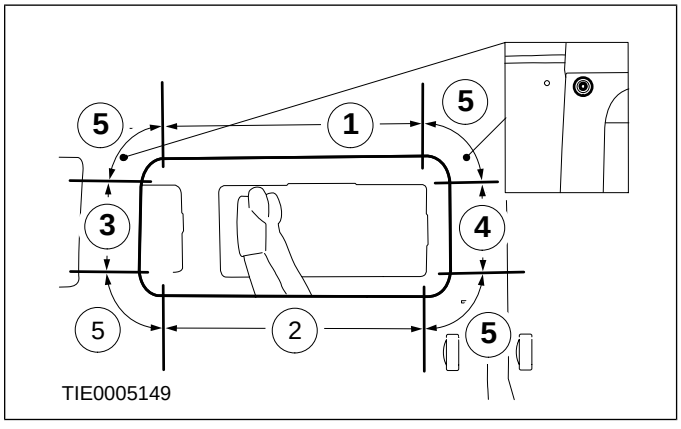
CAUTION: Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

NOTE: Some resistance may be encountered when cutting through the glass locating pegs in the upper corners of the glass.

Using a suitable direct glazing cutter for bonded glass, cut the PU adhesive and, with the aid of another technician, use glazing suction cups to remove the sliding door window glass.

- Cut the PU adhesive from inside the vehicle to the given maximum depths.

1. 45 mm.
2. 55 mm.
3. 120 mm.
4. 125 mm.
5. 160 mm.



TIE0005149

Installation

1. **Carefully remove the remaining part of the locating pegs from the sliding door window glass flange.**
2. **CAUTIONS:**

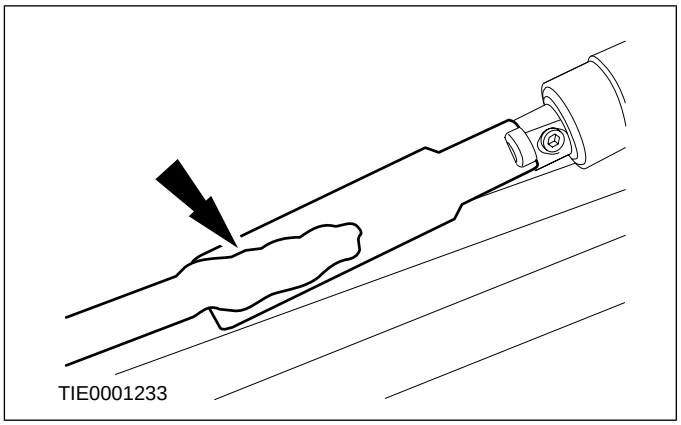
   During the curing period of the PU adhesive, the door windows must be left open to avoid a build up of pressure when the doors are opened and closed.

REMOVAL AND INSTALLATION

⚠Do not touch the adhesive surface as re-bonding will be impaired.

NOTE: Make sure the spacers located at the lower corners of the sliding door window glass flange are secure.

Carefully trim the remaining PU adhesive from the sliding door window glass flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.

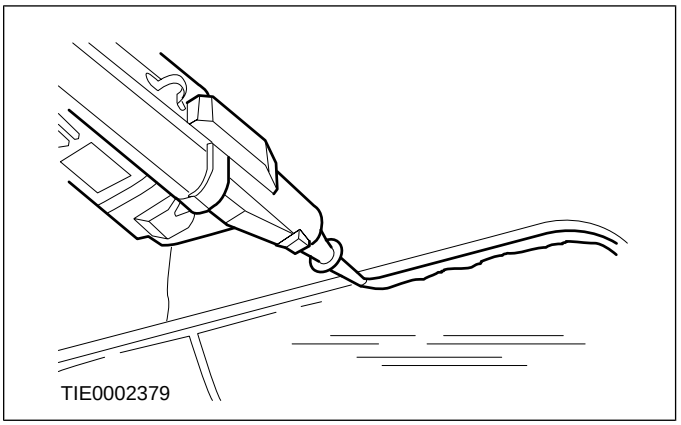

TIE0001233

3. **Check the sliding door window glass flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.**
4. **⚠CAUTION:To make sure that the PU adhesive cures, it is essential that all bonding surfaces are free of moisture.**

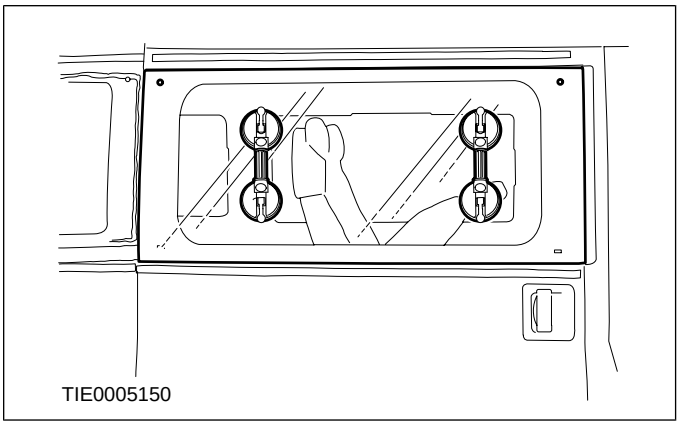
   Using a hot air gun, apply warm air (25°C) to the sliding door window glass flange and glass bond line to remove all traces of moisture.
5. **Prepare the glass, sliding door window glass flange and trimmed PU adhesive in accordance with the instructions supplied with the adhesive kit.**
6. **NOTE:Discard the first 100 mm of PU adhesive as this may have a reduce working time.**

NOTE: To avoid water leaks, any breakage in the continuous bead must be overlapped by 20 mm.

Using the mixing/applicator gun, apply the PU adhesive in a continuous bead of between 8 and 10 mm in height to the sliding door window glass flange along the bond line.


TIE0002379

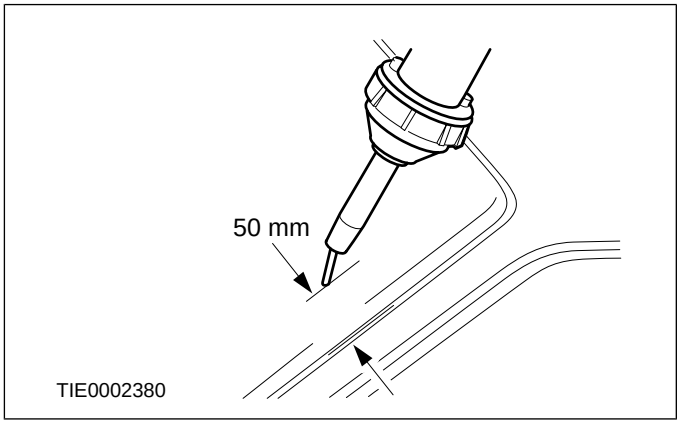
7. **With the aid of another technician, use glazing suction cups to install the sliding door window glass.**
   - Press firmly and evenly into position.


TIE0005150

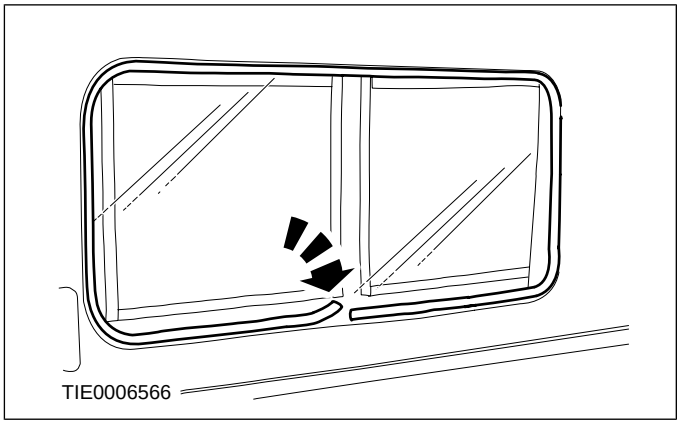
8. **Using suitable tape, secure the sliding door window glass in the correct position until the PU adhesive has cured.**

REMOVAL AND INSTALLATION

9. If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (inside or outside the vehicle).



10. Install the sliding door window glass weatherstrip.



11. Install the sliding door trim panel.

    For additional information, refer to: Sliding Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

REMOVAL AND INSTALLATION

Third Row Side Window Glass

General Equipment

Hot air gun
Direct glazing cutter for bonded glass
Mixing/applicator gun
Direct glazing adhesive oven
Glazing suction cups

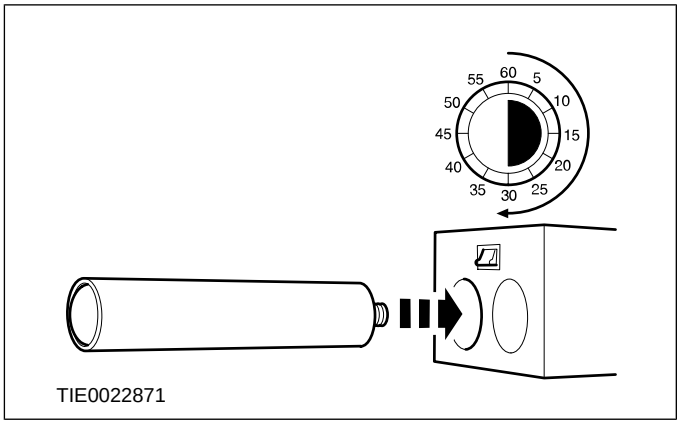
Materials

Name	Specification
Windshield Adhesive Kit	WSK-M11P57-A1

Removal

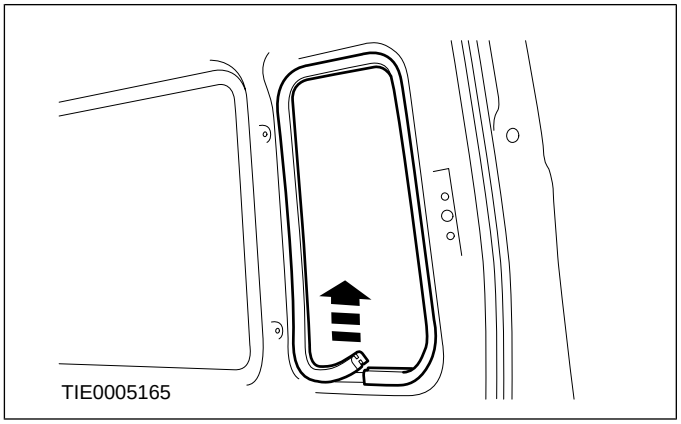
All vehicles

1. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**



Vehicles with rear quarter window

2. **Remove the rear quarter window glass weatherstrip.**



3. **WARNING:Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in personal injury.**

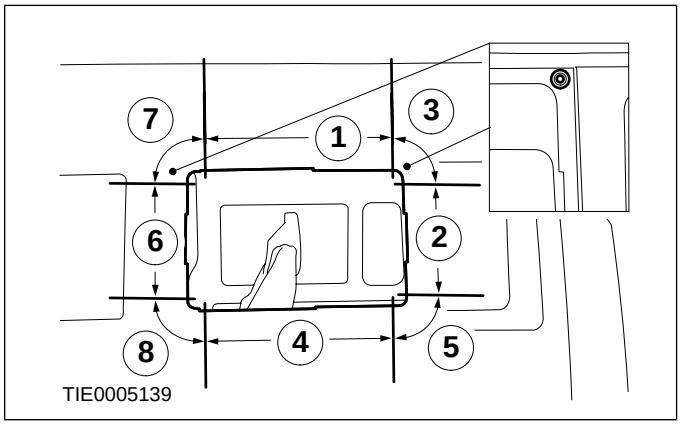
CAUTION:Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

NOTE: Some resistance may be encountered when cutting through the glass locating pegs in the upper corners of the glass.

Using a suitable direct glazing cutter for bonded glass, cut the PU adhesive and with the aid of another technician, use glazing suction cups to remove the third row side window glass.

- Cut the PU adhesive from inside the vehicle to the given maximum depths.

1. 25 mm.
2. 30 mm.
3. 55 mm.
4. 85 mm.
5. 95 mm.
6. 100 mm.
7. 110 mm
8. 140 mm



Vehicles without rear quarter window

4. **WARNING:Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in personal injury.**

REMOVAL AND INSTALLATION

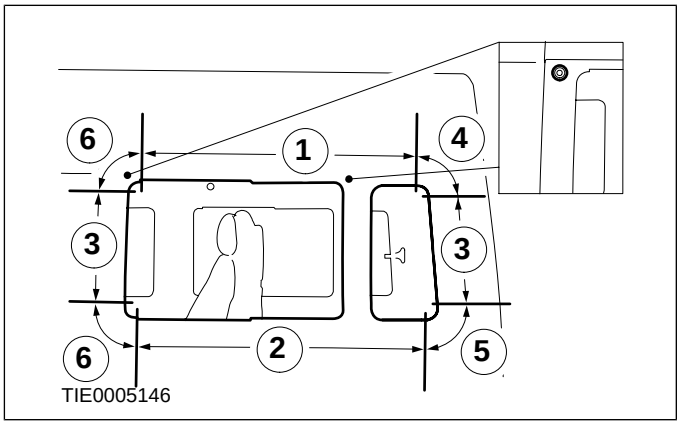
CAUTION:Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

NOTE: Some resistance may be encountered when cutting through the glass locating pegs in the upper corners of the glass.

Using a suitable direct glazing cutter for bonded glass, cut the PU adhesive and with the aid of another technician, use glazing suction cups to remove the third row side window glass.

- Cut the PU adhesive from inside the vehicle to the given maximum depths.

1. 30 mm.
2. 35 mm.
3. 55 mm.
4. 75 mm.
5. 95 mm.
6. 115 mm.



TIE0005146

Installation

All vehicles

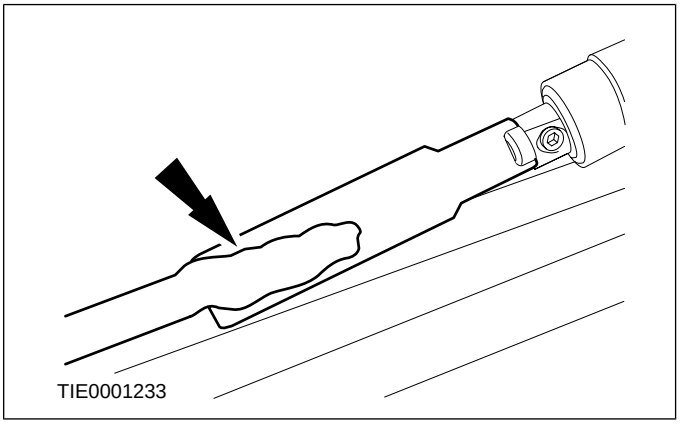
1. **Carefully remove the remaining part of the locating pegs from the third row side window glass flange.**
2. **CAUTIONS:**

   During the curing period of the PU adhesive, the door windows must be left open to avoid a build up of pressure when the doors are opened and closed.

   Do not touch the adhesive surface as re-bonding will be impaired.

NOTE: Make sure the spacers located at the lower corners of the third row side window glass flange are secure.

Carefully trim the remaining PU adhesive from the third row side window glass flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.


TIE0001233

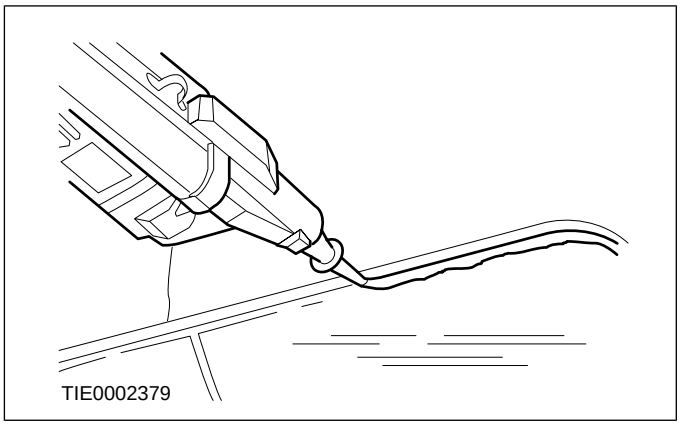
3. **Check the third row side window flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.**
4. **CAUTION:To make sure that the PU adhesive cures, it is essential that all bonding surfaces are free of moisture.**

   Using a hot air gun, apply warm air (25°C) to the third row side window glass flange and glass bond line to remove all traces of moisture.
5. **Prepare the glass, third row side window glass flange and trimmed PU adhesive in accordance with the instructions supplied with the adhesive kit.**
6. **NOTE:Discard the first 100 mm of PU adhesive as this may have a reduced working time.**

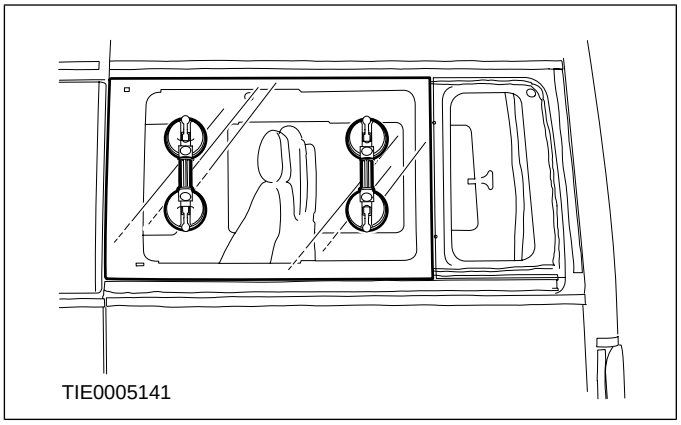
NOTE: To avoid water leaks, any breakage in the continuous bead must be overlapped by 20 mm.

REMOVAL AND INSTALLATION

Using the mixing/applicator gun, apply the PU adhesive in a continuous bead of between 8 and 10 mm in height to the third row side window glass flange along the bond line.

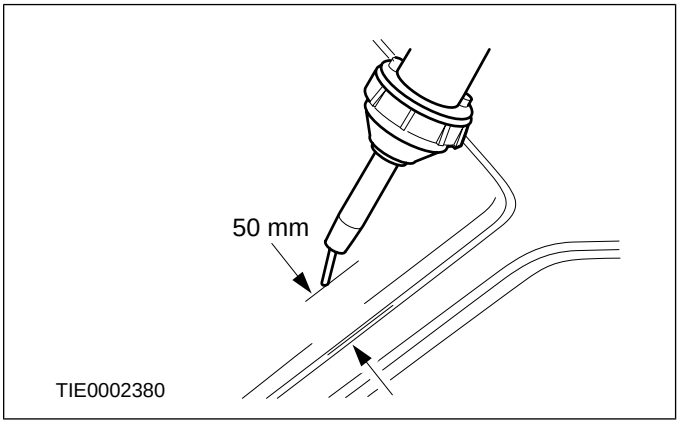


7. **With the aid of another technician, use glazing suction cups to install the third row side window glass (vehicle with rear quarter window shown).**
   - Press firmly and evenly into position.



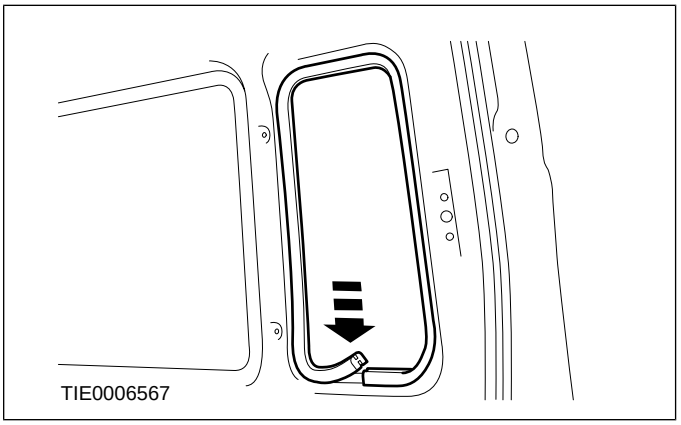
8. **Using suitable tape, secure the third row side window glass in the correct position until the PU adhesive has cured.**

9. **If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (inside or outside the vehicle).**



Vehicles with rear quarter window

10. **Install the rear quarter window glass weatherstrip.**



REMOVAL AND INSTALLATION

Rear Door Window Glass (42 315 0)

General Equipment

Hot air gun
Direct glazing cutter for bonded glass
Mixing/applicator gun
Direct glazing adhesive oven
Glazing suction cups

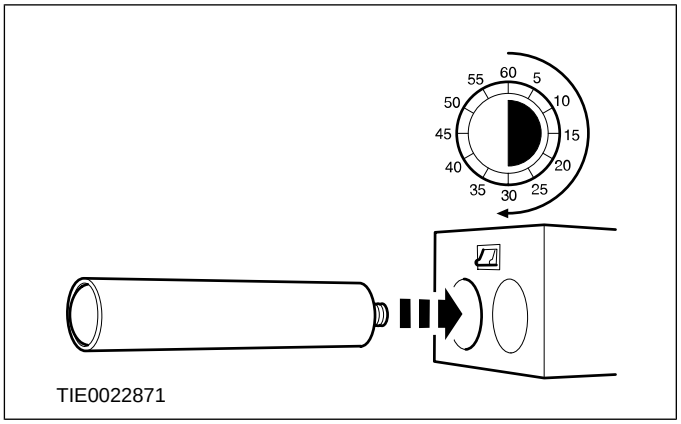
Materials

Name	Specification
Windshield Adhesive Kit	WSK-M11P57-A1

Removal

All vehicles

1. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**

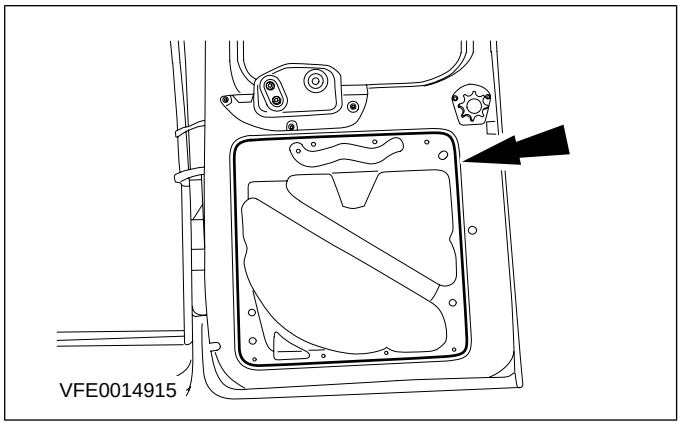


2. **Remove the rear door trim panel.**

   For additional information, refer to: Rear Door Trim Panel - Van/Kombi/Bus (501-05 Interior Trim and Ornamentation, Removal and Installation).

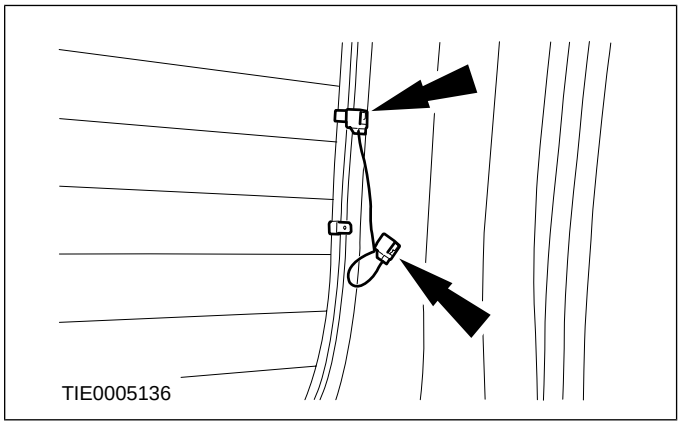
3. **CAUTION: Do not touch the adhesive surface as re-bonding will be impaired.**

Detach the watershield from the rear door panel.



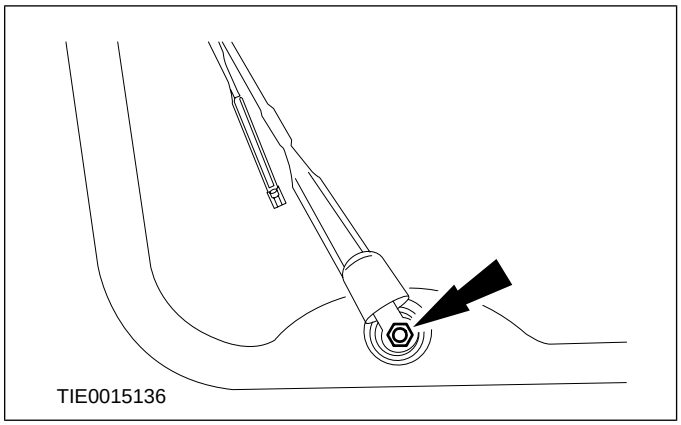
Vehicles with heated rear window

4. **Disconnect the heated rear window electrical connectors.**



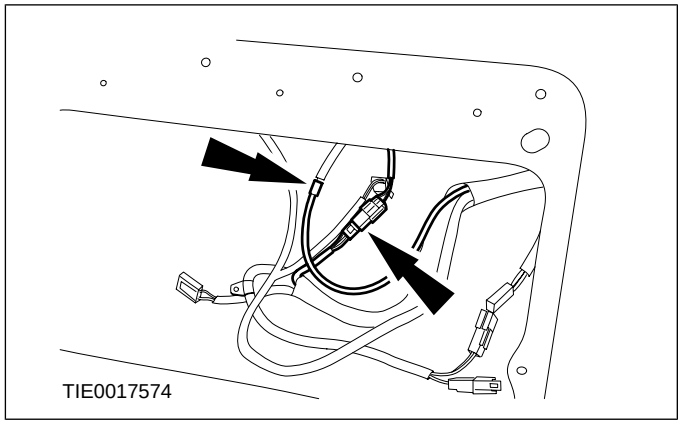
Vehicles with rear window wiper

5. **Remove the rear window wiper arm.**



REMOVAL AND INSTALLATION

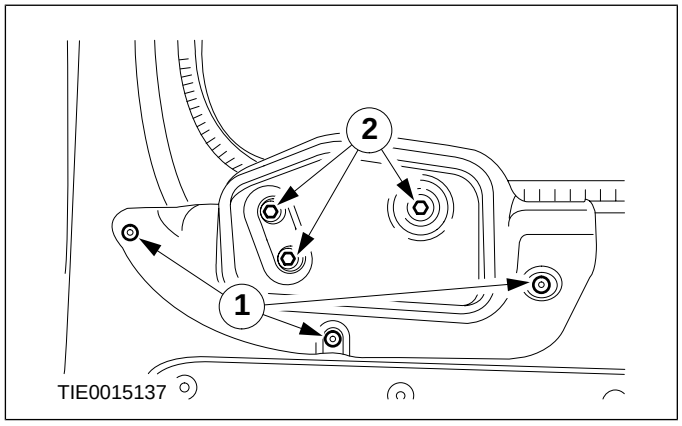
6. **Disconnect the rear window wiper motor electrical connector and washer hose.**



7. **NOTE:Note the position of the three spacers between the rear window wiper motor and the cover.**

   Remove the rear window wiper motor cover.

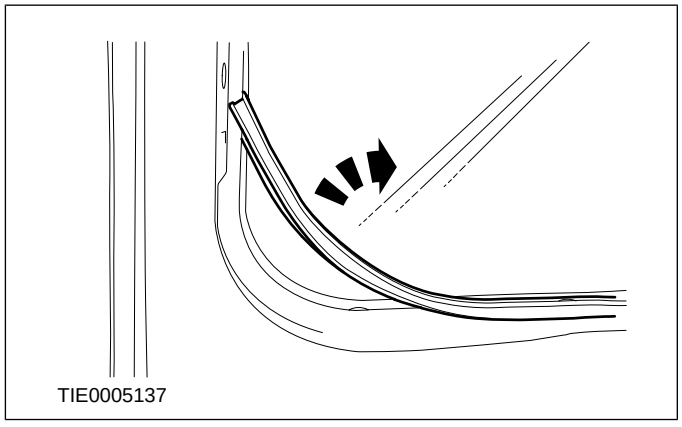
   1. Remove the rivets.
   2. Remove the bolts.



8. **Remove the rear window wiper motor.**

All vehicles

9. **Remove the rear door window glass weatherstrip.**



10. **WARNING:Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in personal injury.**

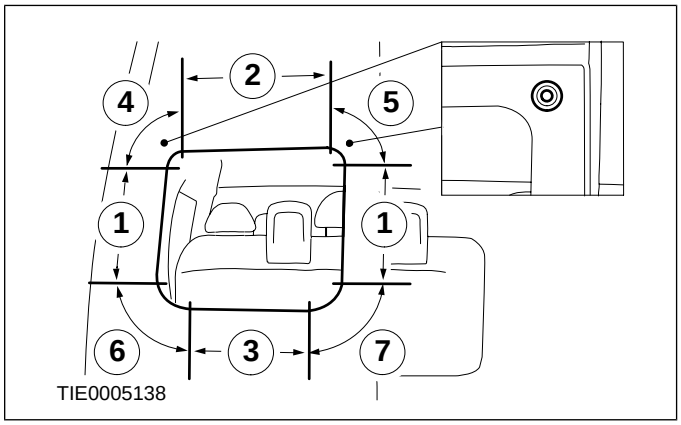
CAUTION:Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

NOTE: Some resistance may be encountered when cutting through the glass locating pegs in the upper corners of the glass.

Using a suitable direct glazing cutter for bonded glass, cut the PU adhesive and, with the aid of another technician, use glazing suction cups to remove the rear door window glass.

- Cut the PU adhesive from inside the vehicle to the given maximum depths.

1. 50 mm.
2. 57 mm.
3. 65 mm.
4. 75 mm.
5. 110 mm.
6. 115 mm.
7. 145 mm.



Installation

All vehicles

1. **Carefully remove the remaining part of the locating pegs from the rear door window glass flange.**
2. **CAUTIONS:**

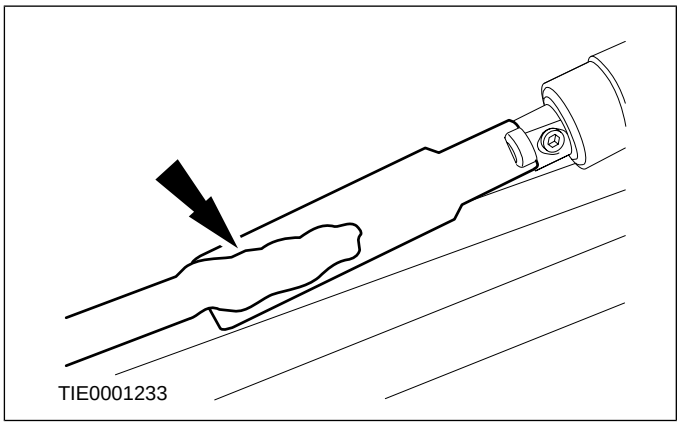
REMOVAL AND INSTALLATION

⚠During the curing period of the PU adhesive, the door windows must be left open to avoid a build up of pressure when the doors are opened and closed.

⚠Do not touch the adhesive surface as re-bonding will be impaired.

NOTE: Make sure the spacers located at the lower corners of the rear door window glass flange are secure.

Carefully trim the remaining PU adhesive from the rear door window glass flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.

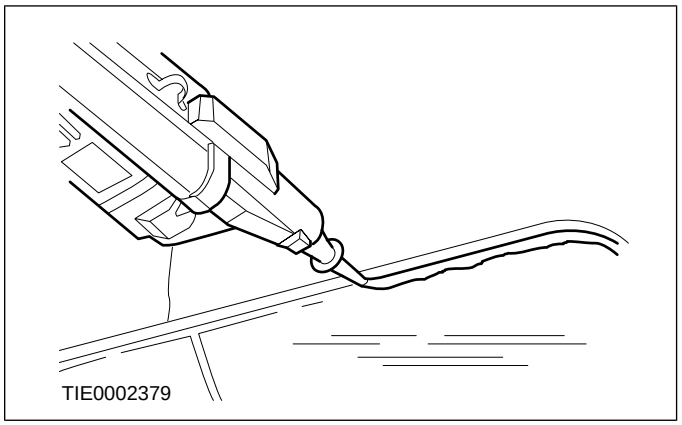

TIE0001233

3. **Check the rear door window glass flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.**
4. **⚠CAUTION:To make sure that the PU adhesive cures, it is essential that all bonding surfaces are free of moisture.**

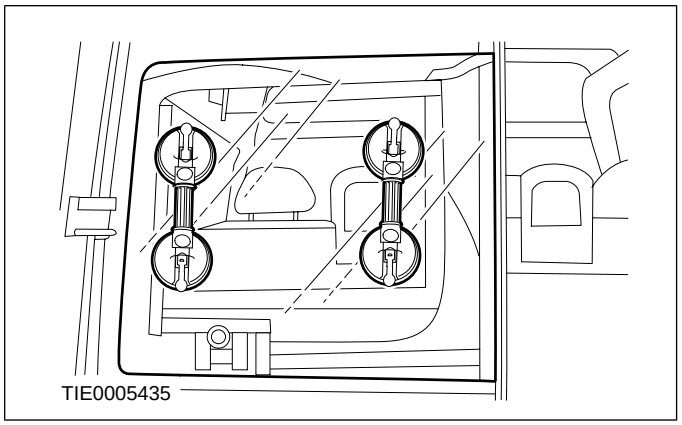
   Using a hot air gun, apply warm air (25°C) to the rear door window glass flange and glass bond line to remove all traces of moisture.
5. **Prepare the glass, rear door window glass flange and trimmed PU adhesive in accordance with the instructions supplied with the adhesive kit.**
6. **NOTE:Discard the first 100 mm of PU adhesive as this may have a reduced working time.**

NOTE: To avoid water leaks, any breakage in the continuous bead must be overlapped by 20 mm.

Using the mixing/applicator gun, apply the PU adhesive in a continuous bead of between 8 and 10 mm in height to the rear door window glass flange along the bond line.


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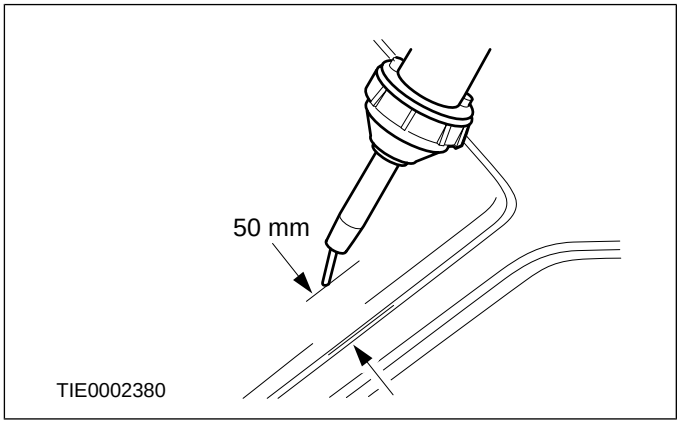
7. **With the aid of another technician, use glazing suction cups to install the rear door window glass.**
   - Press firmly and evenly into position.


TIE0005435

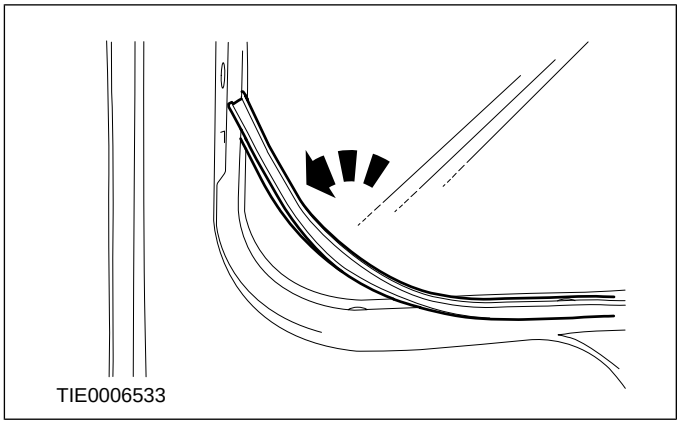
8. **Using a suitable tape, secure the rear door window glass in the correct position until the PU adhesive has cured.**

REMOVAL AND INSTALLATION

9. **If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (inside or outside the vehicle).**

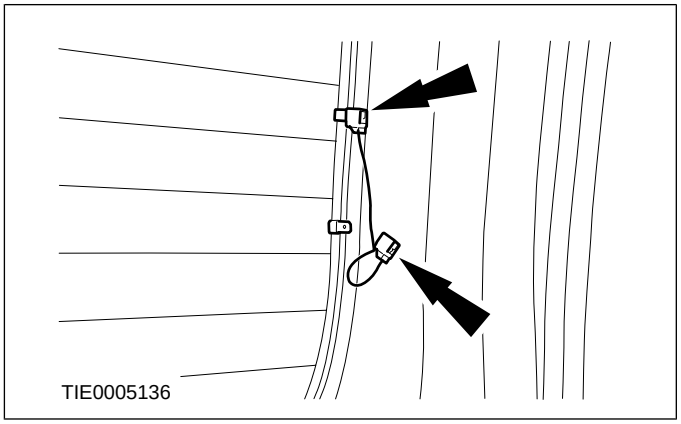


10. **Install the rear door window glass weatherstrip.**



Vehicles with heated rear window

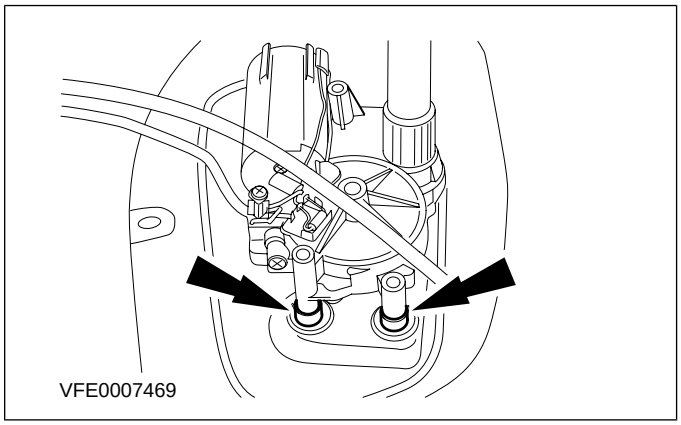
11. **Connect the heated rear window electrical connectors.**



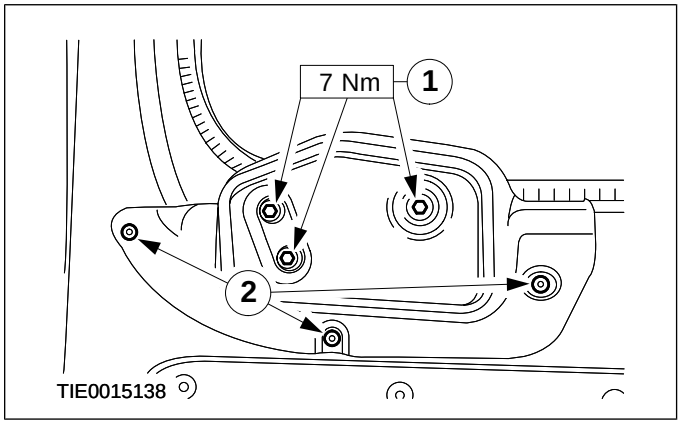
Vehicles with rear window wiper

12. **NOTE:Install the three spacers between the rear window wiper motor and the cover.**

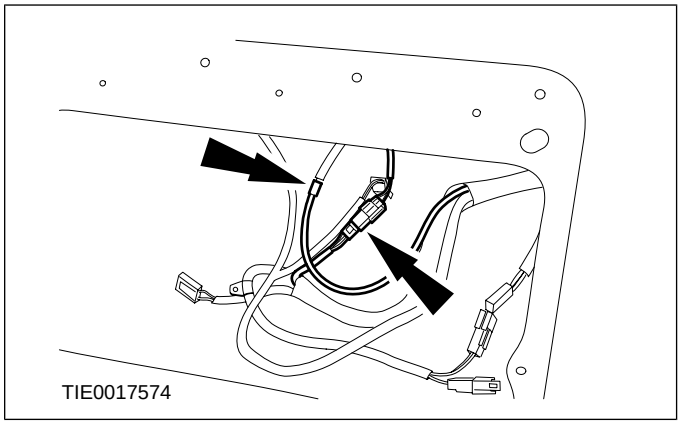
Install the rear window wiper motor.



13. **Install the rear window wiper motor cover.**
    1. Install the bolts.
    2. Install the rivets.

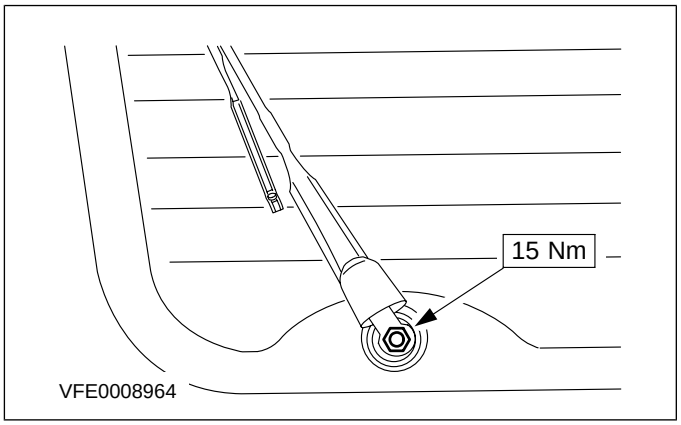


14. **Connect the rear window wiper motor electrical connector and washer hose.**



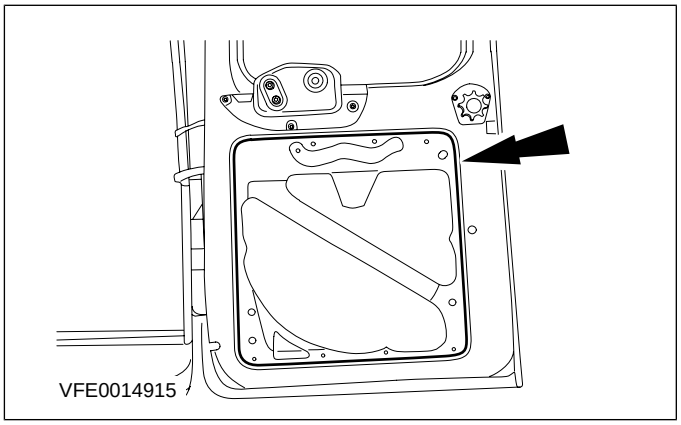
REMOVAL AND INSTALLATION

15. **Install the rear window wiper arm.**



All vehicles

16. **Attach the watershield to the rear door panel.**



17. **Install the rear door trim panel.**

    For additional information, refer to:Rear Door Trim Panel - Van/Kombi/Bus (501-05 Interior Trim and Ornamentation, Removal and Installation).

REMOVAL AND INSTALLATION

Rear Door Window Glass — Chassis Double Cab (42 315 0)

General Equipment

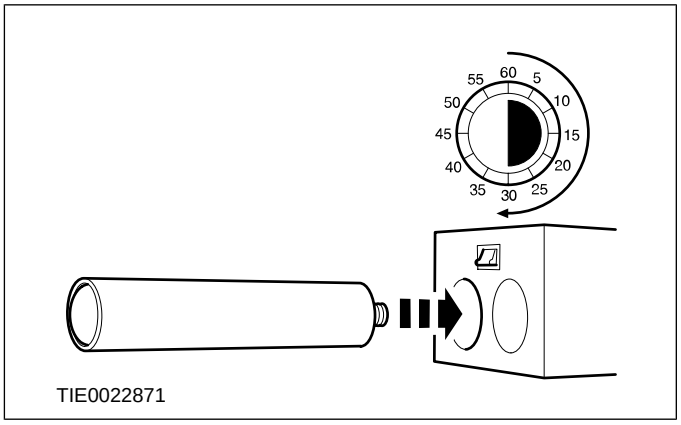
Hot air gun
Direct glazing cutter for bonded glass
Mixing/applicator gun
Direct glazing adhesive oven
Glazing suction cups

Materials

Name	Specification
Windshield Adhesive Kit	WSK-M11P57-A1

Removal

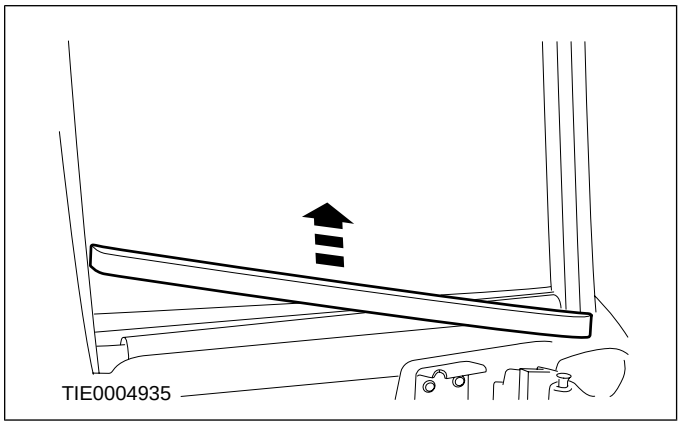
1. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**



2. **Remove the rear door trim panel.**

   For additional information, refer to: Rear Door Trim Panel - Chassis Cab (501-05 Interior Trim and Ornamentation, Removal and Installation).

3. **Remove the rear door window glass weatherstrip.**



4. **WARNING: Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in personal injury.**

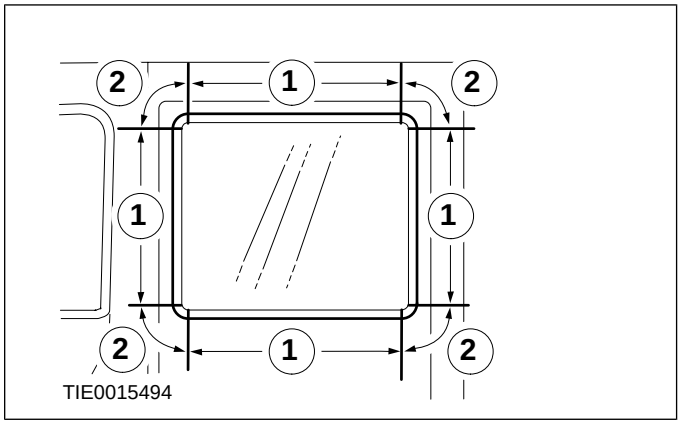
   CAUTION: Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

NOTE: Some resistance may be encountered when cutting through the glass locating pegs in the upper corners of the glass.

Using a suitable direct glazing cutter for bonded glass, cut the PU adhesive and, with the aid of another technician, use glazing suction cups to remove the rear door window glass.

- Cut the PU adhesive from inside the vehicle to the given maximum depths.

1. 35 mm.
2. 60 mm.



REMOVAL AND INSTALLATION

Installation

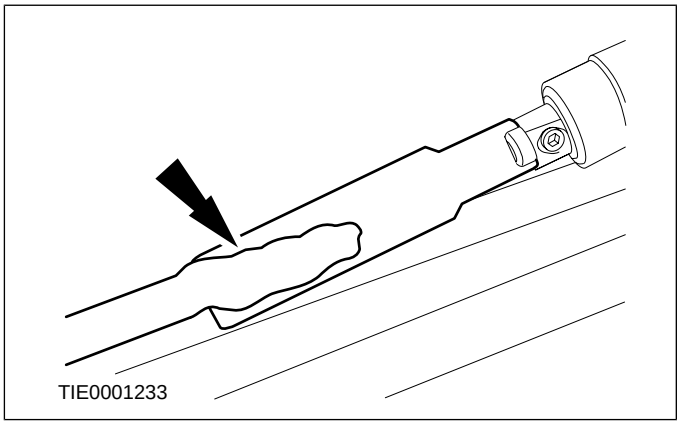
1. **Carefully remove the remaining part of the locating pegs from the rear door window glass flange.**
2. **CAUTIONS:**

   ⚠ During the curing period of the PU adhesive, the door windows must be left open to avoid a build up of pressure when the doors are opened and closed.

   ⚠ Do not touch the adhesive surface as re-bonding will be impaired.

NOTE: Make sure the spacers located at the lower corners of the rear door window glass flange are secure.

Carefully trim the remaining PU adhesive from the rear door window glass flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.

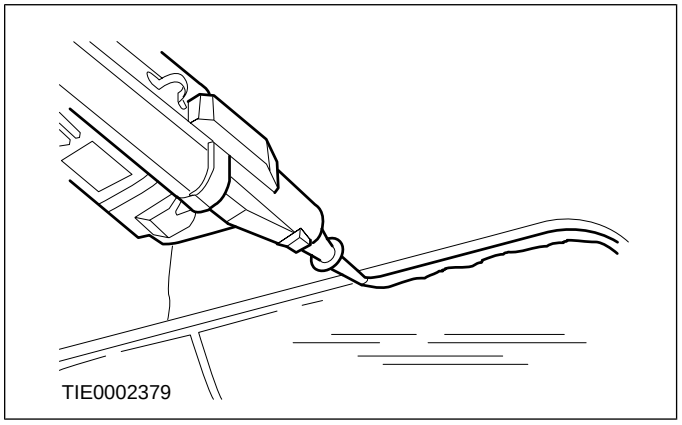

TIE0001233

3. **Check the rear door window glass flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.**
4. **⚠ CAUTION: To make sure that the PU adhesive cures, it is essential that all bonding surfaces are free of moisture.**

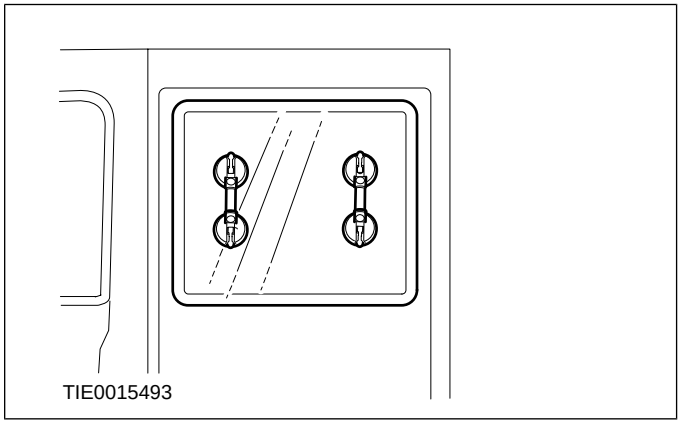
   Using a hot air gun, apply warm air (25°C) to the rear door window glass flange and glass bond line to remove all traces of moisture.
5. **Prepare the glass, rear door window glass flange and trimmed PU adhesive in accordance with the instructions supplied with the adhesive kit.**
6. **NOTE: Discard the first 100 mm of PU adhesive as this may have a reduced working time.**

NOTE: To avoid water leaks, any breakage in the continuous bead must be overlapped by 20 mm.

Using the mixing/applicator gun, apply the PU adhesive in a continuous bead of between 8 and 10 mm in height to the rear door window glass flange along in the bond line.


TIE0002379

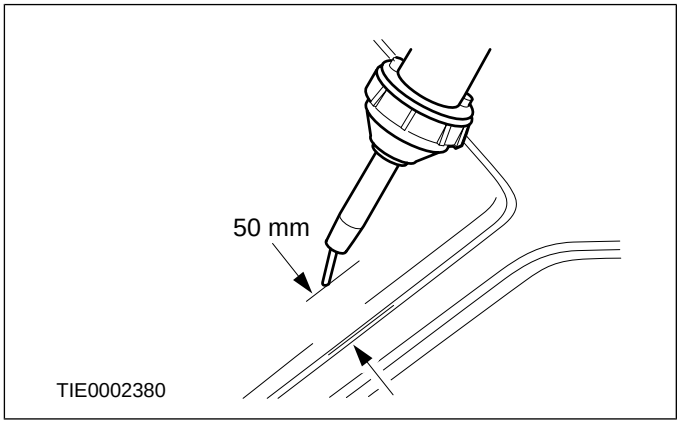
7. **With the aid of another technician, use glazing suction cups to install the rear door window glass.**
   - Press firmly and evenly into position.


TIE0015493

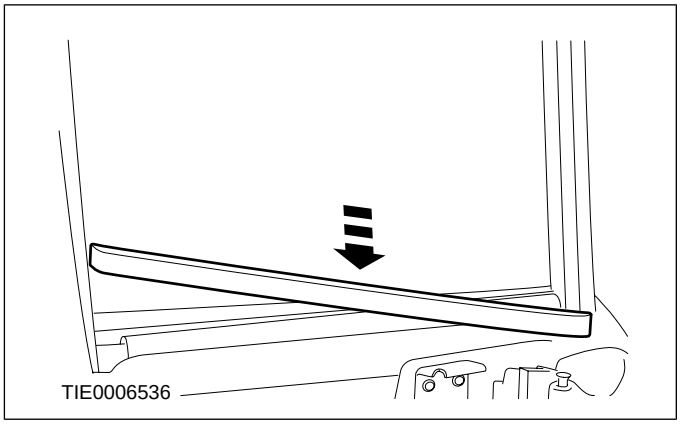
8. **Using suitable tape, secure the rear door window glass in the correct position until the PU adhesive has cured.**

REMOVAL AND INSTALLATION

9. If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (inside or outside the vehicle).



10. Install the rear door window glass weatherstrip.



11. Install the rear door trim panel.

    For additional information, refer to: Rear Door Trim Panel - Chassis Cab (501-05 Interior Trim and Ornamentation, Removal and Installation).

REMOVAL AND INSTALLATION

Rear Window Glass — Chassis Double Cab

General Equipment

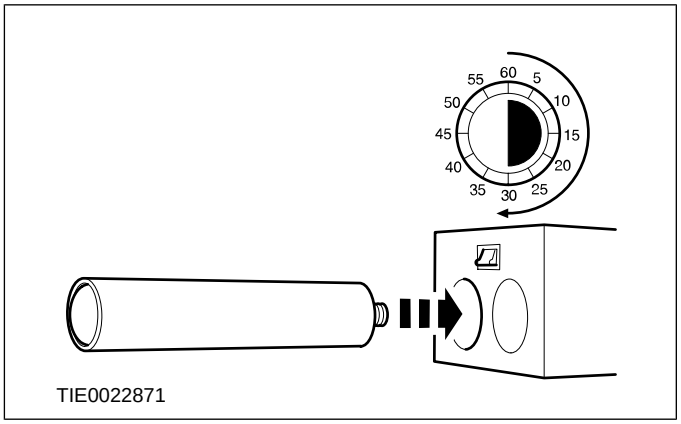
Hot air gun
Direct glazing cutter for bonded glass
Mixing/applicator gun
Direct glazing adhesive oven
Glazing suction cups

Materials

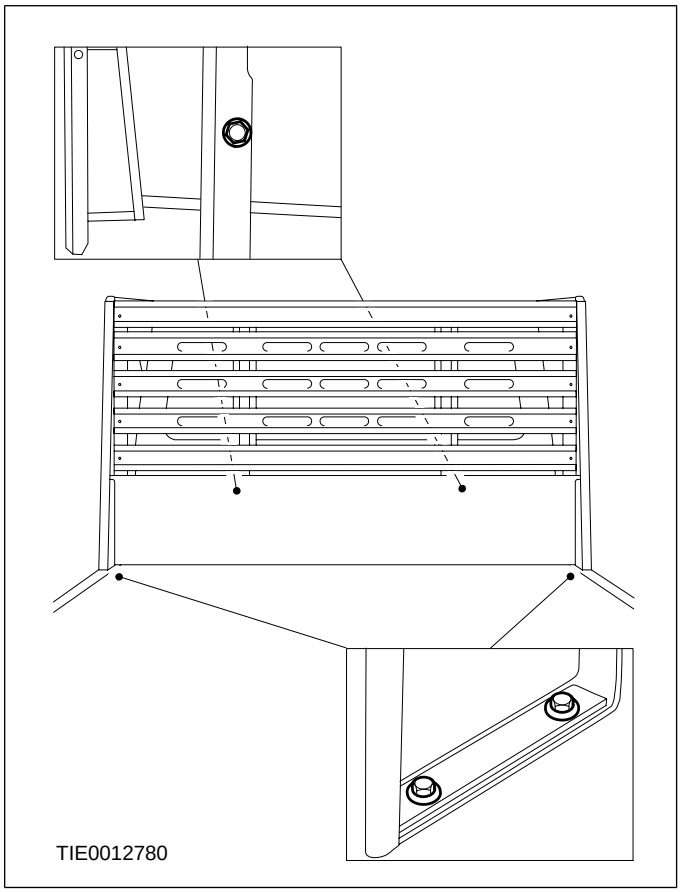
Name	Specification
Windshield Adhesive Kit	WSK-M11P57-A1

Removal

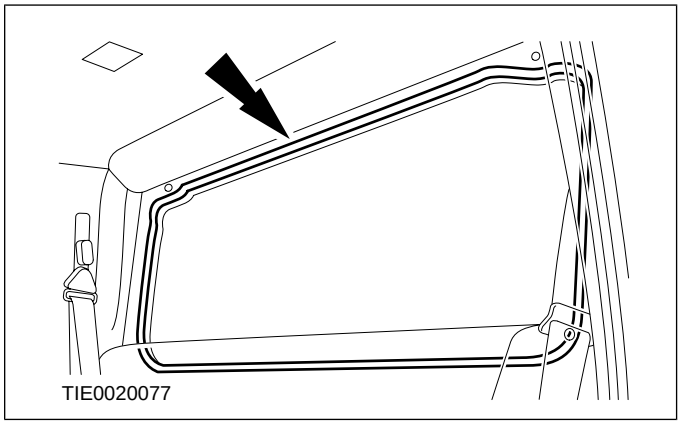
1. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**



2. **With the aid of another technician remove the backboard (if equipped).**



3. **Remove the rear window glass weatherstrip.**



4. **WARNING:Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in personal injury.**

REMOVAL AND INSTALLATION

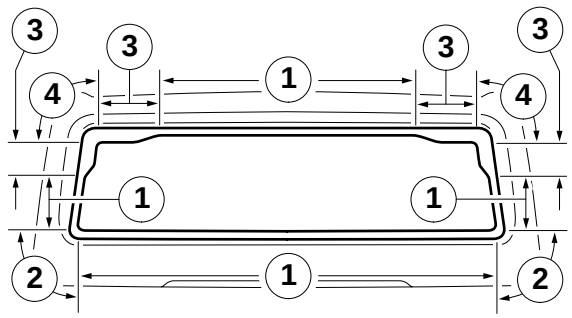
CAUTION:Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

NOTE: Some resistance may be encountered when cutting through the glass locating pegs in the upper corners of the glass.

Using a suitable direct glazing cutter for bonded glass, cut the PU adhesive and, with the aid of another technician, use glazing suction cups to remove the rear window glass.

- Cut the PU adhesive from inside the vehicle to the given maximum depths.

1. 30 mm.
2. 40 mm.
3. 50 mm.
4. 65 mm.



TIE0012782

Installation

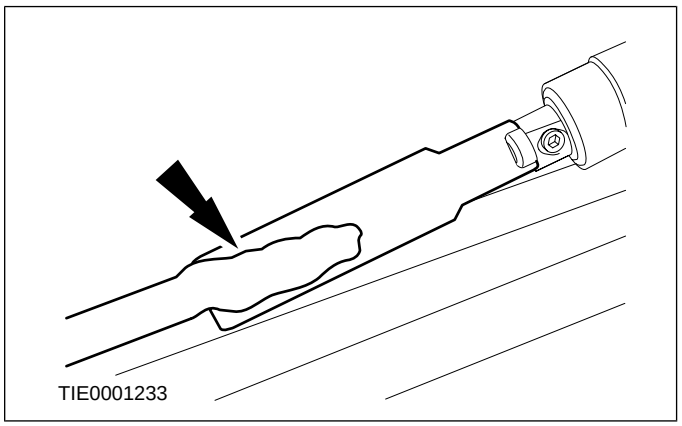
1. **Carefully remove the remaining part of the locating pegs from the rear window glass flange.**
2. **CAUTIONS:**

   During the curing period of the PU adhesive, the door windows must be left open to avoid a build up of pressure when the doors are opened and closed.

   Do not touch the adhesive surface as re-bonding will be impaired.

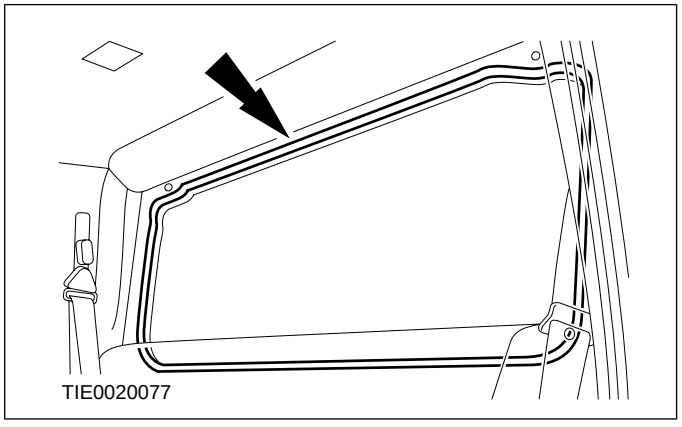
NOTE: Make sure the spacers located at the lower corners of the rear window glass flange are secure.

Carefully trim the remaining PU adhesive from the rear window glass flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.


TIE0001233

3. **Check the rear window glass flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.**
4. **CAUTION:To make sure that the PU adhesive cures, it is essential that all bonding surfaces are free of moisture.**

   Using a hot air gun, apply warm air (25°C) to the rear window glass flange and glass bond line to remove all traces of moisture.
5. **Prepare the glass, rear window glass flange and trimmed PU adhesive in accordance with the instructions supplied with the adhesive kit.**
6. **Install the rear window glass weatherstrip.**

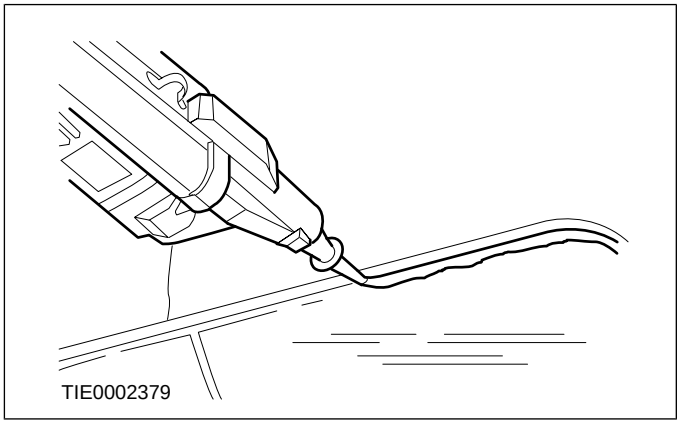

TIE0020077

7. **NOTE:Discard the first 100 mm of PU adhesive as this may have a reduced working time.**

NOTE: To avoid water leaks, any breakage in the continuous bead must be overlapped by 20 mm.

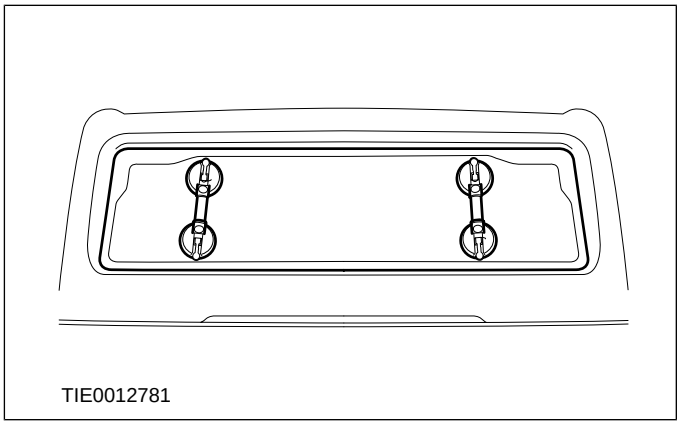
REMOVAL AND INSTALLATION

Using the mixing/applicator gun, apply the PU adhesive in a continuous bead of between 8 and 10 mm in height to the rear window glass flange along the bond line.



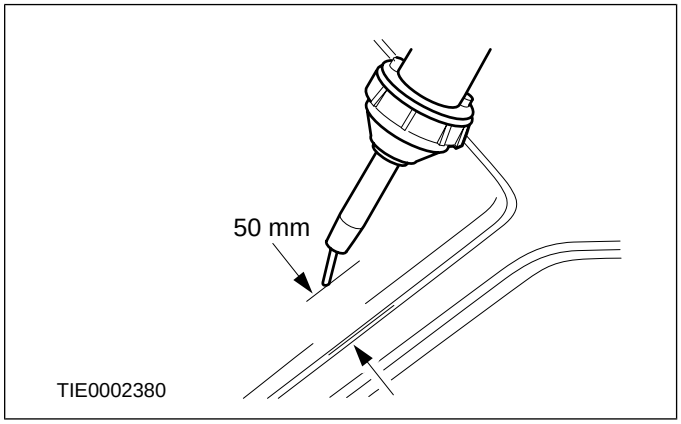
8. With the aid of another technician, use glazing suction cups to install the rear window glass.

- Press firmly and evenly into position.

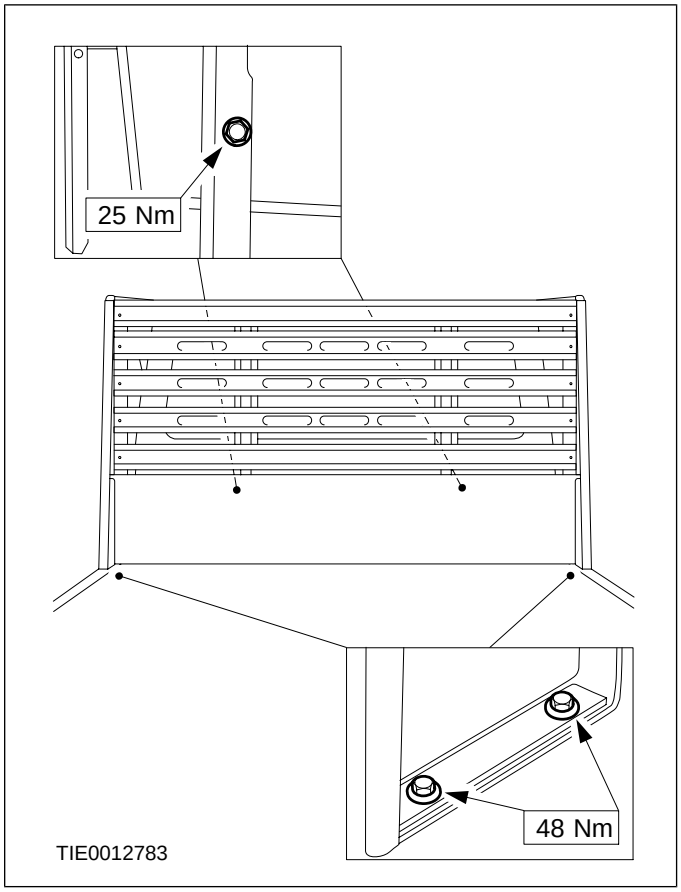


9. Using suitable tape, secure the rear window glass in the correct position until the PU adhesive has cured.

10. If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (inside or outside the vehicle).



11. With the aid of another technician install the backboard (if equipped).



REMOVAL AND INSTALLATION

Liftgate Window Glass

General Equipment

Hot air gun
Direct glazing cutter for bonded glass
Mixing/applicator gun
Direct glazing adhesive oven
Glazing suction cups

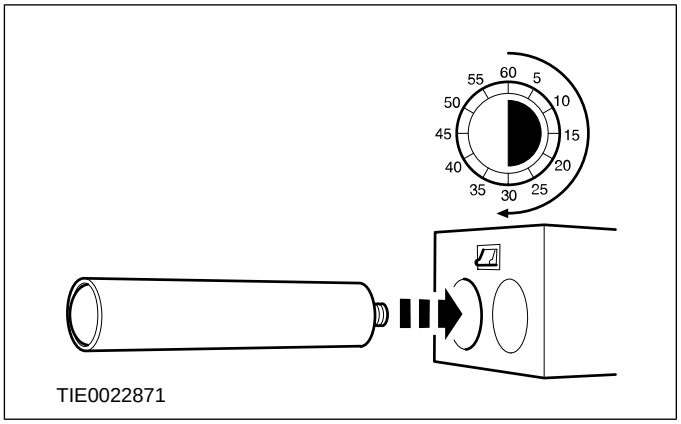
Materials

Name	Specification
Windshield Adhesive Kit	WSK-M11P57-A1

Removal

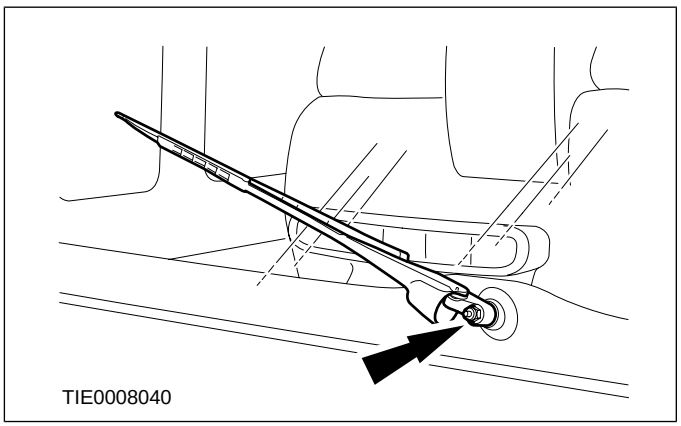
All vehicles

1. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**



TIE0022871

2. **Remove the rear window wiper arm (if equipped).**

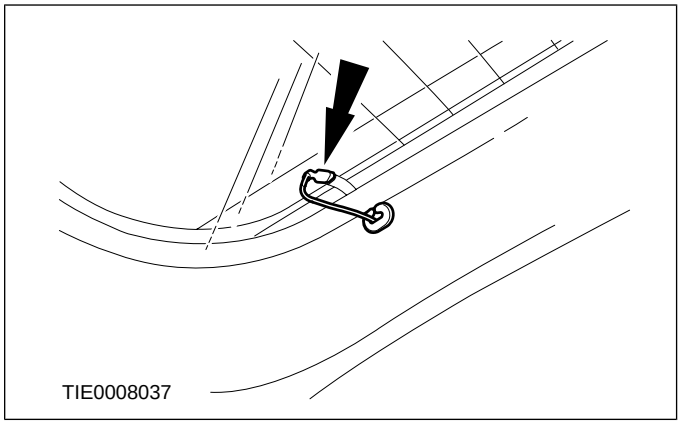

TIE0008040

3. **Remove the liftgate trim panel.**

   For additional information, refer to: Liftgate Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Vehicles with heated rear window

4. **Disconnect the heated rear window electrical connectors.**


TIE0008037

All vehicles

5. **WARNING: Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in personal injury.**

   CAUTION: Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

NOTE: Some resistance may be encountered when cutting through the glass locating pegs in the upper corners of the glass.

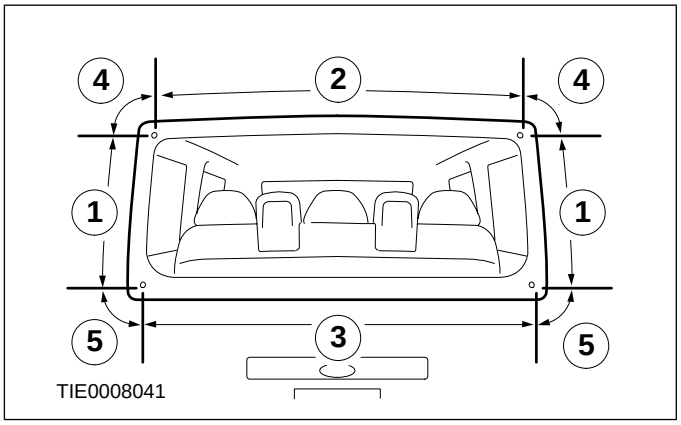
Using a suitable direct glazing cutter for bonded glass, cut the PU adhesive and, with the aid of another technician, use glazing suction cups to remove the liftgate window glass.

- Cut the PU adhesive from inside the vehicle to the given maximum depths.

1. 55 mm.
2. 60 mm.
3. 70 mm.
4. 80 mm.

REMOVAL AND INSTALLATION

5. 120 mm.



Installation

All vehicles

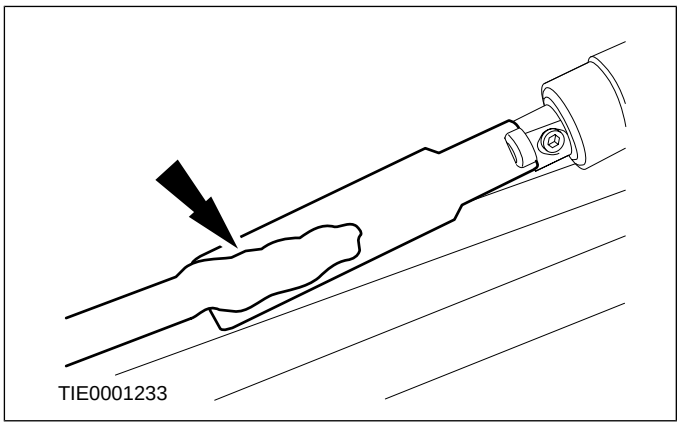
1. **Carefully remove the remaining part of the locating pegs from the liftgate window glass flange.**
2. **CAUTIONS:**

   ⚠During the curing period of the PU adhesive, the door windows must be left open to avoid a build up of pressure when the doors are opened and closed.

   ⚠Do not touch the adhesive surface as re-bonding will be impaired.

NOTE: Make sure the spacers located at the lower corners of the liftgate window glass flange are secure.

Carefully trim the remaining PU adhesive from the liftgate window glass flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.

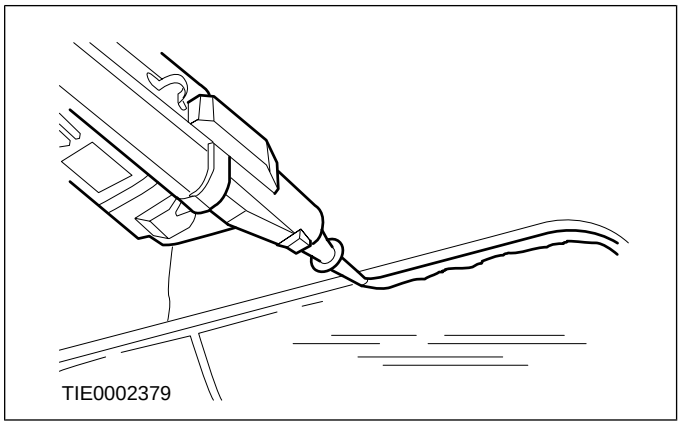


3. **Check the liftgate window glass flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.**
4. **⚠CAUTION:To make sure that the PU adhesive cures, it is essential that all bonding surfaces are free of moisture.**

   Using a hot air gun, apply warm air (25°C) to the liftgate window glass flange and glass bond line to remove all traces of moisture.
5. **Prepare the glass, liftgate window glass flange and trimmed PU adhesive in accordance with the instructions supplied with the adhesive kit.**
6. **NOTE:Discard the first 100 mm of PU adhesive as this may have a reduced working time.**

NOTE: To avoid water leaks, any breakage in the continuous bead must be overlapped by 20 mm.

Using the mixing/applicator gun, apply the PU adhesive in a continuous bead of between 8 and 10 mm in height to the liftgate window glass flange along the bond line.

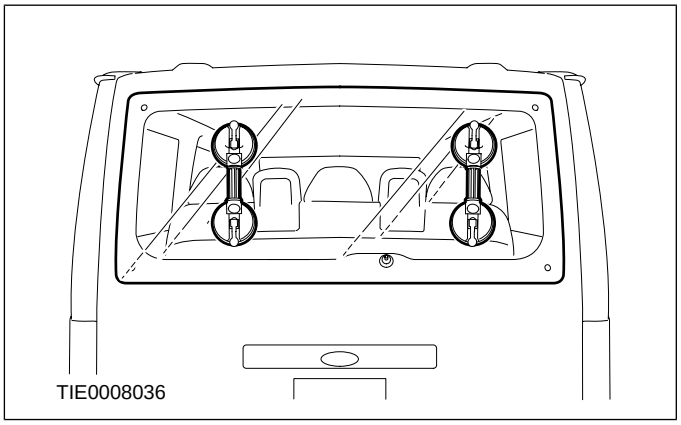


7. **NOTE:Make sure the rear window wiper grommet is correctly installed in the liftgate window glass.**

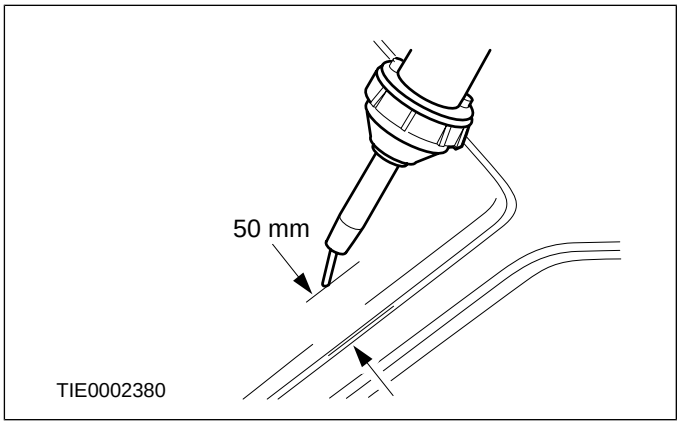
   With the aid of another technician, use glazing suction cups to install the liftgate window glass.

REMOVAL AND INSTALLATION

- Press firmly and evenly into position.

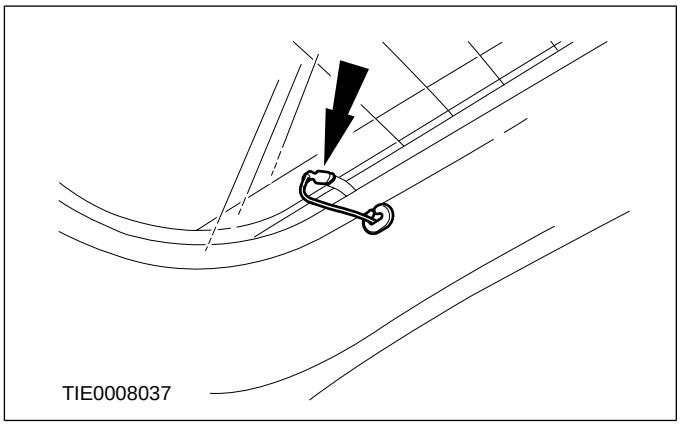


8. **Using suitable tape, secure the liftgate window glass in the correct position until the PU adhesive has cured.**
9. **If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (inside or outside the vehicle).**



Vehicles with heated rear window

10. **Connect the heated rear window electrical connectors.**

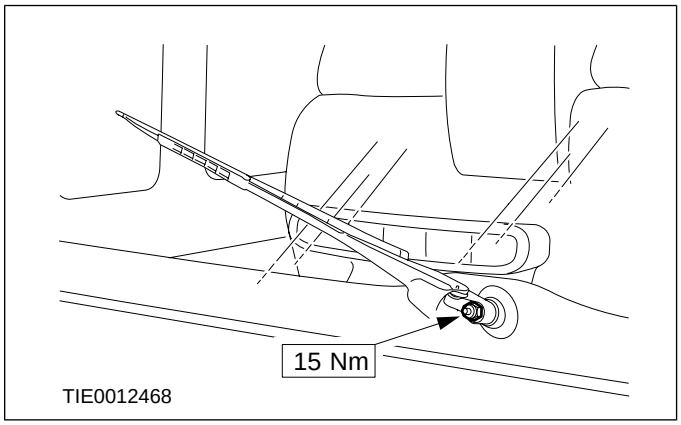


All vehicles

11. **Install the liftgate trim panel.**

    For additional information, refer to: Liftgate Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

12. **Install the rear window wiper arm (if equipped).**



REMOVAL AND INSTALLATION

Front Door Window Regulator (42 338 0)

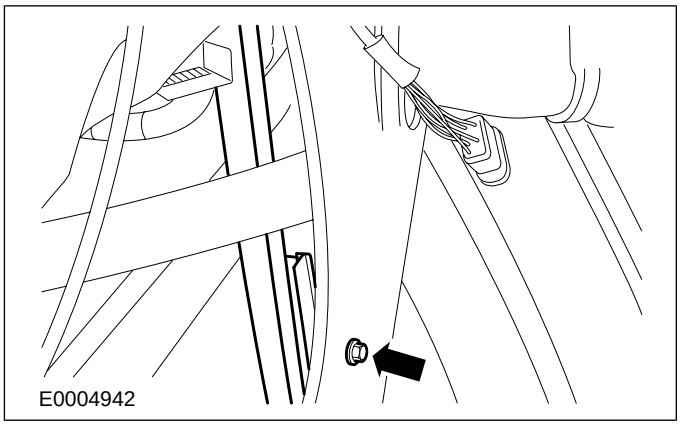
Removal

1. **Remove the front door window glass.**

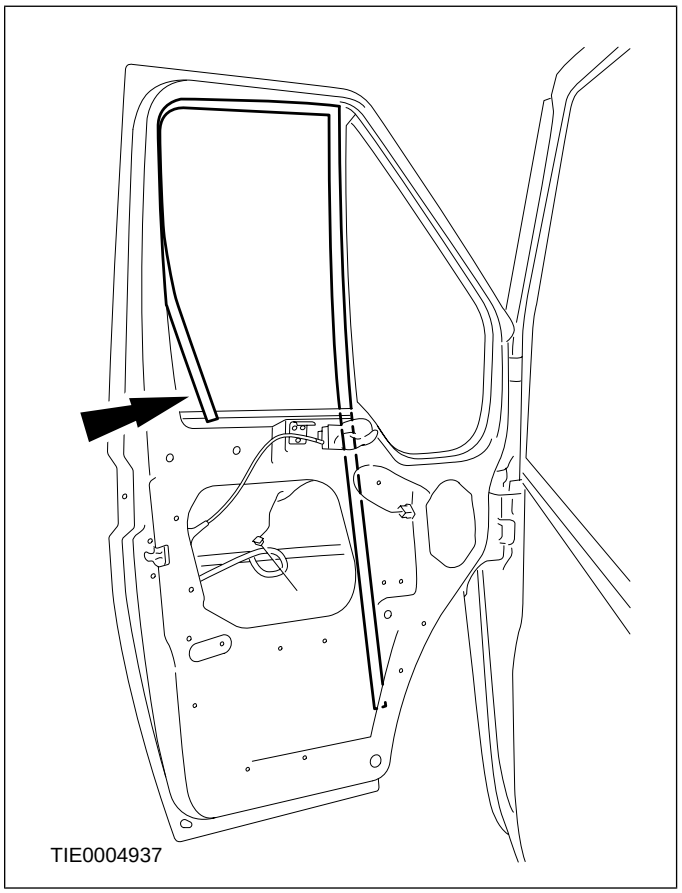
   For additional information, refer to:Front Door Window Glass (501-11 Glass, Frames and Mechanisms, Removal and Installation).

2. **NOTE:Do not remove the front door glass top run inner retaining bracket from the front door glass top run.**

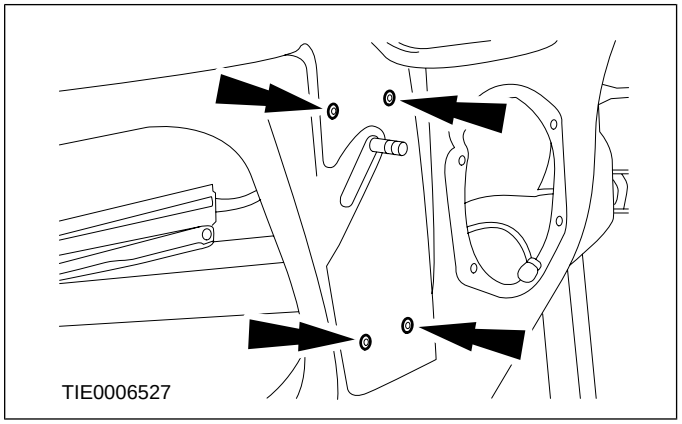
   Detach the front door glass top run inner retaining bracket from the door panel.



3. **Remove the front door glass top run.**

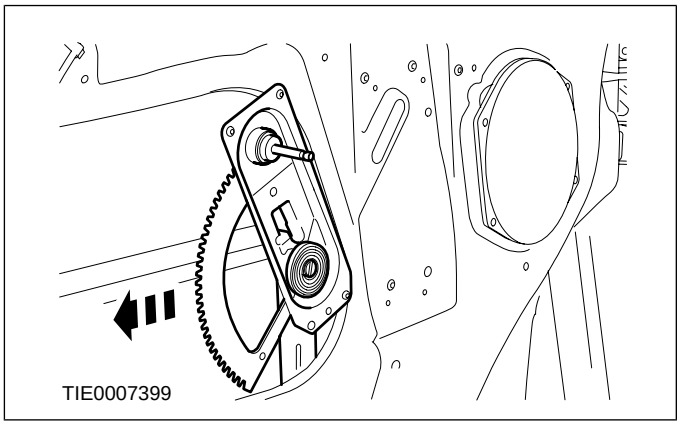


4. **Remove the window regulator rivets.**



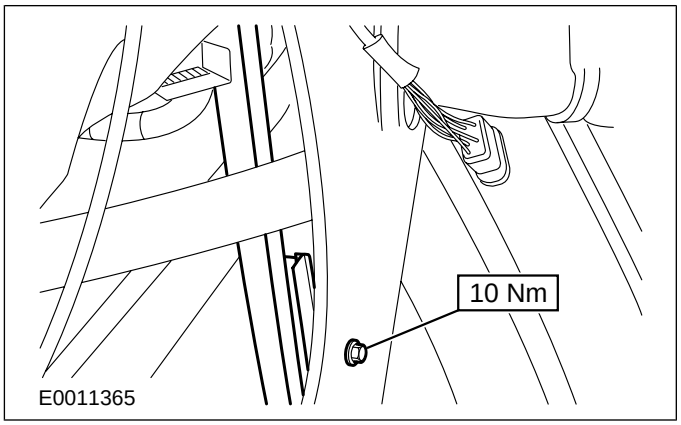
REMOVAL AND INSTALLATION

5. Remove the window regulator.



Installation

1. To install, reverse the removal procedure.



REMOVAL AND INSTALLATION

Front Door Window Regulator and Motor (42 338 0)

General Equipment

Electric hand drill
5 mm drill bit
Blind rivet gun

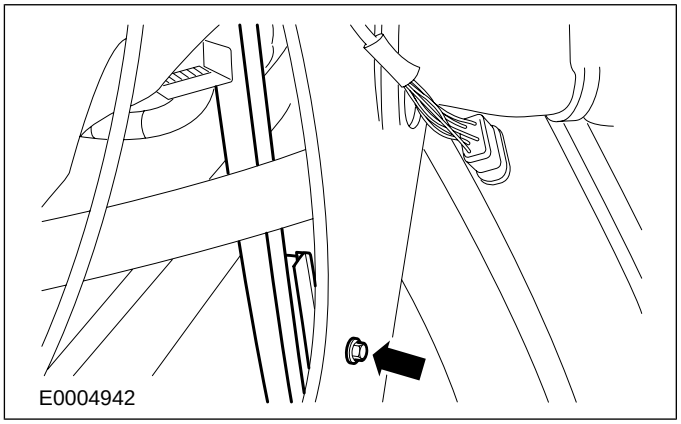
Removal

1. **Remove the front door window glass.**

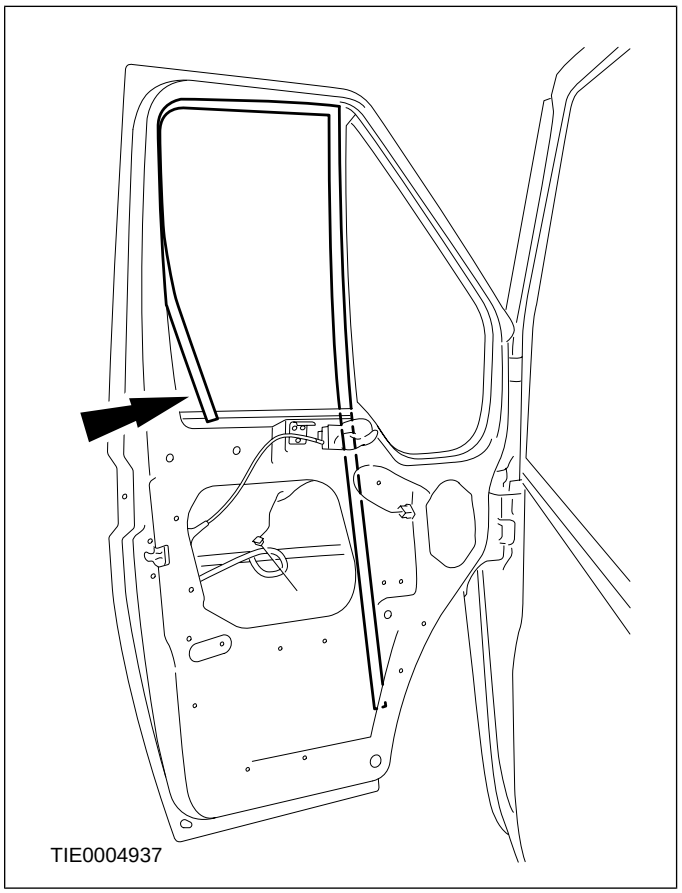
   For additional information, refer to:Front Door Window Glass (501-11 Glass, Frames and Mechanisms, Removal and Installation).

2. **NOTE:Do not remove the front door glass top run inner retaining bracket from the front door glass top run.**

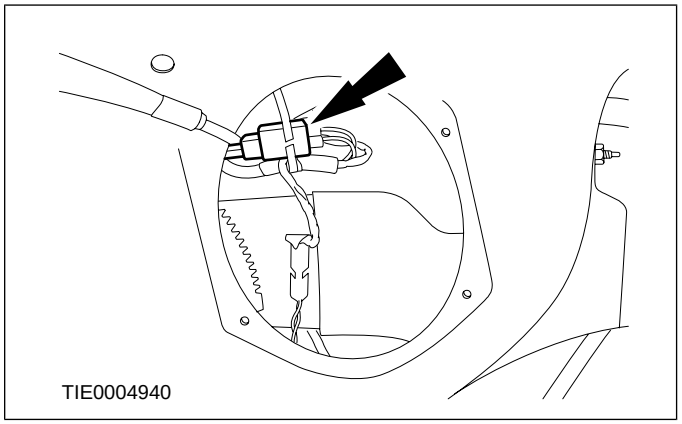
   Detach the front door glass top run inner retaining bracket from the door panel.



3. **Remove the front door glass top run.**



4. **Disconnect the front door window regulator motor electrical connector.**

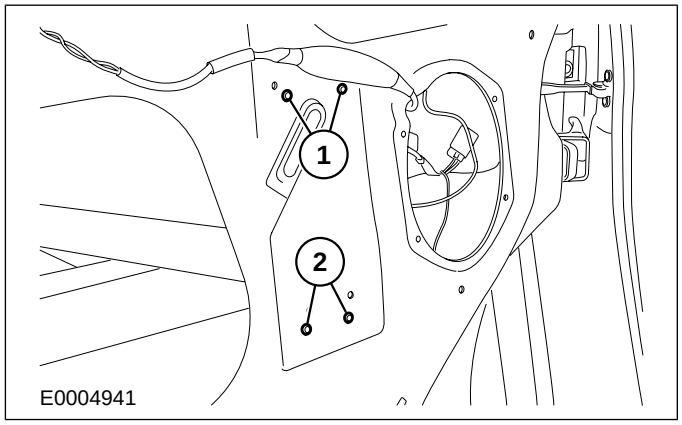


5. **Detach the front door window regulator and motor from the door panel.**

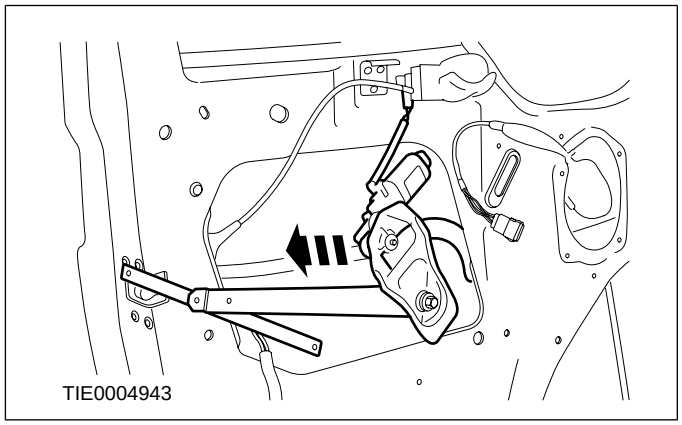
   1. Using a electric hand drill and 5 mm drill bit, remove the rivets.

REMOVAL AND INSTALLATION

2. Remove the nuts.



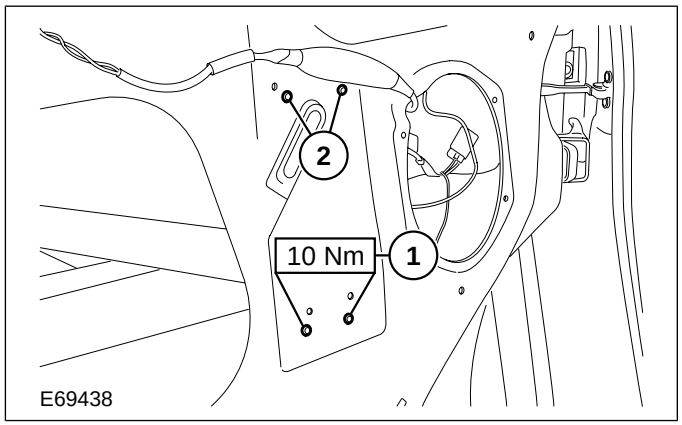
6. Remove the front door window regulator and motor.



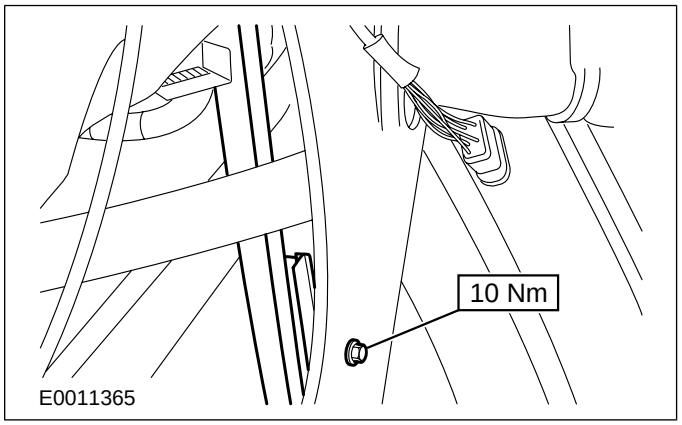
Installation

1. Install the front door window regulator and motor.

1. Install the nuts.
2. Using a blind rivet gun, install new rivets.



2. To install, reverse the removal procedure.



REMOVAL AND INSTALLATION

Windshield Glass (42 115 0)

General Equipment

Hot air gun
Direct glazing cutter for bonded glass
Mixing/applicator gun
Direct glazing adhesive oven
Glazing suction cups

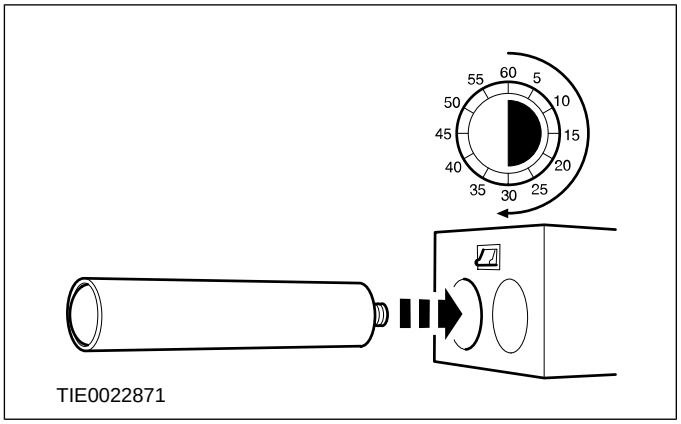
Materials

Name	Specification
Windshield Adhesive Kit	WSK-M11P57-A1

Removal

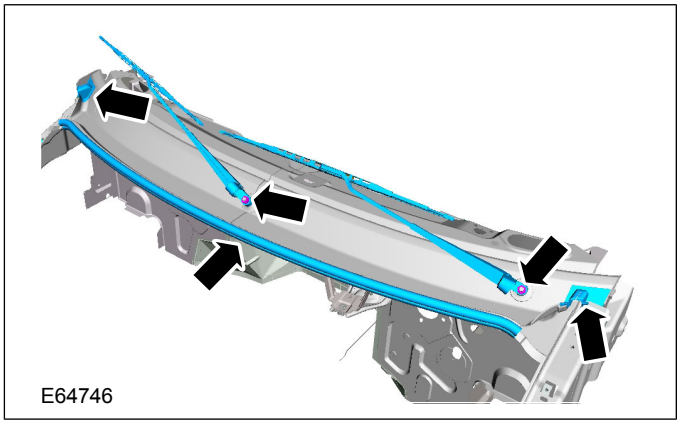
All vehicles

1. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**

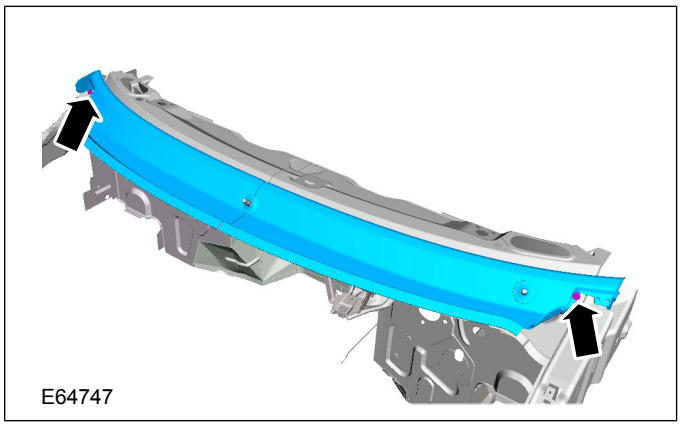


2. **CAUTION:Make sure that the windshield wiper motor is in the park position.**

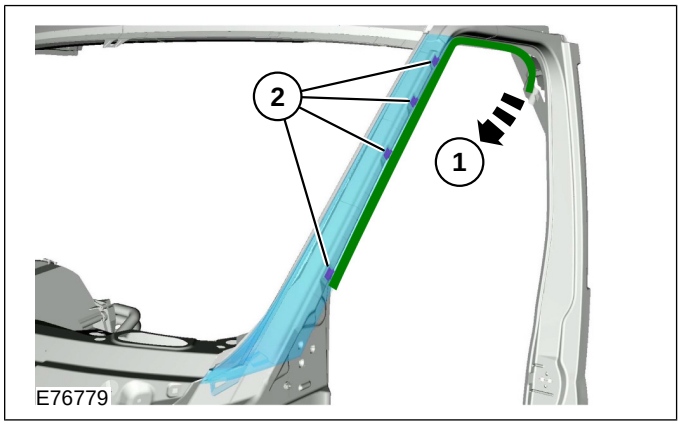
   Remove the windshield wiper arms, hood hinge covers and hood seal.



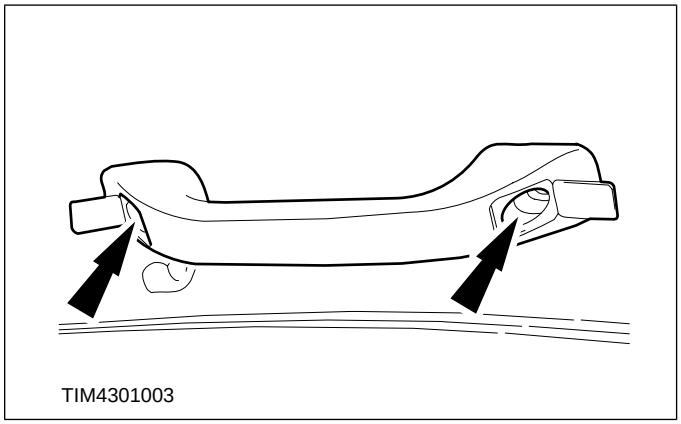
3. **Remove the cowl panel grille.**



4. **Remove the A-pillar exterior trim panels.**
   1. Detach the door aperture upper weatherstrip.
   2. Release the retaining clips.

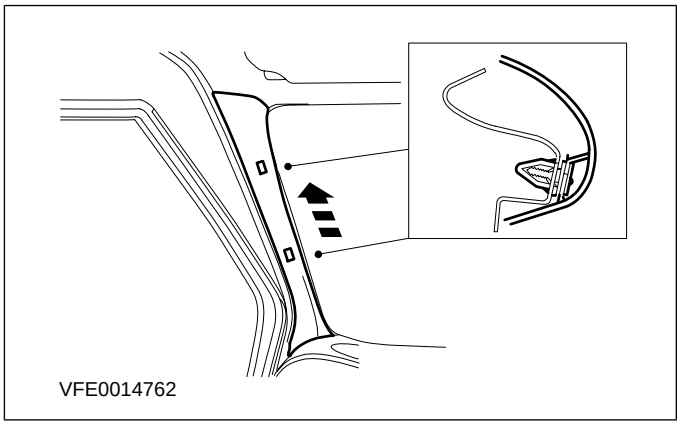


5. **Lower the hood.**
6. **Remove the passenger assist handle.**
   - Lever open the covers to expose the bolts.

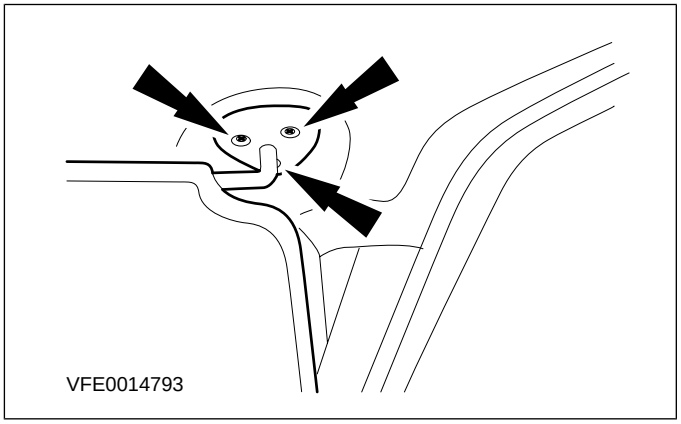


REMOVAL AND INSTALLATION

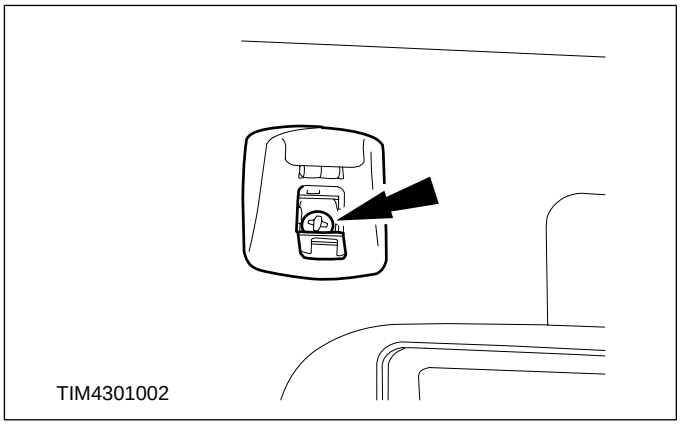
7. Remove the A-pillar trim panels.



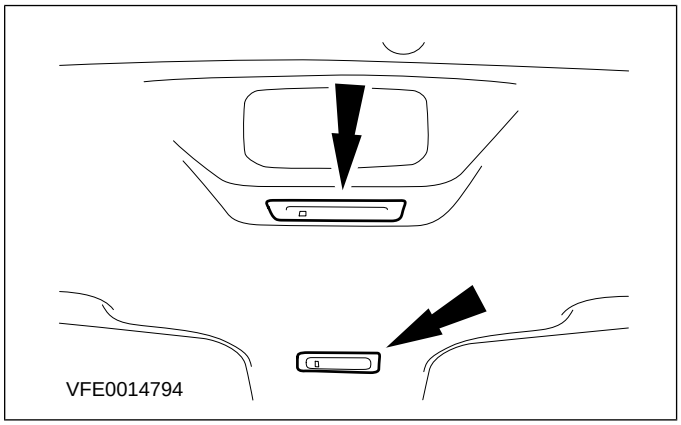
8. Remove the sun visors.



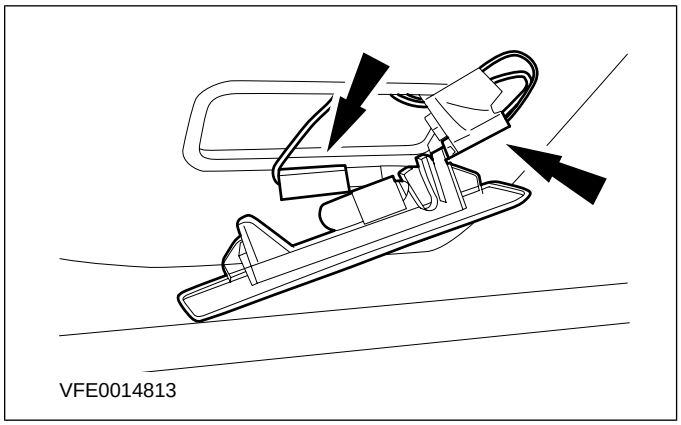
9. Remove the sun visor retaining clips.



10. Detach the front interior lamps.



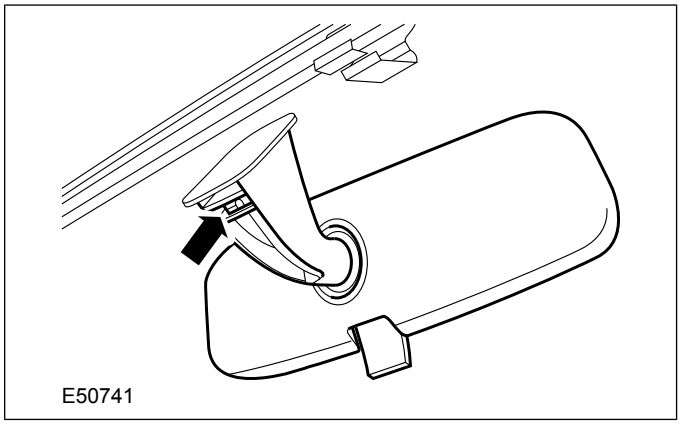
11. Disconnect the electrical connectors and remove the front interior lamps.



Vehicles with manual dimming interior mirror

12. Remove the manual dimming interior mirror.

- Using a thin bladed screwdriver, release the retaining clip.

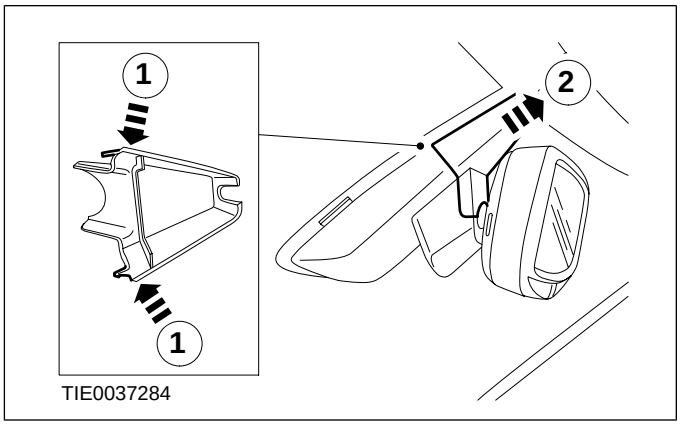


Vehicles with manual dimming interior mirror with rain sensor

13. Remove the manual dimming interior mirror upper trim panel.

REMOVAL AND INSTALLATION

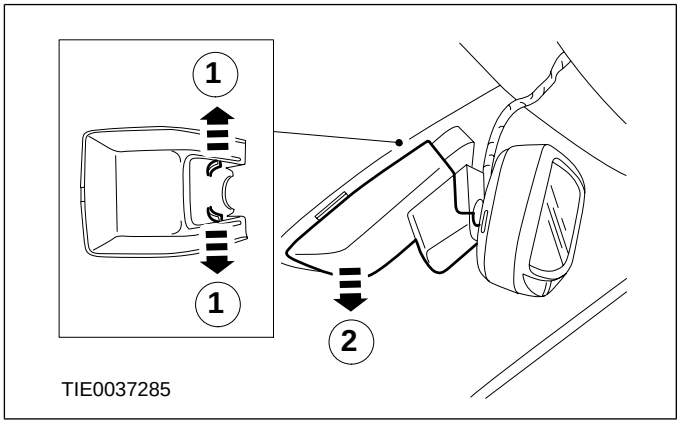
1. Release the retaining clips
2. Pull the manual dimming interior mirror upper trim panel rearwards.



TIE0037284

14. Remove the manual dimming interior mirror lower trim panel.

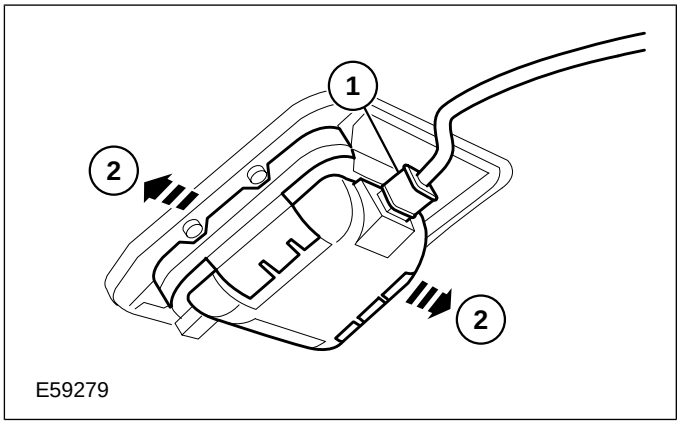
1. Release the retaining clips.
2. Pull the manual dimming interior mirror lower trim panel downwards.



TIE0037285

15. Remove the rain sensor.

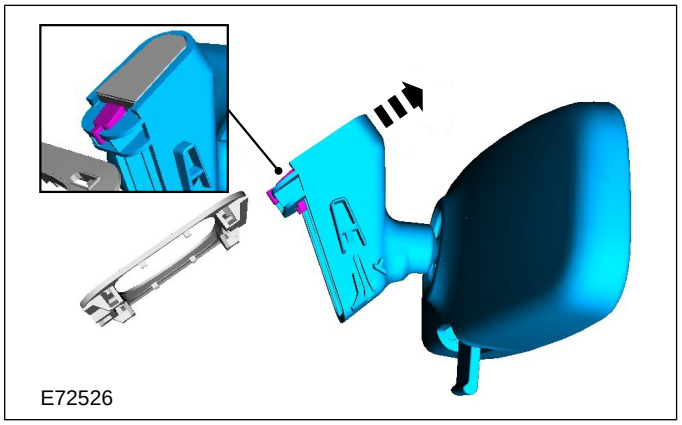
1. Disconnect the rain sensor electrical connector.
2. Release the rain sensor retaining clips.



E59279

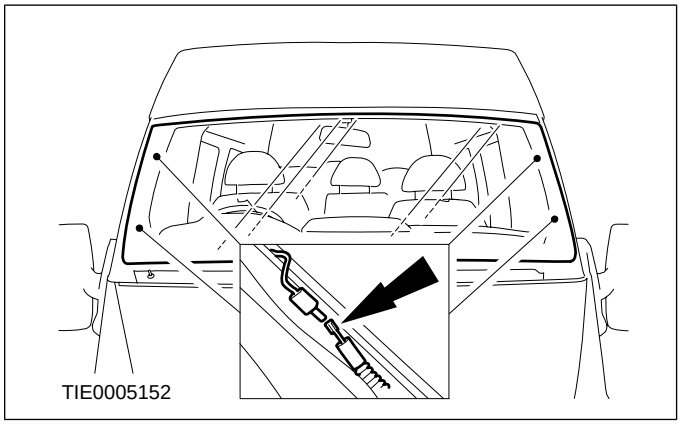
16. Remove the manual dimming interior mirror.

- Using a thin bladed screwdriver, release the retaining clip.


E72526

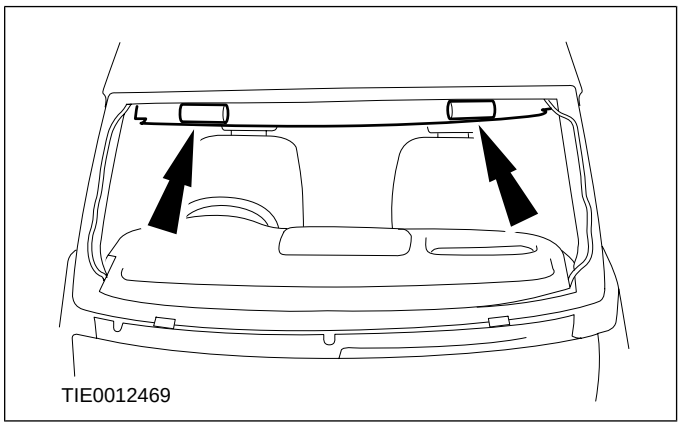
Vehicles with heated windshield

17. Disconnect the heated windshield electrical connectors.


TIE0005152

All vehicles

18. Detach the leading edge of the front headliner and place two blocks of suitable material between the headliner and the roof panel to act as spacers.


TIE0012469

REMOVAL AND INSTALLATION

19. **WARNING:Wear gloves and eye protection when working with the glass cutting tool as the cutting operation may produce splinters. When using the cutter wear ear protectors. Failure to follow these instructions may result in personal injury.**

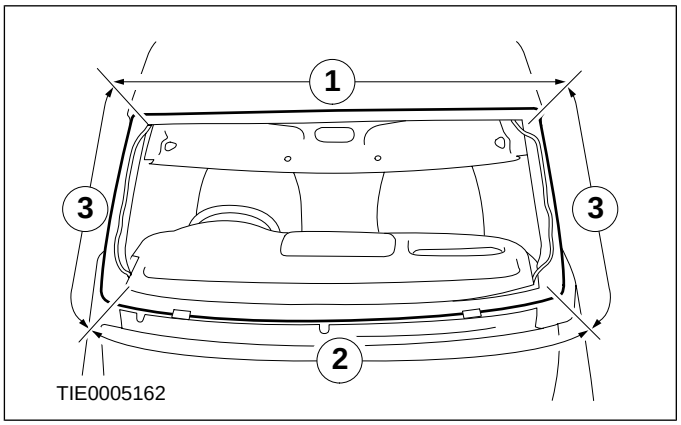
CAUTION:Make sure the cutting blades are changed where the cutting depth changes to avoid damage to the body and trim panels.

NOTE: Some resistance may be encountered when cutting through the glass locating pegs in the upper corners of the glass.

NOTE: Care must be taken when cutting in the area of the locating blocks along the lower edge of the windshield glass.

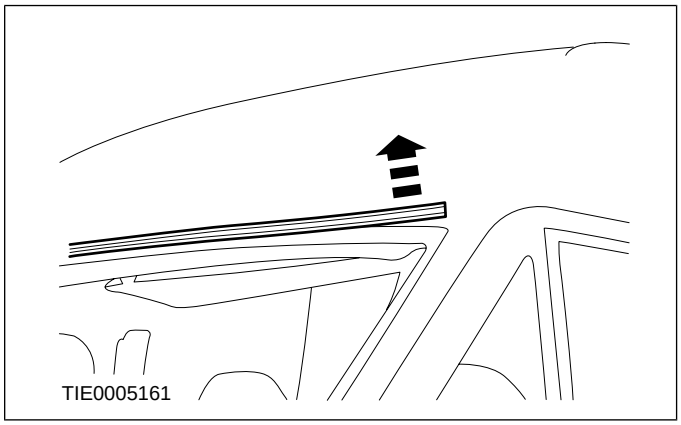
From inside the vehicle, using a suitable direct glazing cutter for bonded glass, cut the PU adhesive to the given maximum depths.

1. 20 mm.
2. 35 mm.
3. 50 mm.



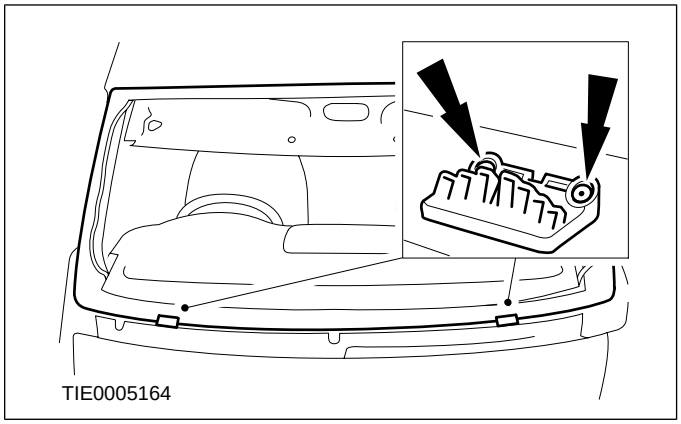
20. **With the aid of another technician, use glazing suction cups to remove the windshield glass.**

21. **Remove the windshield glass weatherstrip.**



22. **Remove the windshield glass locating blocks.**

- Remove the rivets.



Installation

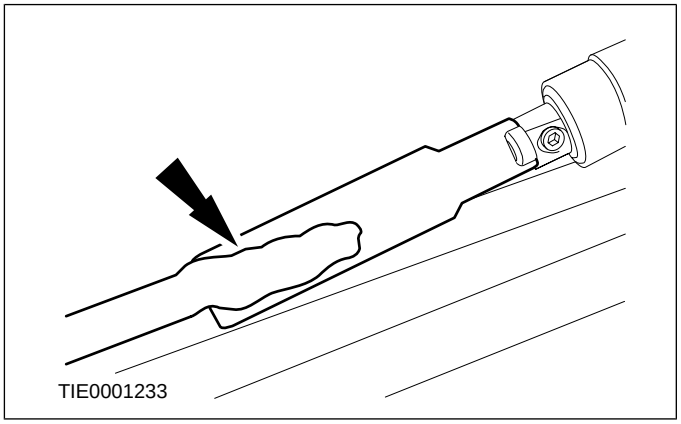
All vehicles

1. **Carefully remove the remaining part of the glass locating pegs from the windshield glass flange.**
2. **CAUTION:Do not touch the adhesive surface as re-bonding will be impaired.**

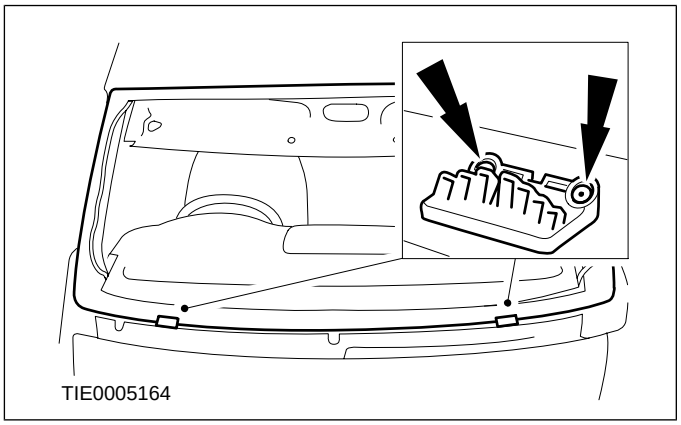
NOTE: Make sure the spacers located at the lower corners of the windshield glass flange are secure.

REMOVAL AND INSTALLATION

Carefully trim the remaining PU adhesive from the windshield glass flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.



3. **Install new windshield glass locating blocks.**

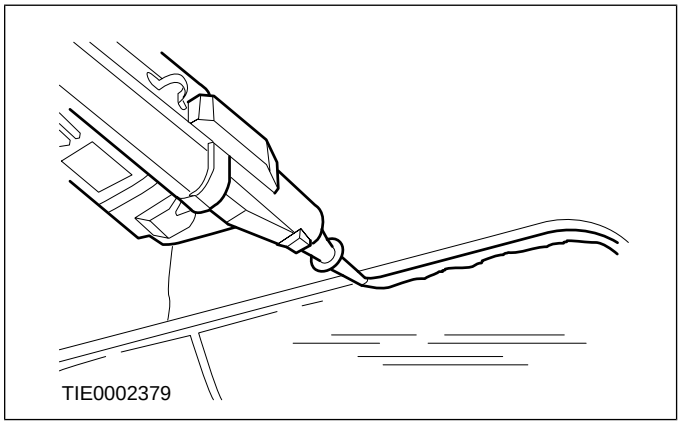


4. **Check the windshield glass flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.**
5. **CAUTION:To make sure that the PU adhesive cures, it is essential that all bonding surfaces are free of moisture.**

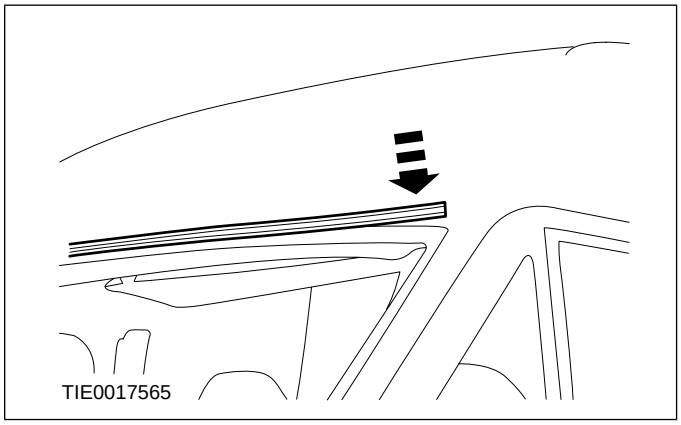
   Using a hot air gun, apply warm air (25°C) to the windshield glass flange and glass bond line to remove all traces of moisture.
6. **Prepare the glass, windshield glass flange and trimmed PU adhesive in accordance with the instructions supplied with the adhesive kit.**
7. **NOTE:Discard the first 100 mm of PU adhesive as this may have a reduced working time.**

NOTE: To avoid water leaks, any breakage in the continuous bead should be overlapped by 20 mm.

Using the mixing/applicator gun, apply a thin continuous bead of PU adhesive to the edge of the windshield glass.



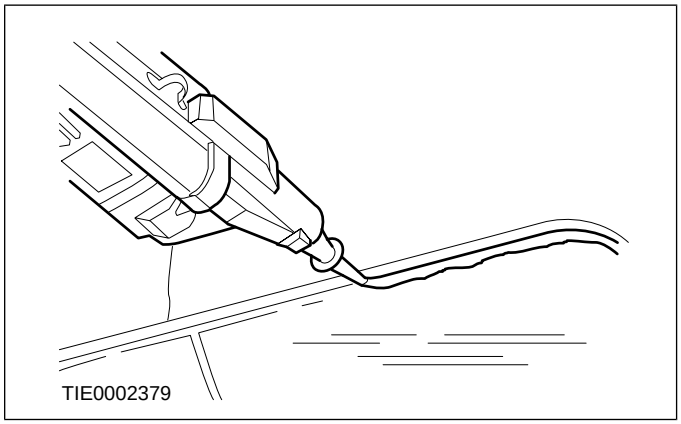
8. **Install the windshield glass weatherstrip.**



9. **NOTE:Discard the first 100 mm of PU adhesive as this may have a reduced working time.**

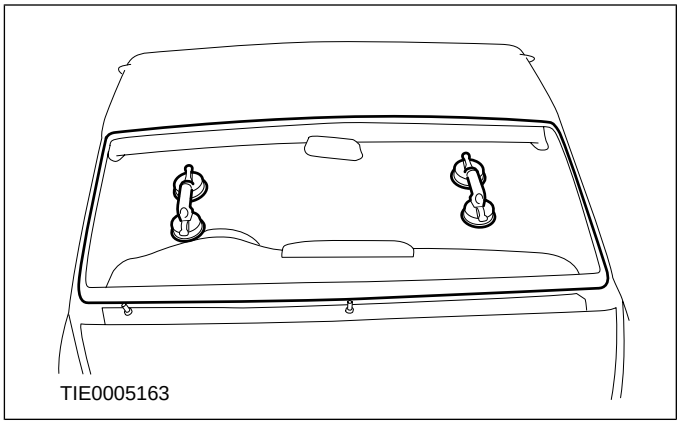
NOTE: To avoid water leaks, any breakage in the continuous bead must be overlapped by 20 mm.

Using the mixing/applicator gun, apply the PU adhesive in a continuous bead of between 8 and 10 mm in height to the windshield glass flange along the bond line.



REMOVAL AND INSTALLATION

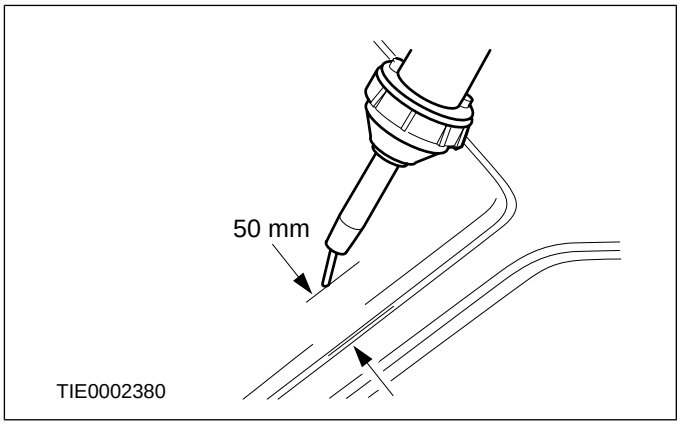
10. **With the aid of another technician, use glazing suction cups.**
    - Press firmly and evenly into position.



11. **CAUTION:During the curing period of the PU adhesive, the door windows must be left open to avoid a build up of pressure when the doors are open and closed.**

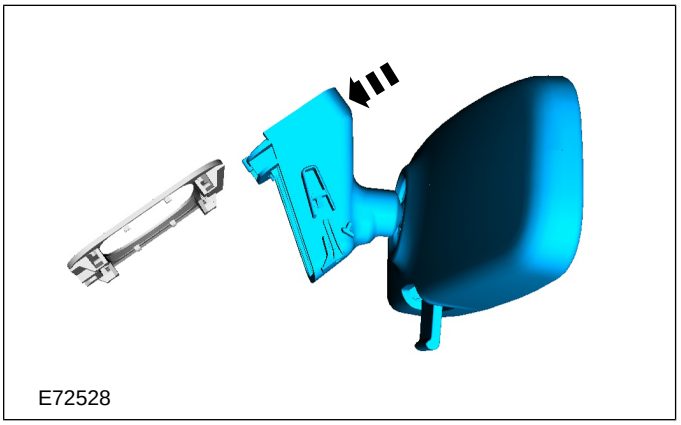
    Using suitable tape, secure the windshield glass in the correct position until the PU adhesive has cured.

12. **If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (inside or outside the vehicle).**

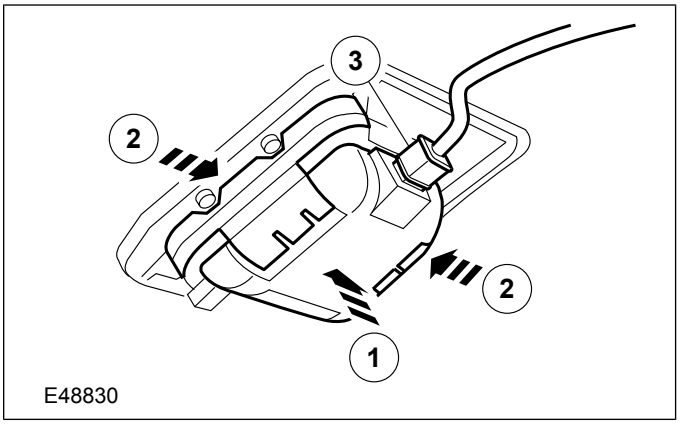


Vehicles with manual dimming interior mirror with rain sensor

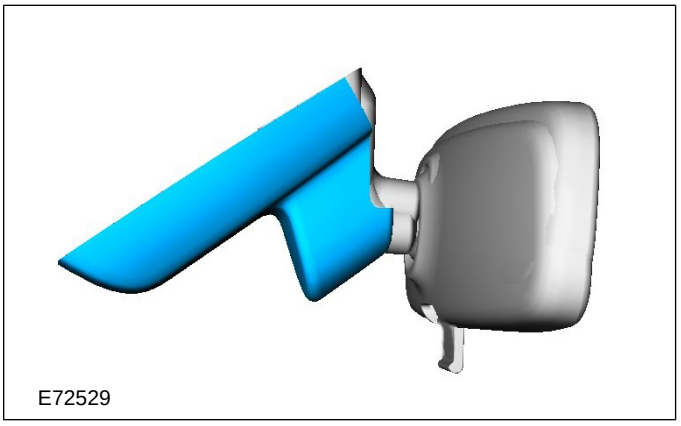
13. **Install the manual dimming interior mirror.**



14. **Install the rain sensor.**
    1. Locate the rain sensor in the rain sensor mounting bracket.
    2. Push in the rain sensor retaining clips.
    3. Connect the rain sensor electrical connector.

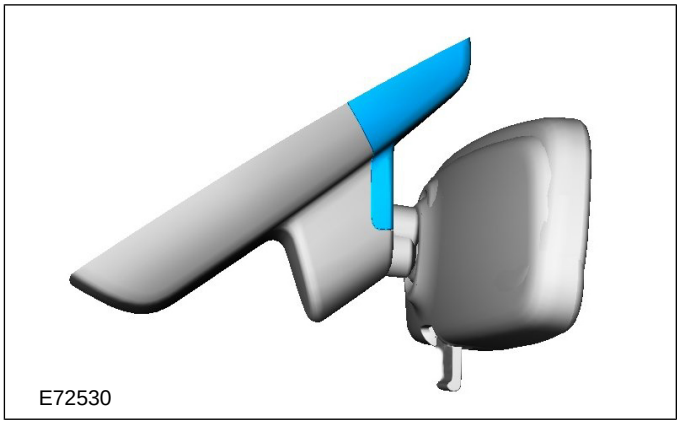


15. **Install the manual dimming interior mirror lower trim panel.**



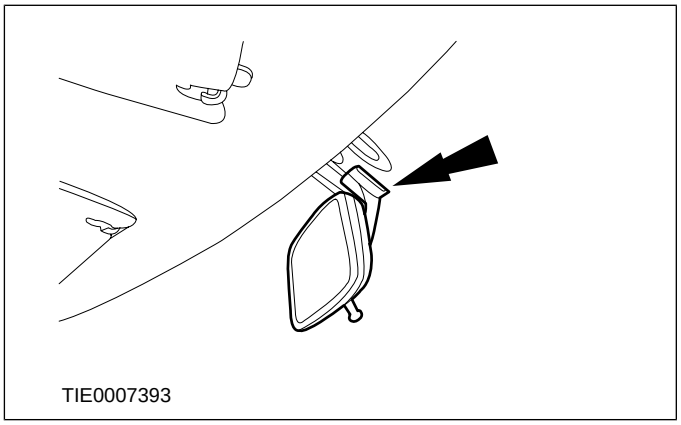
REMOVAL AND INSTALLATION

16. **Install the manual dimming interior mirror upper trim panel.**



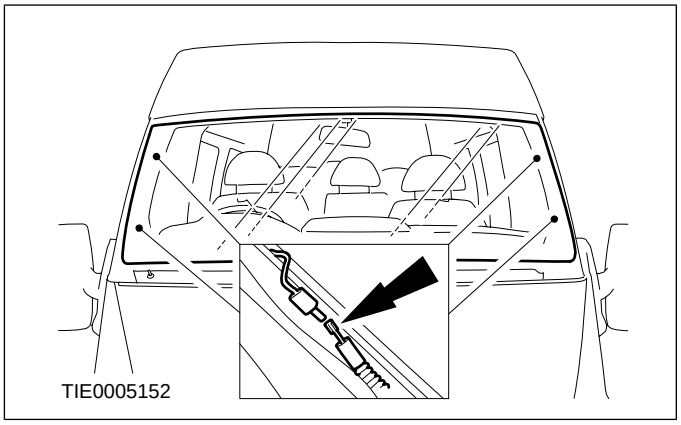
Vehicles with manual dimming interior mirror

17. **Install the interior mirror.**



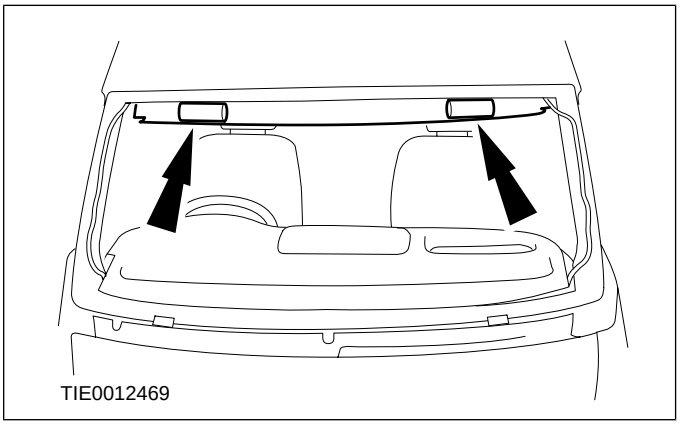
Vehicles with heated windshield

18. **Connect the heated windshield electrical connectors.**

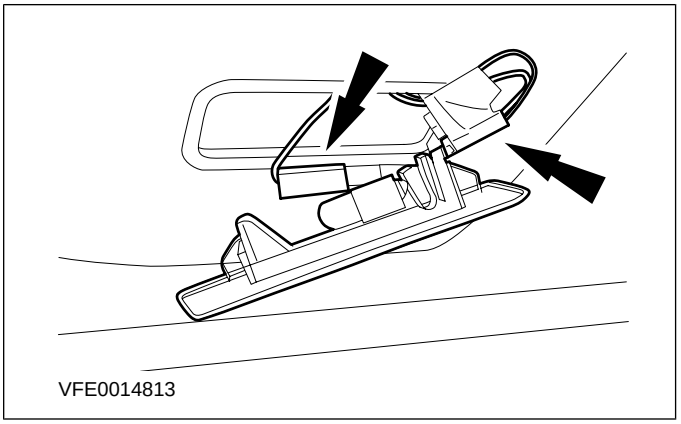


All vehicles

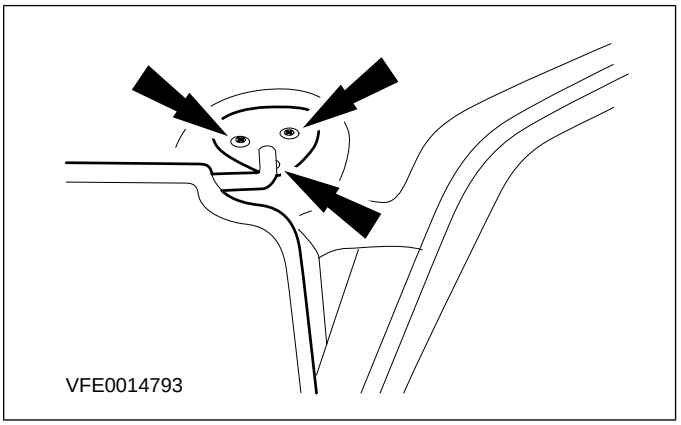
19. **Remove the spacers and attach the leading edge of the front headliner to the roof panel.**



20. **Connect the electrical connectors and install the front interior lamps.**

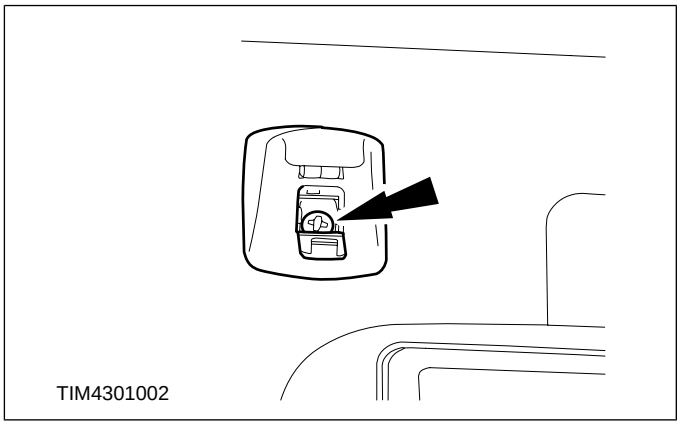


21. **Install the sun visors.**



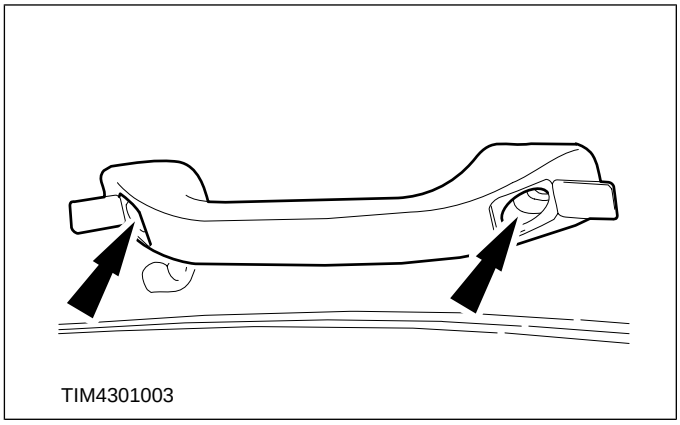
REMOVAL AND INSTALLATION

22. Install the sun visor retaining clips.



23. Install the A-pillar trim panels.

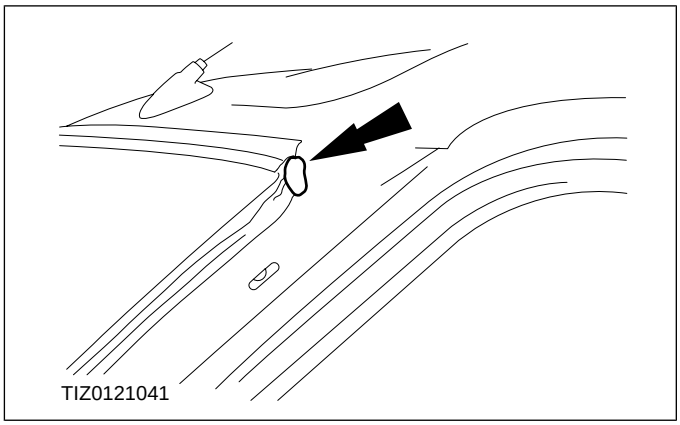
24. Install the passenger assist handle.



25. Raise the hood.

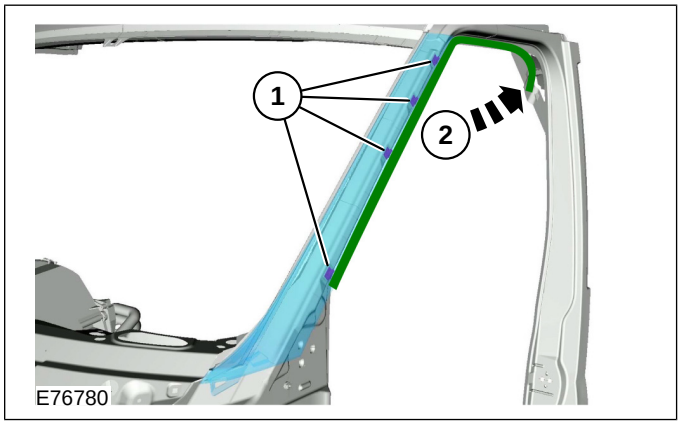
26. NOTE:To eliminate wind noise, apply an additional bead of PU adhesive to the top corners of the windshield.

Apply an additional bead of PU adhesive to the top corners of the windshield.

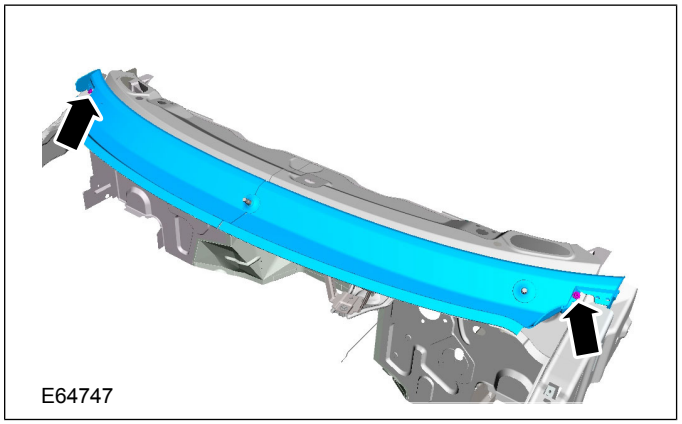


27. Install the A-pillar exterior trim panels.

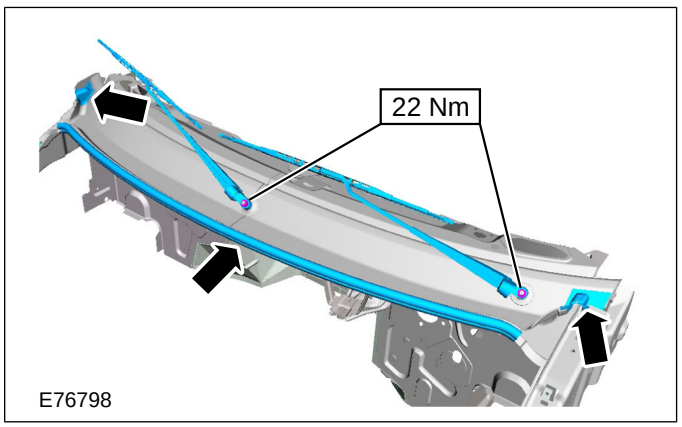
1. Locate the retaining clips.
2. Attach the door aperture upper weatherstrip.



28. Install the cowl panel grille.



29. Install the windshield wiper arms, hood hinge covers and hood seal.



REMOVAL AND INSTALLATION

Front Door Glass Top Run (42 333 0)

Removal

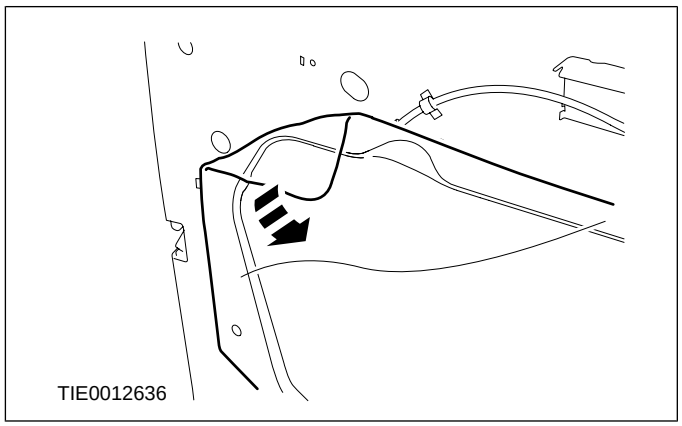
All vehicles

1. **Remove the front door trim panel.**

   For additional information, refer to:Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

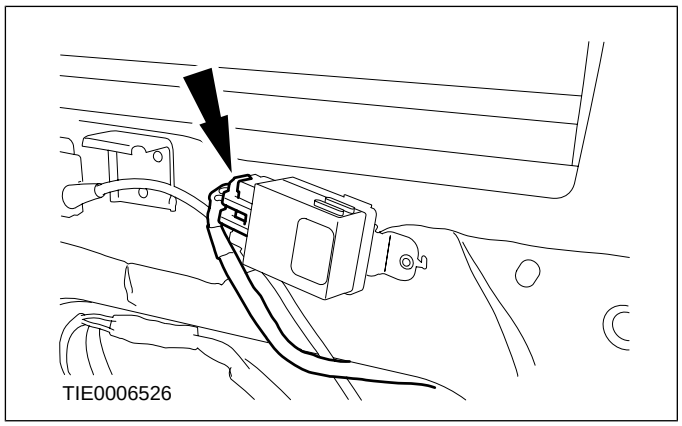
2. **⚠CAUTION:Do not touch the adhesive surface as re - bonding will be impaired.**

   Detach the watershield from the door panel.

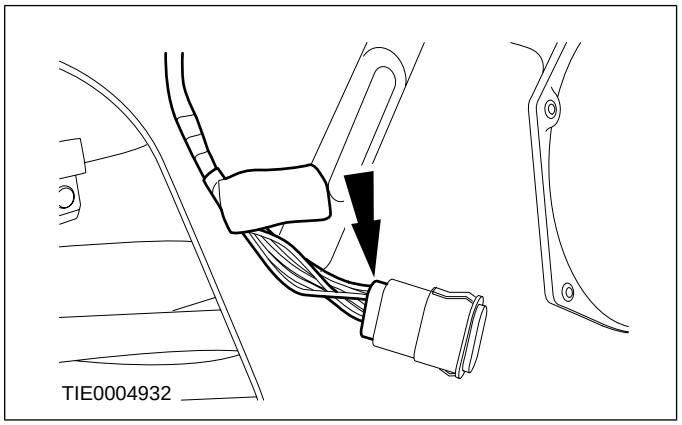


Vehicles with power windows

3. **Disconnect the one - touch down relay electrical connector (if equipped).**

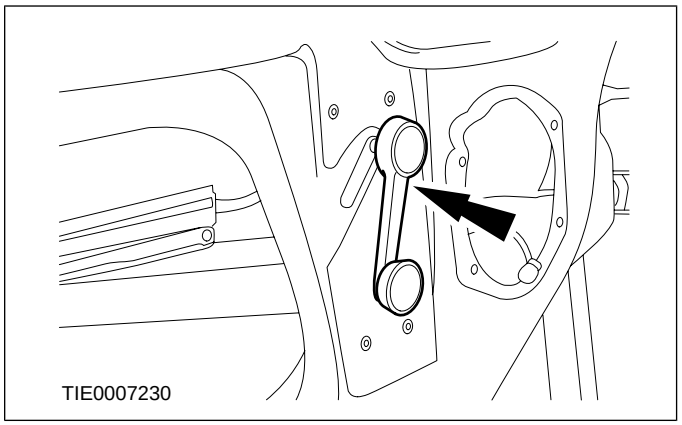


4. **Connect the window control switch electrical connector.**



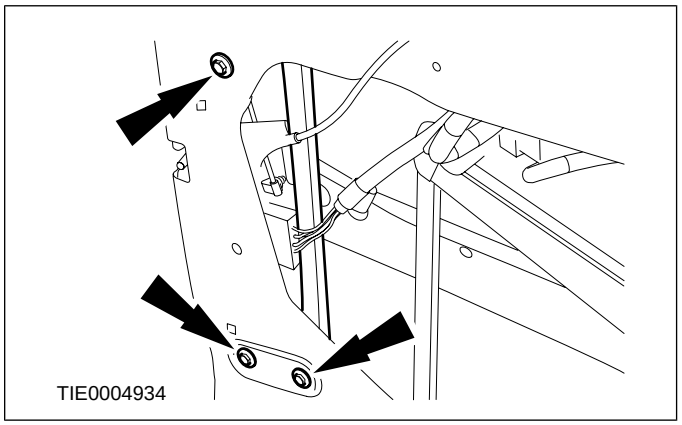
Vehicles with manual windows

5. **Install the window regulator handle.**



All vehicles

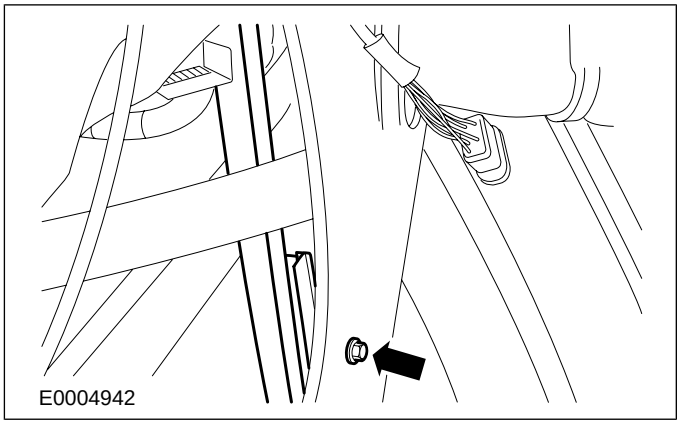
6. **Remove the front door glass top run outer retaining bracket.**



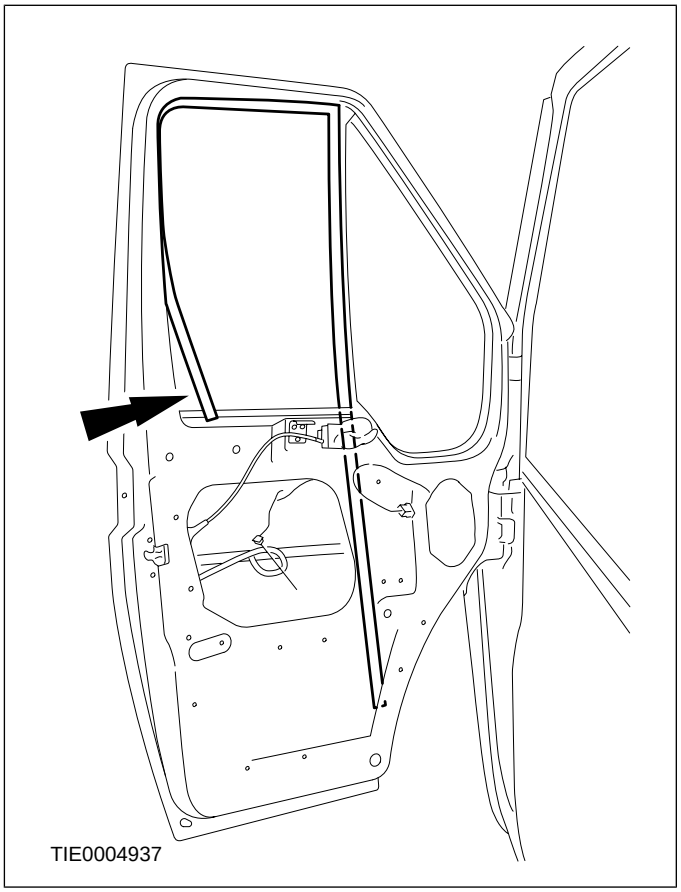
7. **NOTE:Do not remove the front door glass top run inner retaining bracket from the front door glass top run.**

REMOVAL AND INSTALLATION

Detach the front door glass top run inner retaining bracket from the door panel.

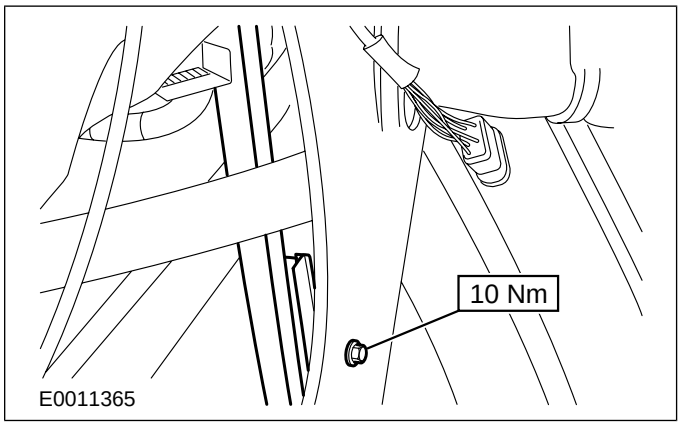


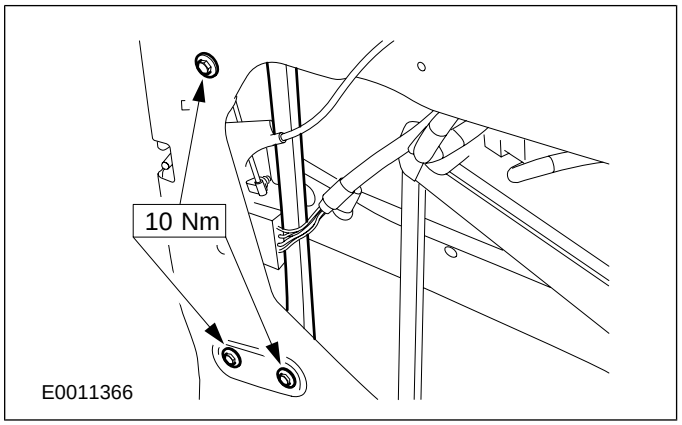
8. **Lower the front door window glass.**
9. **Remove the front door glass top run.**



Installation

1. **To install, reverse the removal procedure.**





SECTION 501-12 Instrument Panel and Console

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 501-12-2

REMOVAL AND INSTALLATION

Instrument Panel..... 501-12-3

DISASSEMBLY AND ASSEMBLY

Instrument Panel..... 501-12-8

SPECIFICATIONS

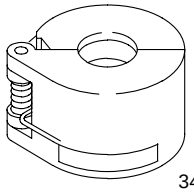
Torque Specifications

Description	Nm	lb-ft	lb-in
Instrument panel top bolts	5	-	44
Instrument panel side bolts	30	22	-
Instrument panel brace bolts	20	15	-
Instrument panel strut lower brace bolts	12	9	-
Steering column bracket nuts	20	15	-

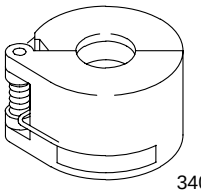
REMOVAL AND INSTALLATION

Instrument Panel

Special Tool(s)

 34001	Disconnect Tool, Spring Lock Coupling (1/2" blue) 412-027

Special Tool(s)

 34003	Disconnect Tool, Spring Lock Coupling (5/8" black) 412-038

Removal

NOTE: Removal steps in this procedure may contain installation details.

All vehicles

1. Drain the air conditioning system.

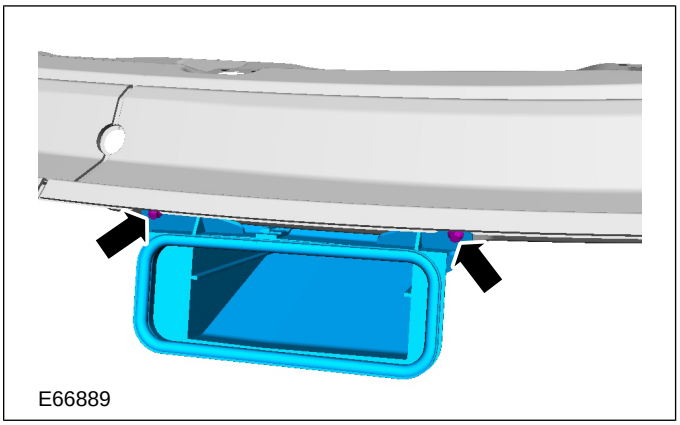
   Refer to:Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).

2. Drain the cooling system.

   Refer to:Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to:Cooling System Draining, Filling and Bleeding - 2.3L Duratec-HE (MI4), Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to:Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles Without: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).
   Refer to:Cooling System Draining, Filling and Bleeding - 2.2L Duratorq-TDCi (Puma) Diesel/2.4L Duratorq-TDCi (Puma) Diesel, Vehicles With: Fuel Fired Booster Heater (303-03 Engine Cooling, General Procedures).

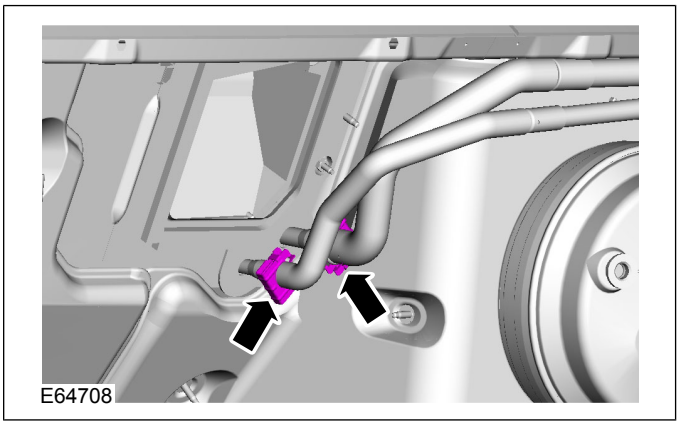
Vehicles with 2.3L engine or 2.4L diesel engine

3.


E66889

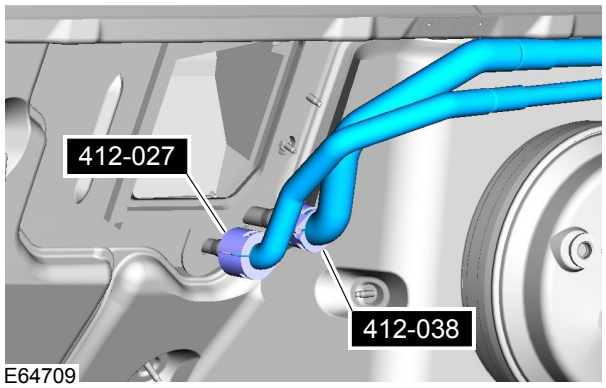
All vehicles

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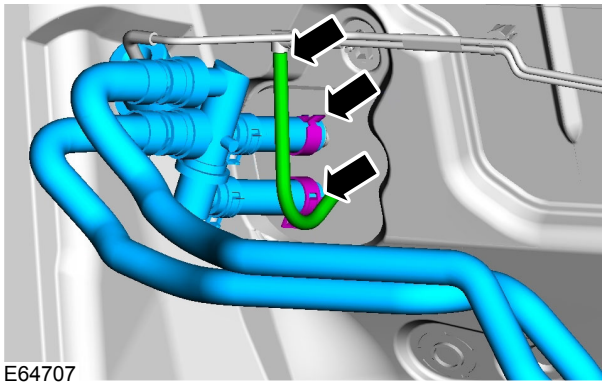

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REMOVAL AND INSTALLATION

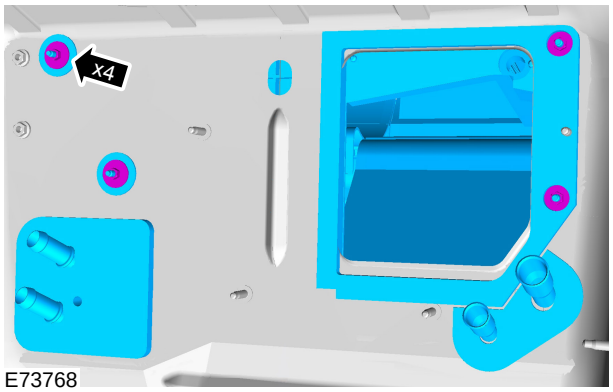
5. Special Tool(s): 412-027, 412-038



6.



7. Torque: 8 Nm



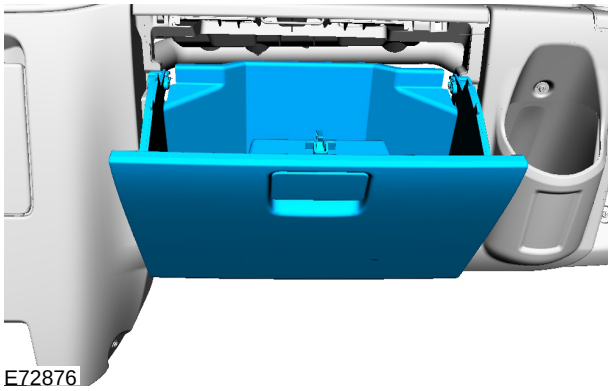
8. Remove the A-Pillar trim panel on both sides.

Refer to:A-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

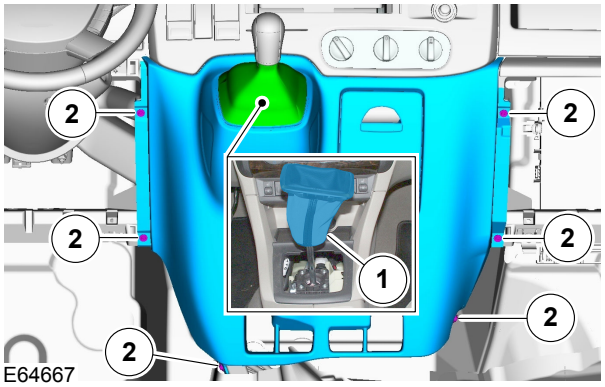
9. Remove the steering column.

Refer to:Steering Column (211-04 Steering Column, Removal and Installation).

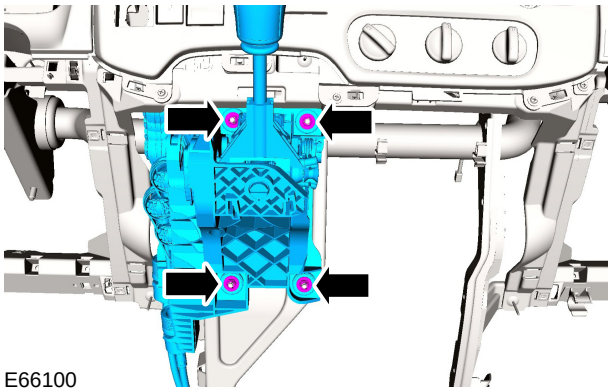
10.



11.

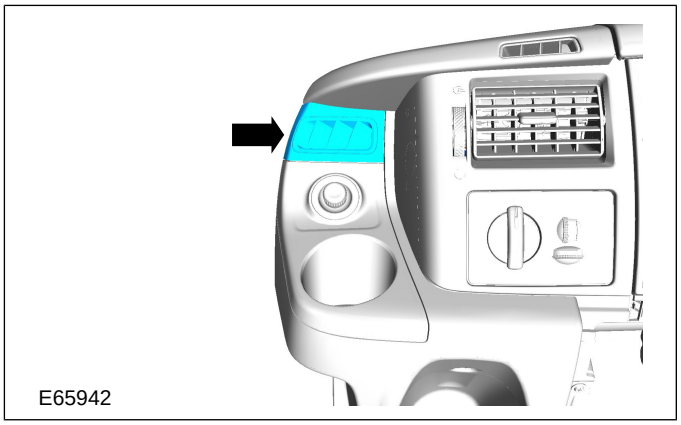


12. Torque: 8 Nm

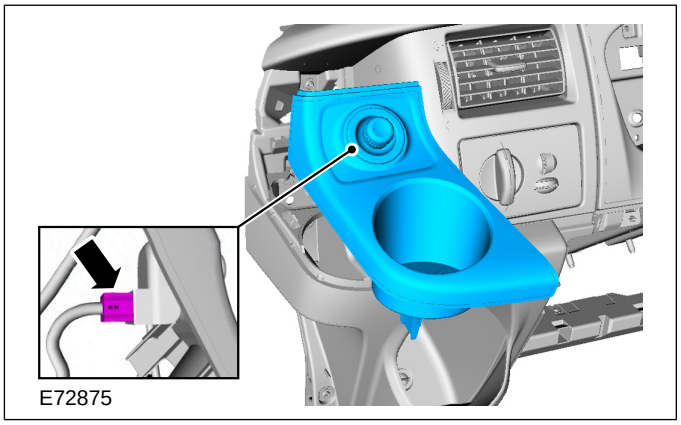


REMOVAL AND INSTALLATION

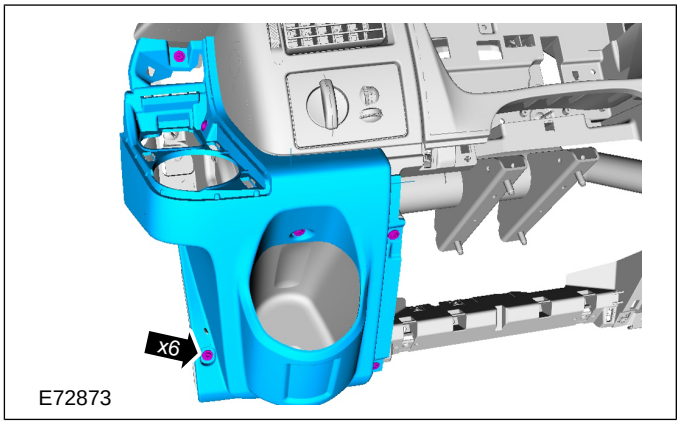
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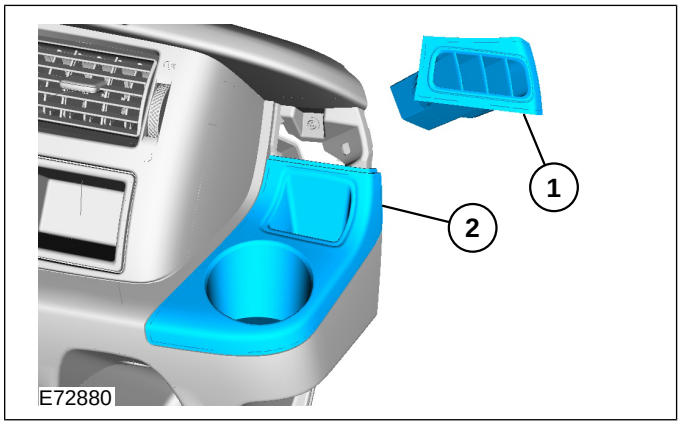
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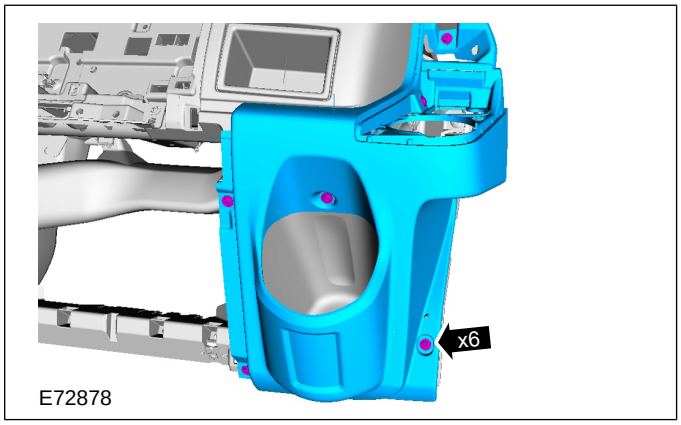
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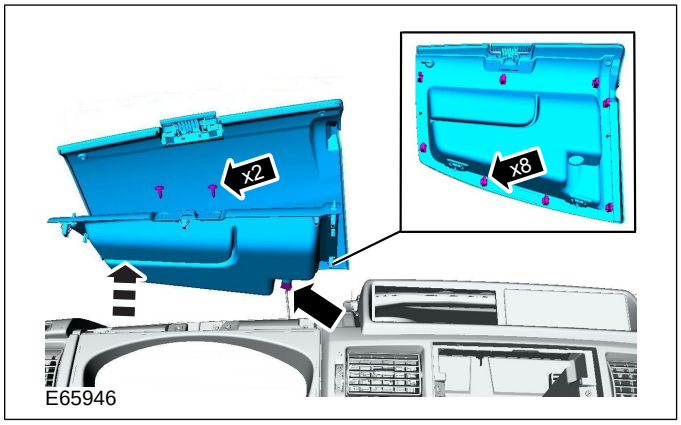
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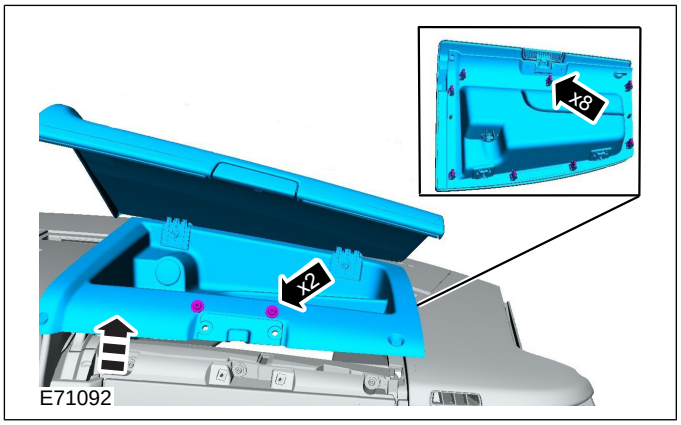


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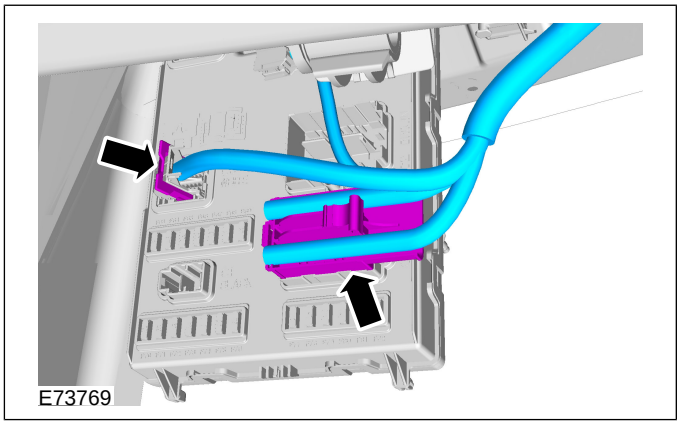


REMOVAL AND INSTALLATION

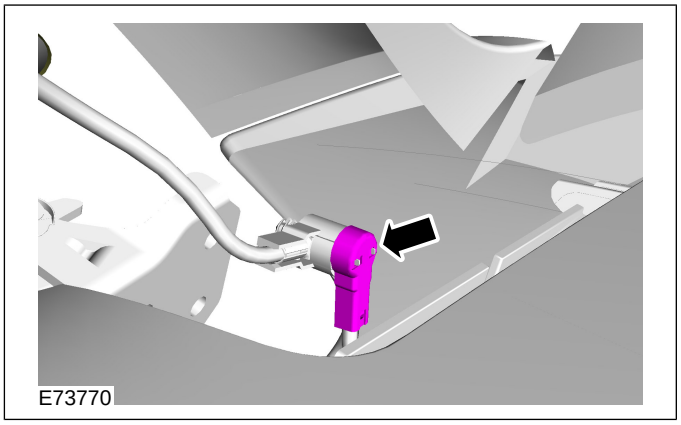
19.



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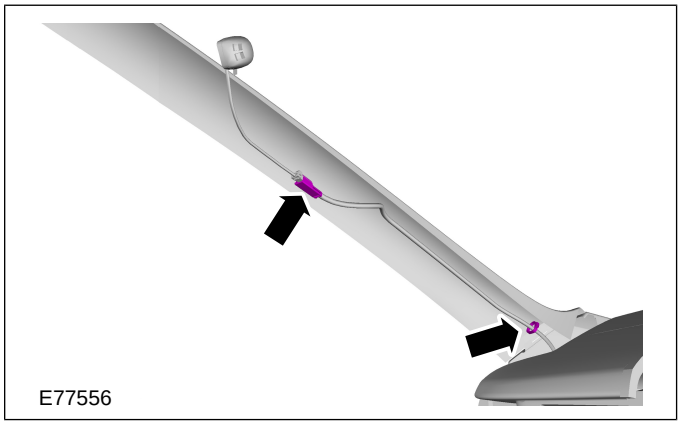


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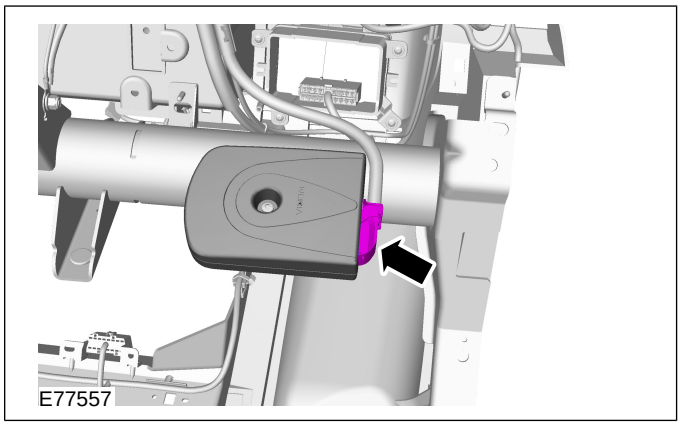


Vehicles with cellular phone

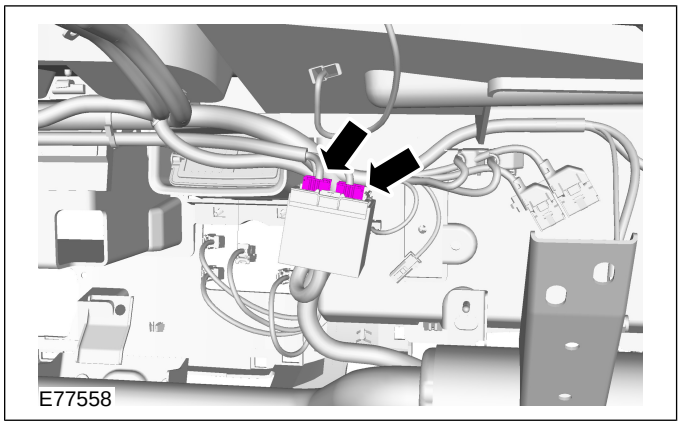
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23.

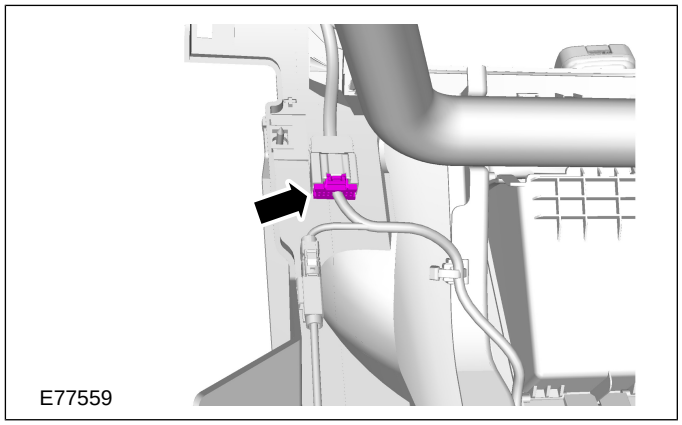


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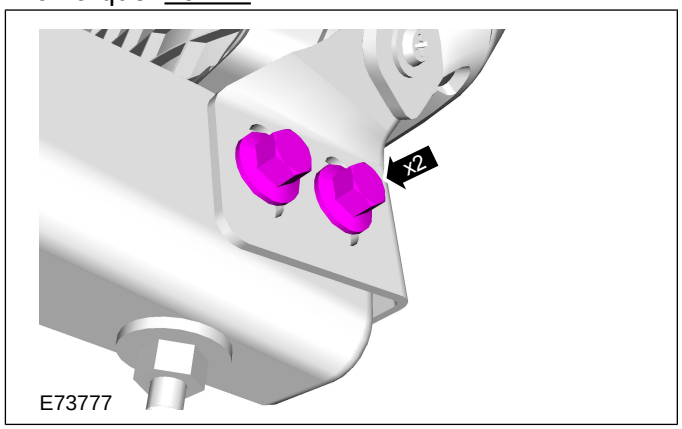
REMOVAL AND INSTALLATION

25.

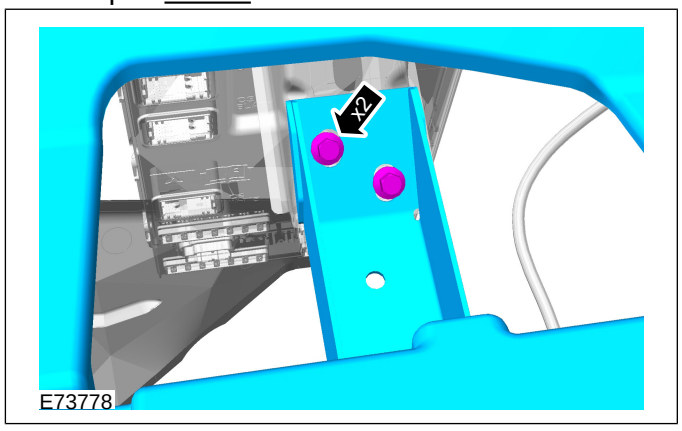


All vehicles

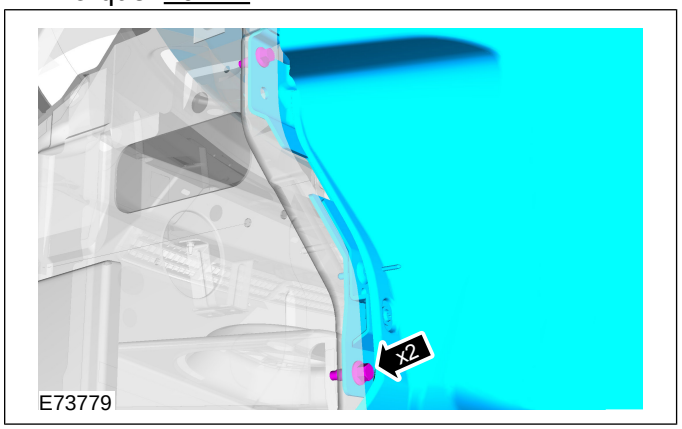
26. Torque: 10 Nm



27. On both sides.
Torque: 10 Nm



28. On both sides.
Torque: 20 Nm



Installation

1. To install, reverse the removal procedure.

DISASSEMBLY AND ASSEMBLY

Instrument Panel

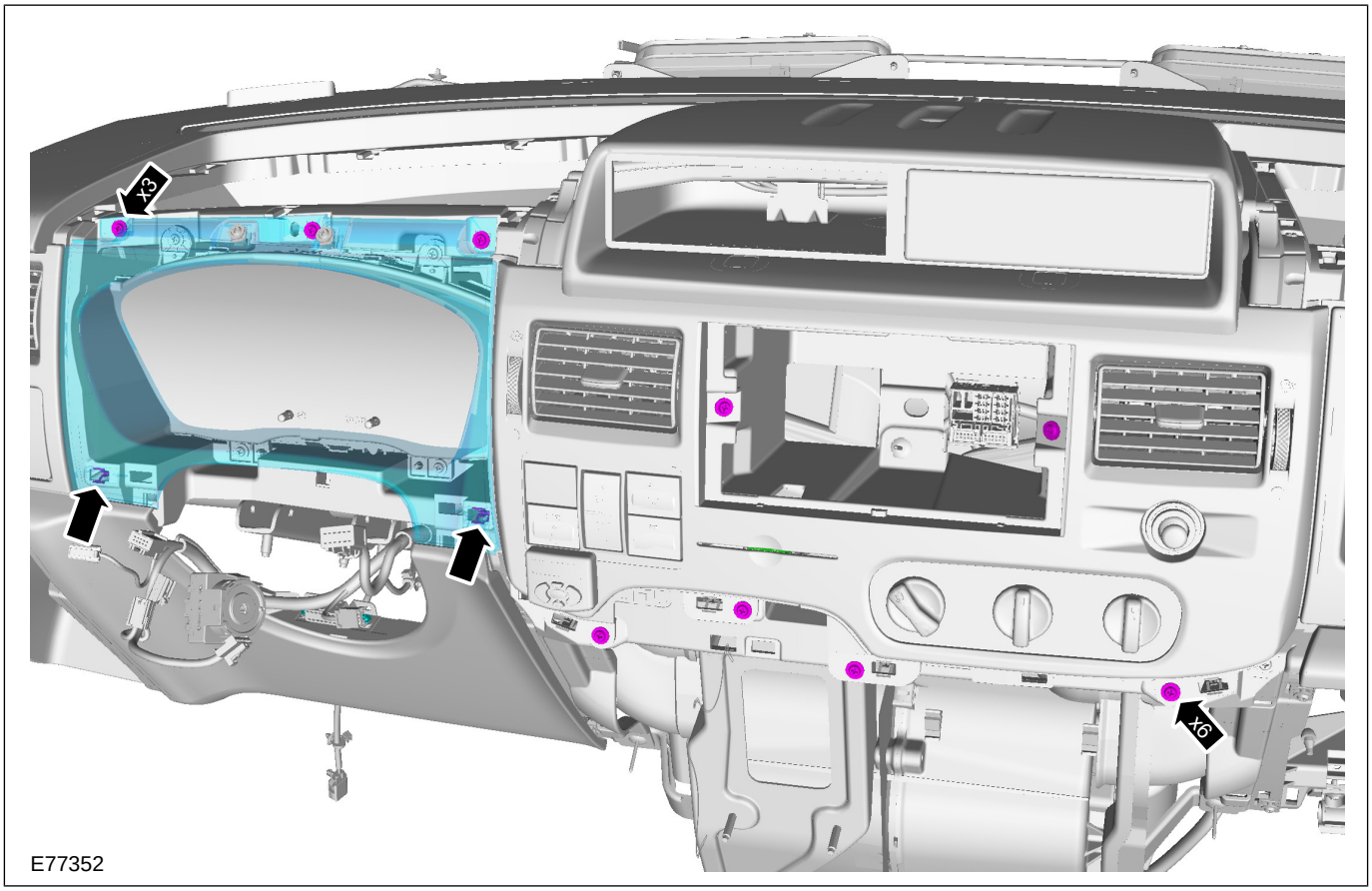
Disassembly

All vehicles

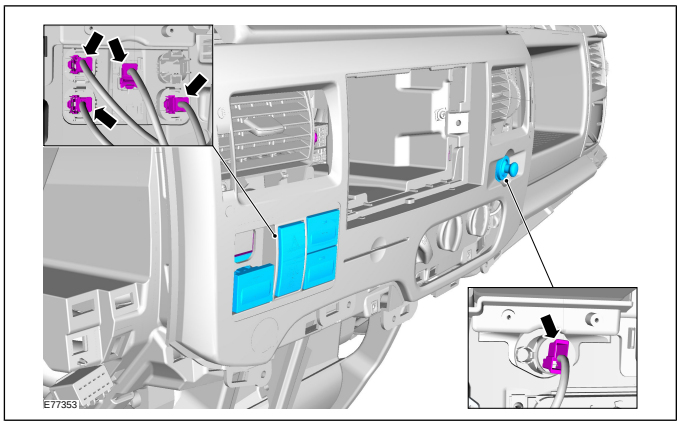
1. Remove the audio unit.

   Refer to:Audio Unit (415-01 Information and Entertainment System, Removal and Installation).

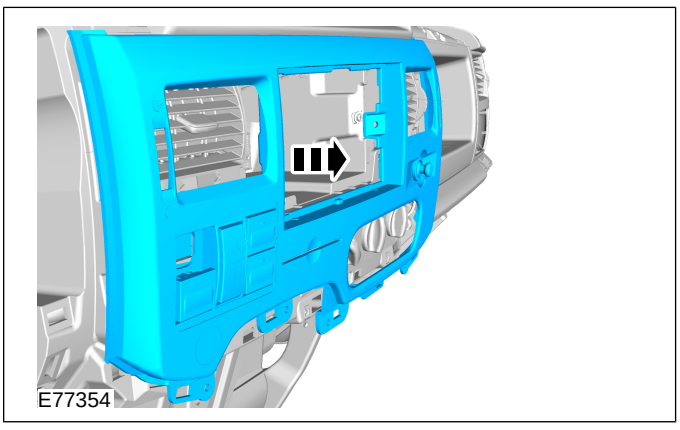
2.



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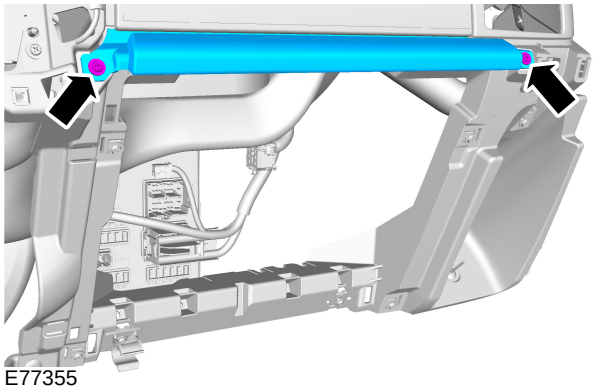


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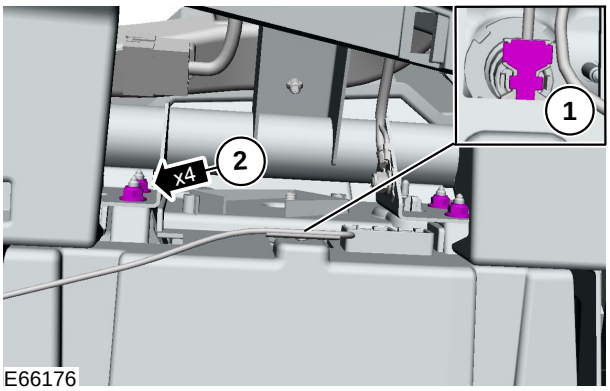
DISASSEMBLY AND ASSEMBLY

5.

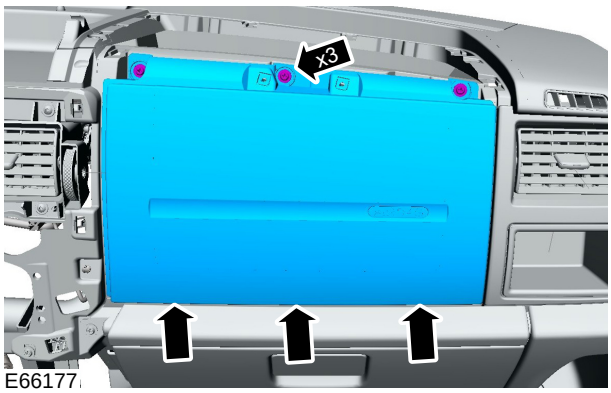


Vehicles with passenger air bag

6.

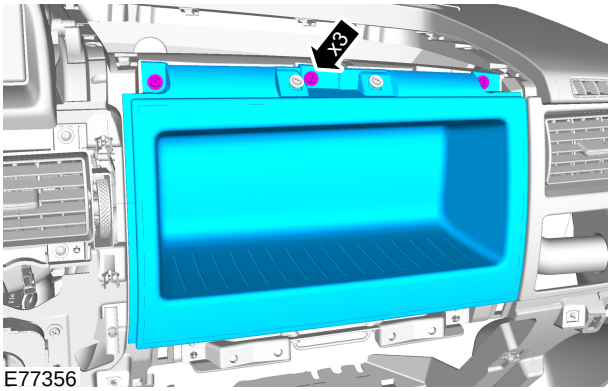


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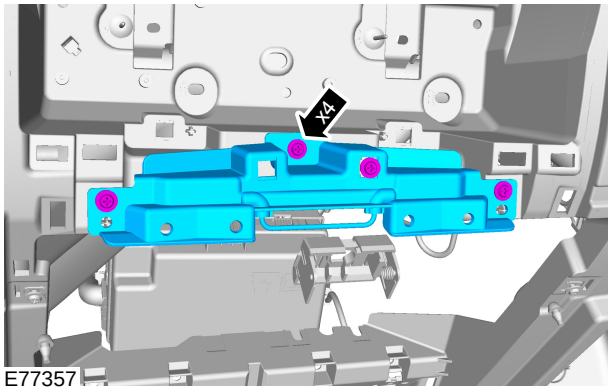


All vehicles

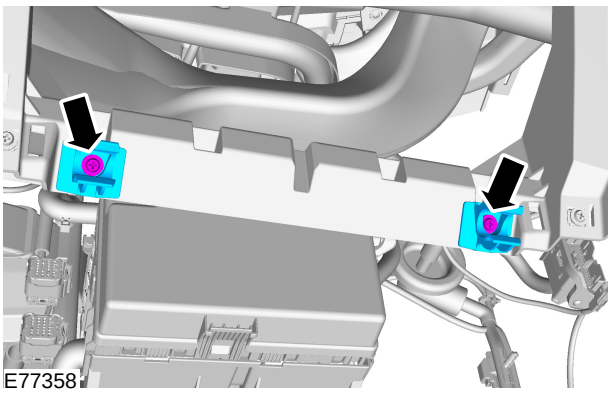
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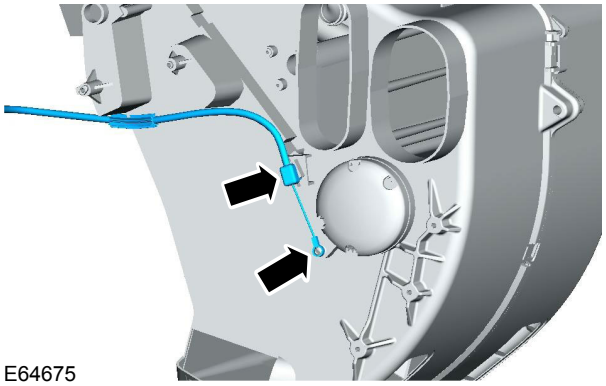


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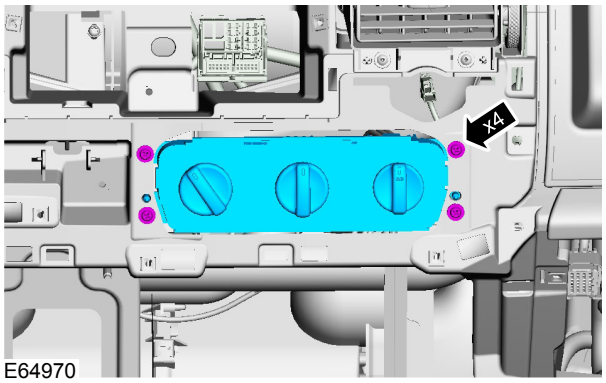


DISASSEMBLY AND ASSEMBLY

11.

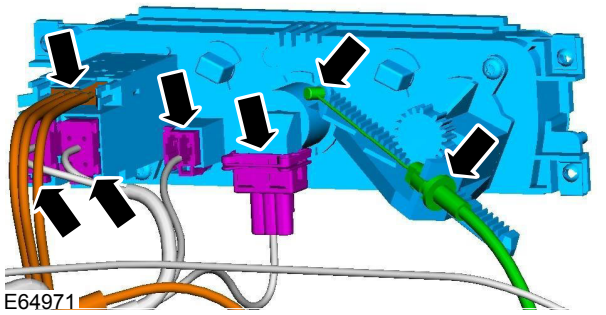


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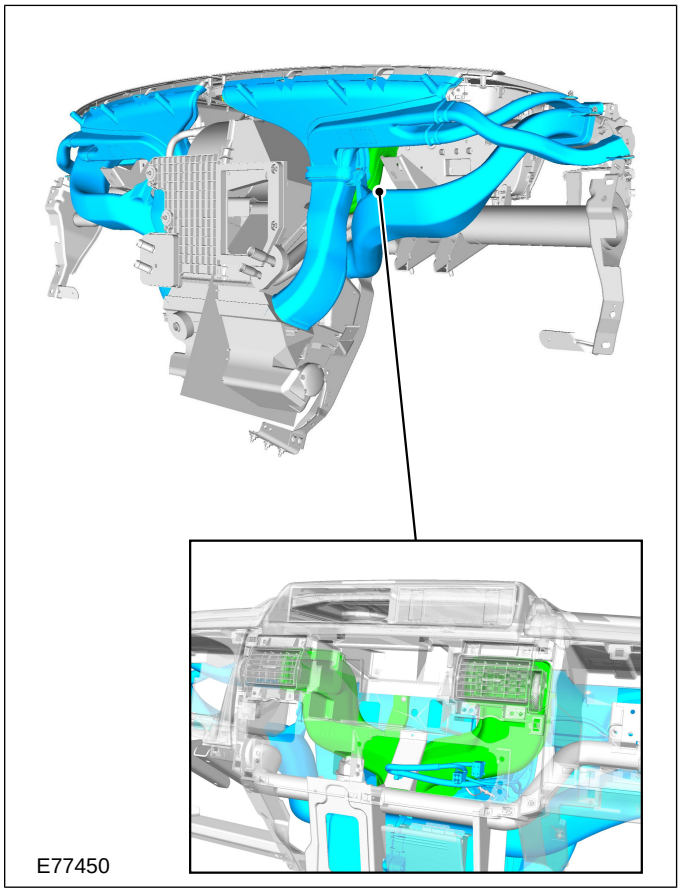


Vehicles with air conditioning

13.

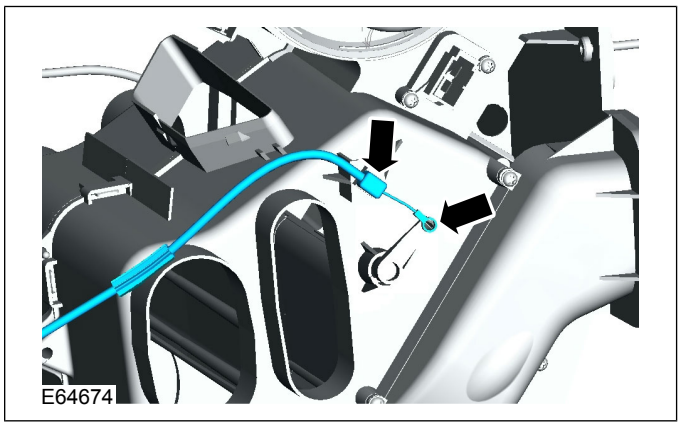


14.



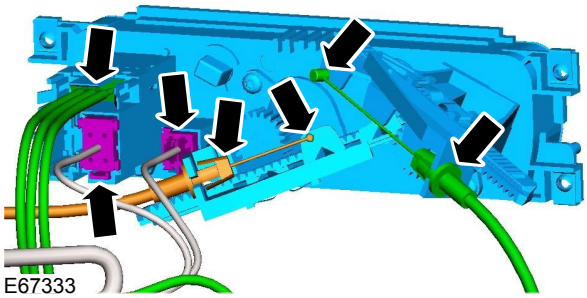
Vehicles without air conditioning

15.

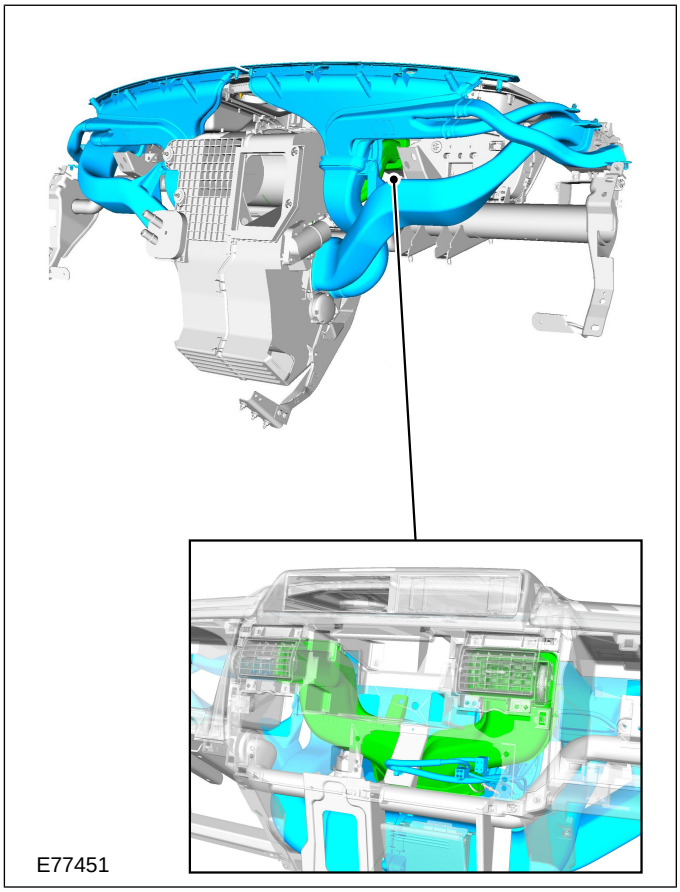


DISASSEMBLY AND ASSEMBLY

16.

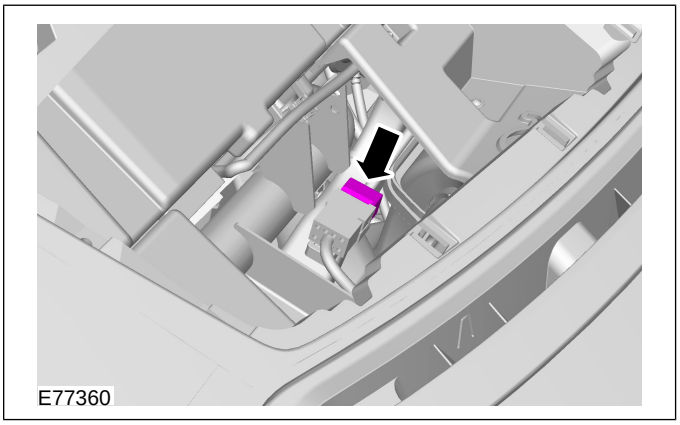


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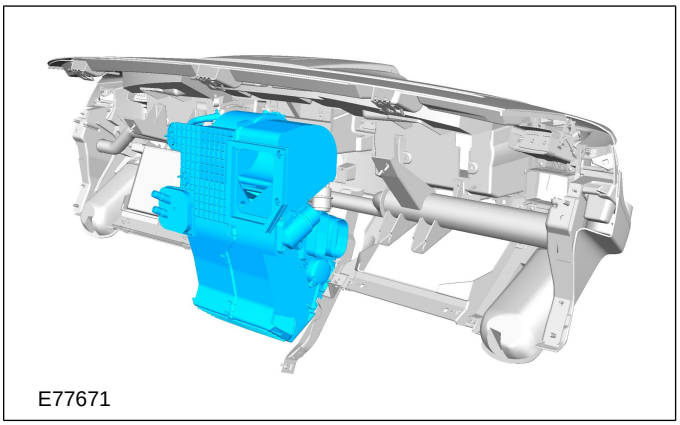


All vehicles

18.



19.

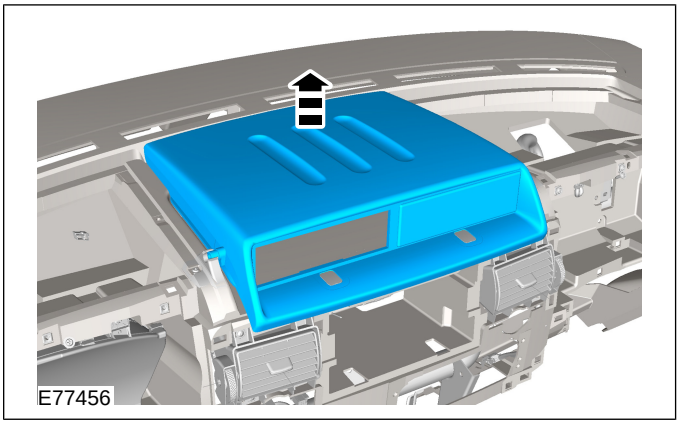


Vehicles with tachograph

20. Remove the tachograph.

Refer to:Tachograph (413-17 Tachograph, Removal and Installation).

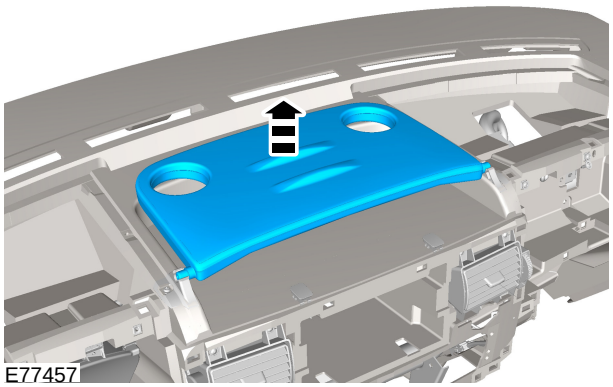
21.



DISASSEMBLY AND ASSEMBLY

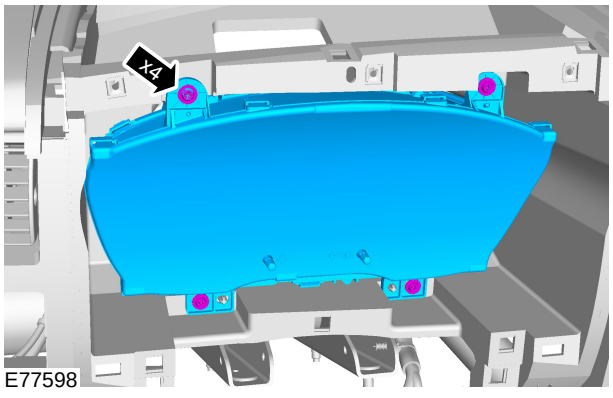
Vehicles without tachograph

22.

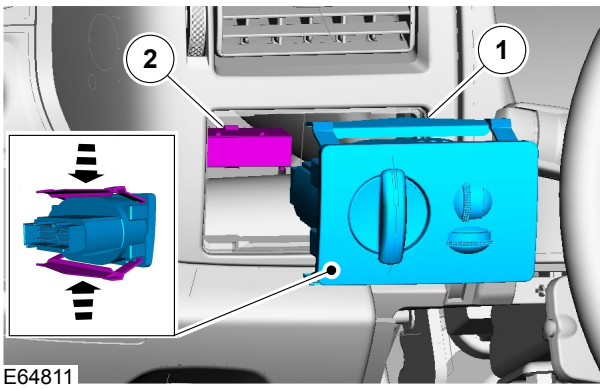


All vehicles

23.

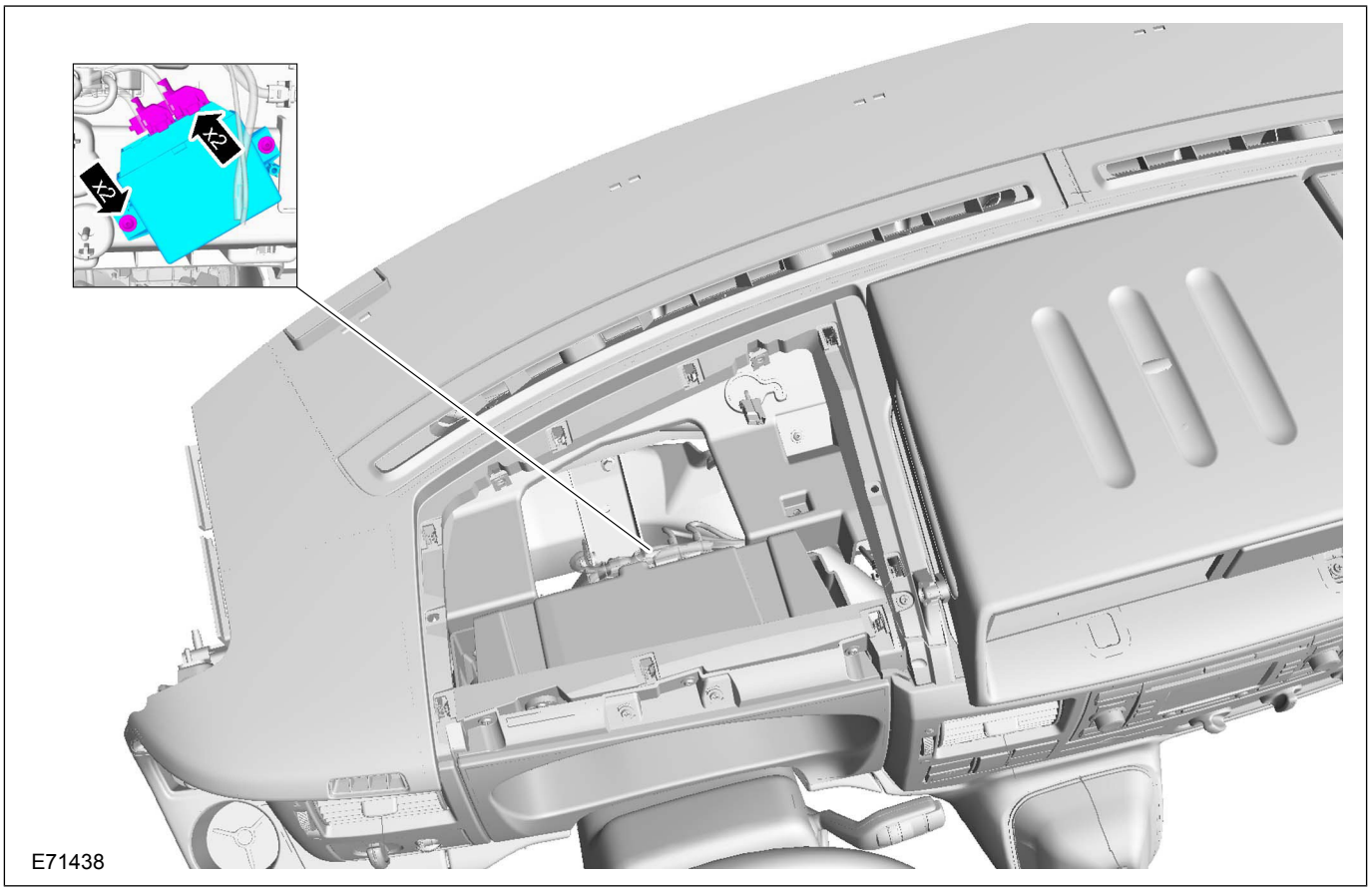


24. • Unclip the headlamp light switch through the cutout in the footwell trim.

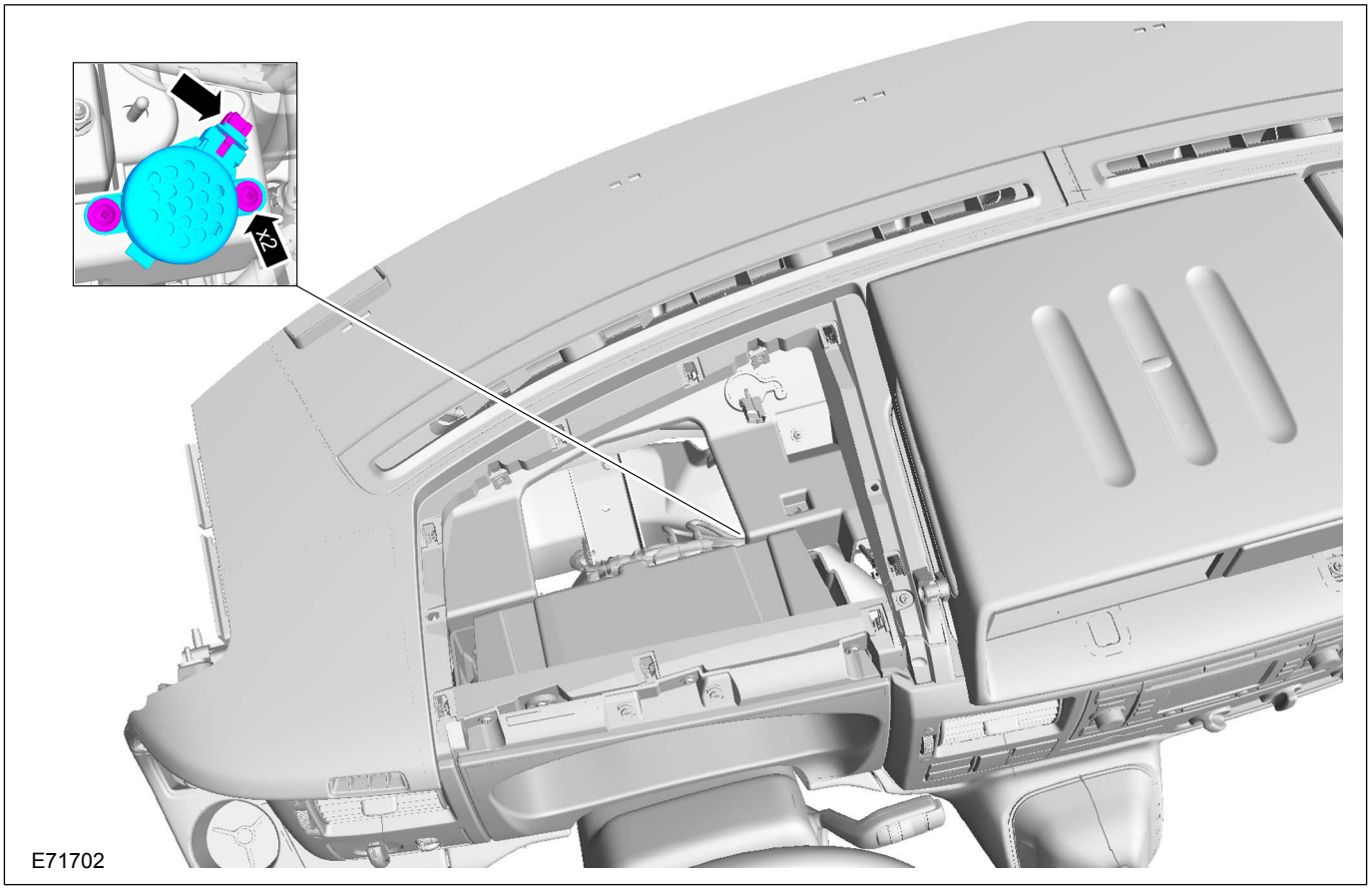


25.

DISASSEMBLY AND ASSEMBLY

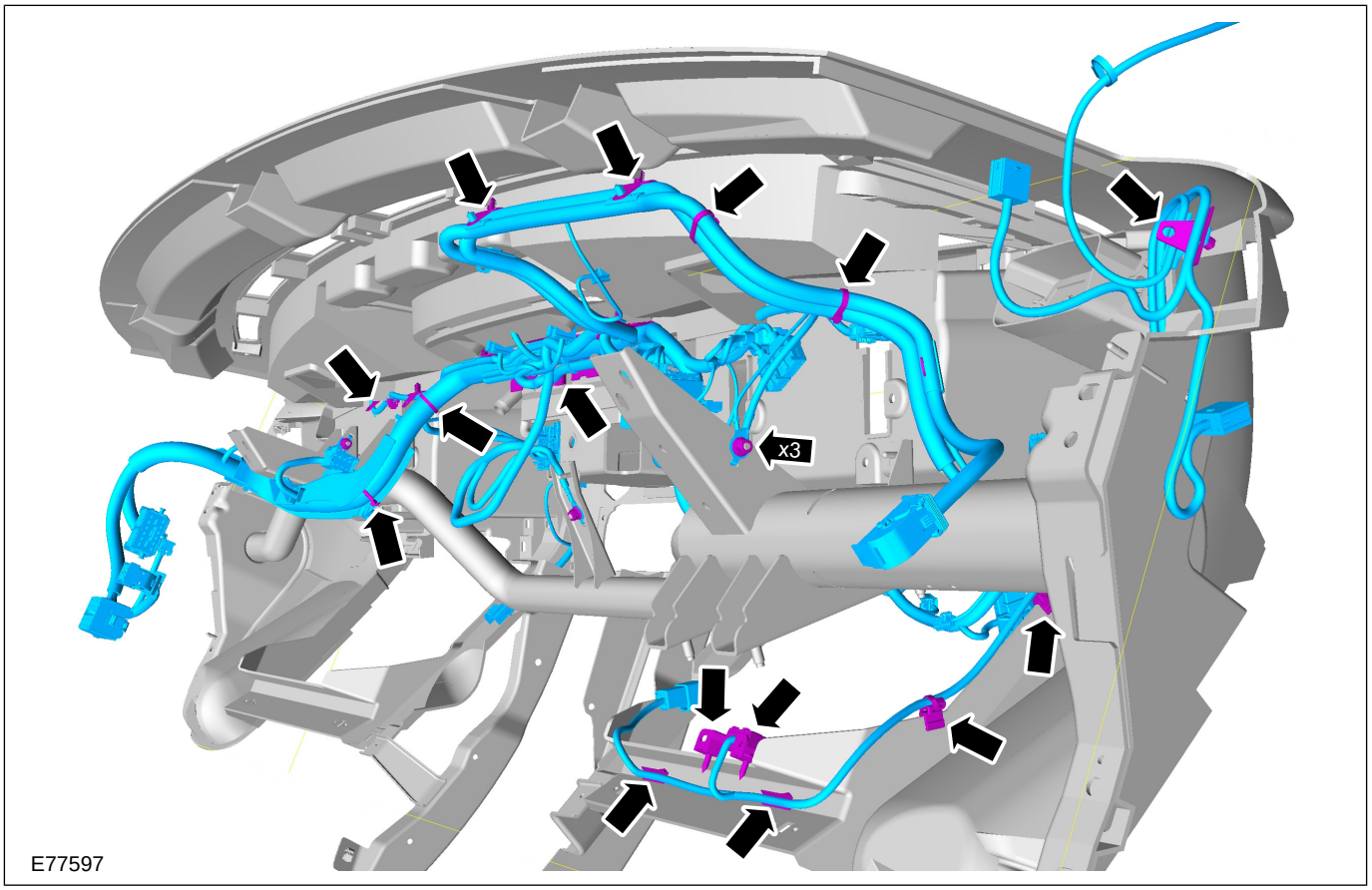


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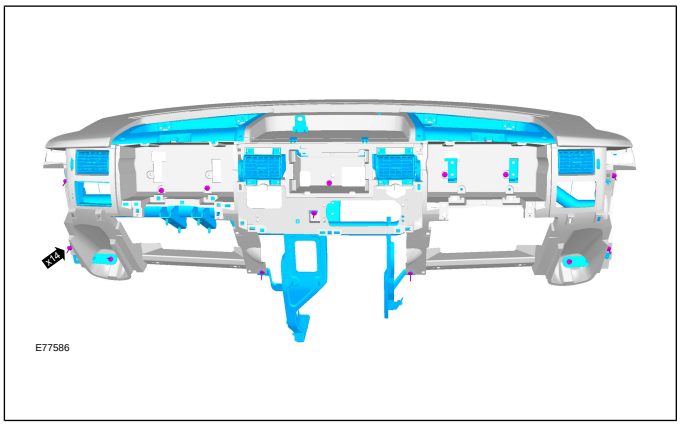


DISASSEMBLY AND ASSEMBLY

27.



28.



Assembly

29. For assembly, reverse the disassembly procedure.

SECTION 501-14 Handles, Locks, Latches and Entry Systems

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 501-14-2

DESCRIPTION AND OPERATION

Handles, Locks, Latches and Entry Systems 501-14-3

DIAGNOSIS AND TESTING

Locks, Latches and Entry Systems 501-14-5
Inspection and Verification 501-14-5

GENERAL PROCEDURES

Remote Keyless Entry Transmitter Programming 501-14-6

REMOVAL AND INSTALLATION

Front Door Latch ..... (41 351 0) 501-14-7
Sliding Door Latch 501-14-9
Liftgate Latch ..... (41 666 0) 501-14-11
Rear Door Latch — Van/Kombi/Bus ..... (41 352 0) 501-14-12
Rear Door Latch — Chassis Double Cab ..... (41 352 0) 501-14-14
Rear Door Lower Latch 501-14-16
Rear Door Upper Latch 501-14-17
Exterior Front Door Handle 501-14-18
Exterior Sliding Door Handle 501-14-19
Exterior Rear Door Handle LH — Van/Kombi/Bus 501-14-20
Exterior Rear Door Handle RH — Van/Kombi/Bus 501-14-21
Exterior Rear Door Handle — Chassis Double Cab 501-14-22
Liftgate Release Handle 501-14-23
Front Door Lock Cylinder 501-14-25
Sliding Door Lock Cylinder 501-14-27
Rear Door Lock Cylinder — Van/Kombi/Bus 501-14-29
Rear Door Lock Cylinder — Chassis Double Cab 501-14-31
Liftgate Lock Cylinder ..... (41 664 0) 501-14-33
Front Door Latch Remote Control 501-14-35
Rear Door Latch Remote Control — Chassis Double Cab 501-14-36
Sliding Door Latch Remote Control 501-14-37
Hood Latch 501-14-39
Hood Lock Cylinder 501-14-40
Ignition Lock Cylinder 501-14-41

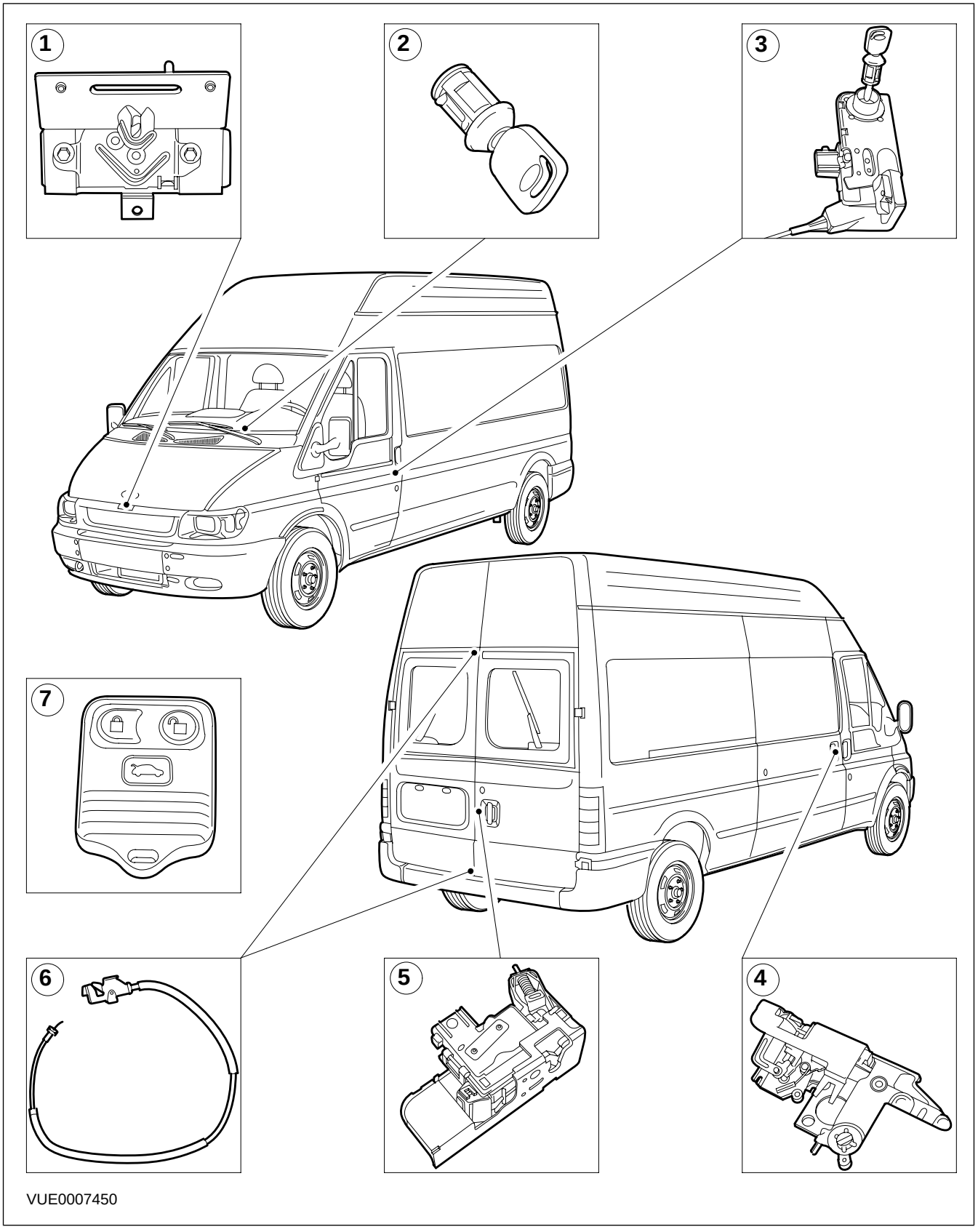
SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Front door latch retaining screws	12	9	–
Front door glass top run outer retaining bracket bolts	10	–	89
Sliding door latch retaining bolts	12	9	–
Hood lock cylinder retaining nut	12	9	–
Hood latch bracket retaining bolts	10	–	89
Hood latch retaining bolts	10	–	89
Radiator support bracket lower bolt	10	–	89
Radiator support bracket upper bolt	10	–	89
Sliding door latch remote control handle retaining screws	12	9	–
Rear door latch retaining screws	12	9	–
Exterior front door handle retaining nut	10	–	89
Exterior sliding door handle retaining nut	10	–	89
Rear door upper latch retaining screws	12	9	–
Rear door lower latch retaining screws	12	9	–
Exterior liftgate handle retaining screws	12	9	–
Liftgate latch retaining screws	12	9	–
Exterior rear door handle retaining nut (Chassis Double Cab)	5	–	44

DESCRIPTION AND OPERATION

Handles, Locks, Latches and Entry Systems



DESCRIPTION AND OPERATION

Item	Part Number	Description
1		Hood latch
2		Ignition lock cylinder
3		Front door latch and cylinder
4		Side door latch
5		Rear door latch
6		Rear door upper and lower latch
7		Remote transmitter

The passenger compartment doors are of a conventional lock to striker plate design with the strikers located on the B pillars.

The hood, load space and sliding side door striker plates locate into latches positioned on the vehicle body.

The hood can only be opened by using the ignition key in the hood lock cylinder. To open the hood:

1. Turn the key fully to the left, this releases the hood onto the safety catch.
2. Turn the key fully to the right, this allows the hood to open.
3. Turn the key back to the central position and remove the key.

NOTE: The ignition key must be removed after opening the hood to avoid accidental breaking the key by knocking against it while working in the engine compartment.

The door latch mechanisms are operated by a conventional actuating rod and cable system connected to the inner and outer latch handles.

On higher specification models a power lock system is integrated into the original locking system, this system consists of power door lock switches, power door lock actuators, circuit wiring and protection.

On models with a power lock system only one lock barrel is fitted, this is located on the driver door. All remaining doors are fitted with blanking plugs and unlock simultaneously with the driver door.

In addition to power locking, higher specification models also have the option of a keyless entry remote locking system. For additional information, refer to Section 419-10 [Multifunction Electronic Modules].

The sliding side door can be a combination of left or right hand side with either twin opening rear doors or a tailgate.

The door handle and latch are removed from the inside of the door panel. The handle and latch cannot be removed separately, they must be removed as a complete unit and then separated.

DIAGNOSIS AND TESTING

Locks, Latches and Entry Systems

Refer to Wiring Diagrams Cell 501–14, Handles, Locks, Latches and Entry Systems for schematic and connector information.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Mechanical	Electrical
– Misaligned door(s) – Misaligned hood – Door latch(es) – Actuating rod(s) – Exterior door handle(s) – Door latch remote control(s) – Door lock cylinder(s) – Cable(s)	– Fuse(s) – Wiring harness – Electrical connector(s) – Door latch actuator(s) – Vehicle battery – Remote transmitter batteries – Remote transmitter – Door lock switch(es) – Anti–theft alarm and double locking module

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to WDS to diagnose the system.

GENERAL PROCEDURES

Remote Keyless Entry Transmitter Programming

1. Refer to:Key and Remote Transmitter Programming Using Diagnostic Equipment (419-01 Anti-Theft - Passive, General Procedures).

REMOVAL AND INSTALLATION

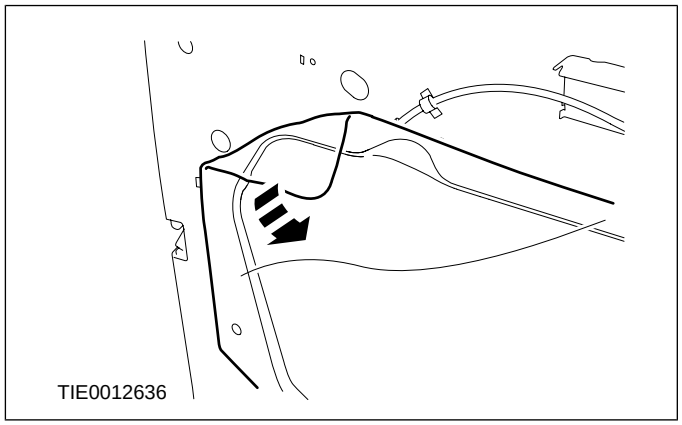
Front Door Latch (41 351 0)

Removal

All vehicles

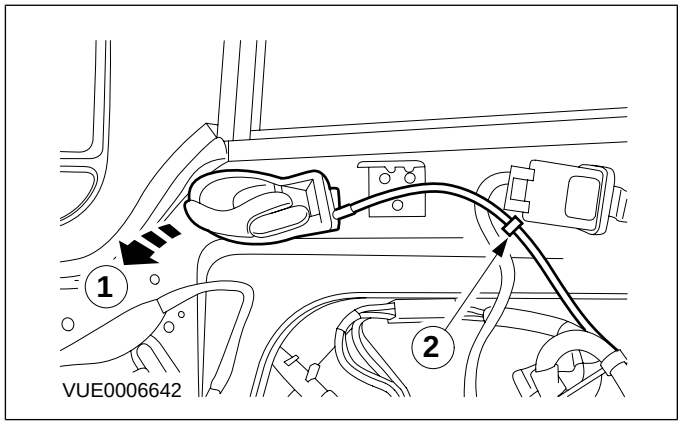
1. **Remove the front door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

   Detach the watershield from the front door panel.



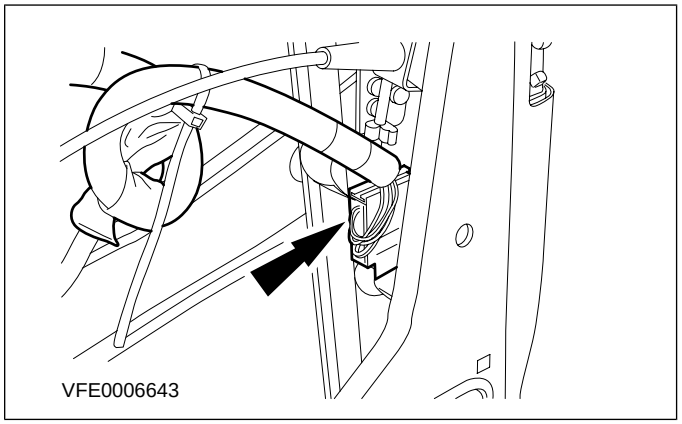
3. **Remove the front door lock cylinder (if equipped).**

   For additional information, refer toFront Door Lock Cylinderin this section.
4. **Detach the front door latch remote control handle.**
   1. Unclip the door latch remote control handle.
   2. Remove the cable tie.



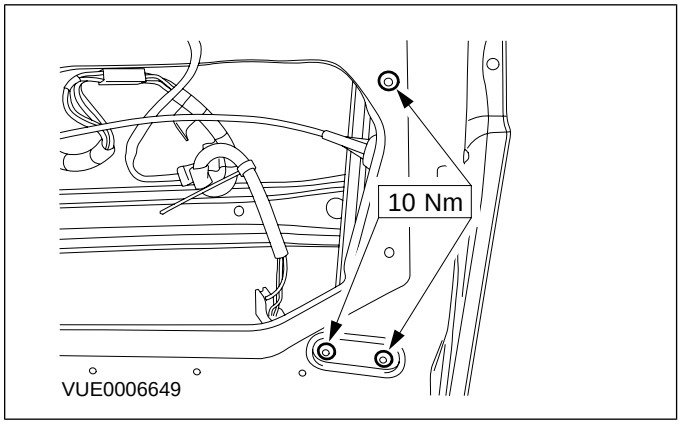
Vehicles with central locking

5. **Disconnect the front door lock actuator electrical connector.**

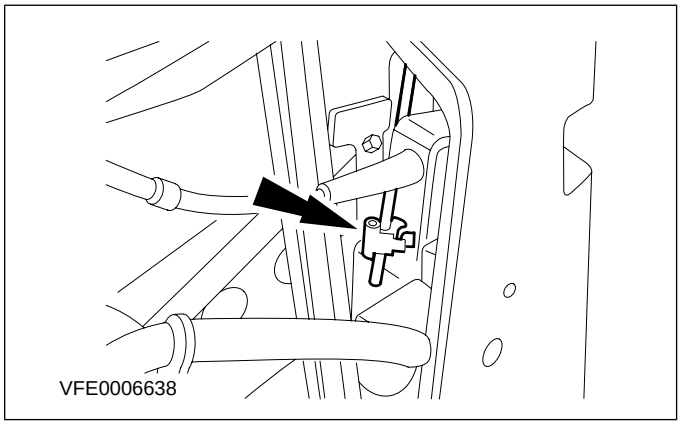


All vehicles

6. **Remove the front door glass top run outer retainer bracket.**

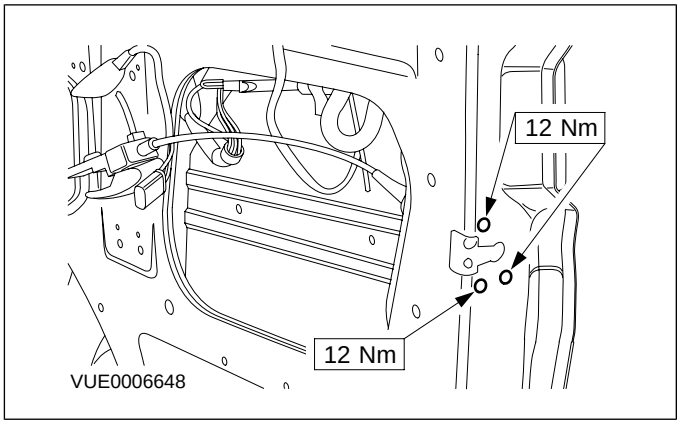


7. **Disconnect the exterior front door handle actuating rod.**
   - Open the clip and pull out the actuating rod.



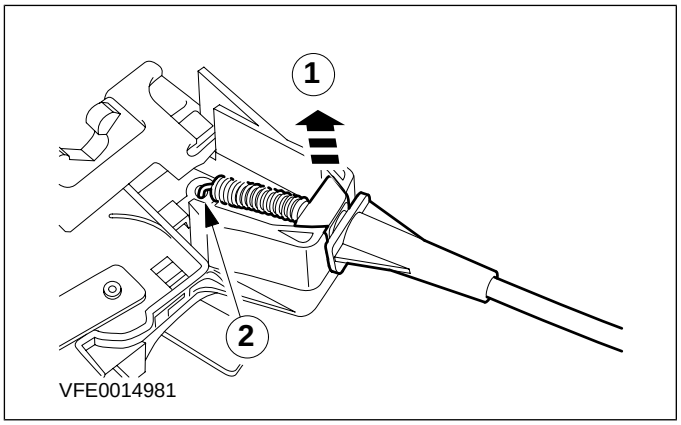
REMOVAL AND INSTALLATION

8. Remove the front door latch and remote control assembly.



9. Disconnect the front door remote control cable.

1. Detach the outer cable.
2. Disconnect the inner cable.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

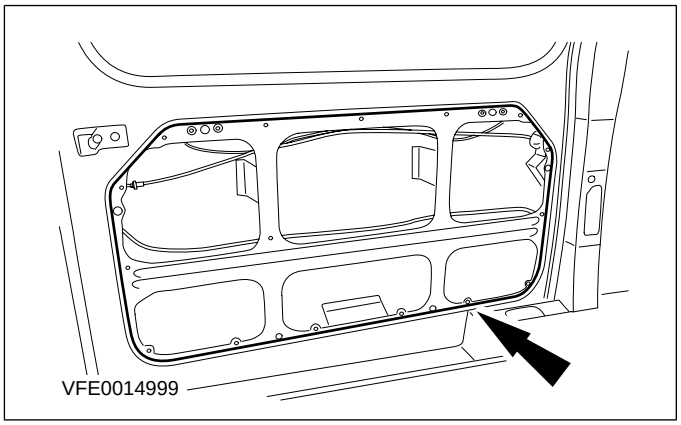
Sliding Door Latch

Removal

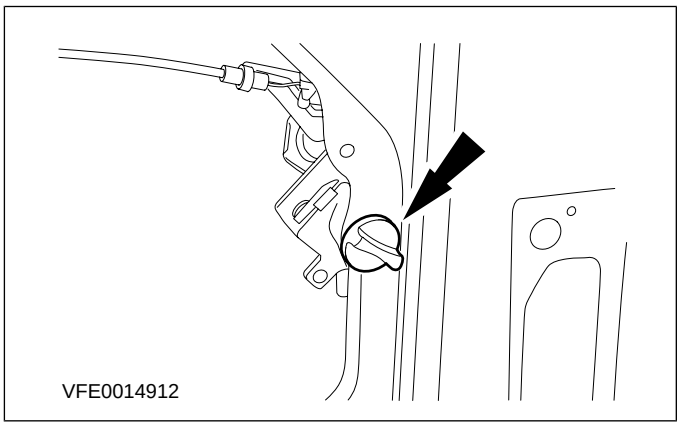
All vehicles

1. **Remove the sliding door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

   Detach the watershield from the sliding door panel.

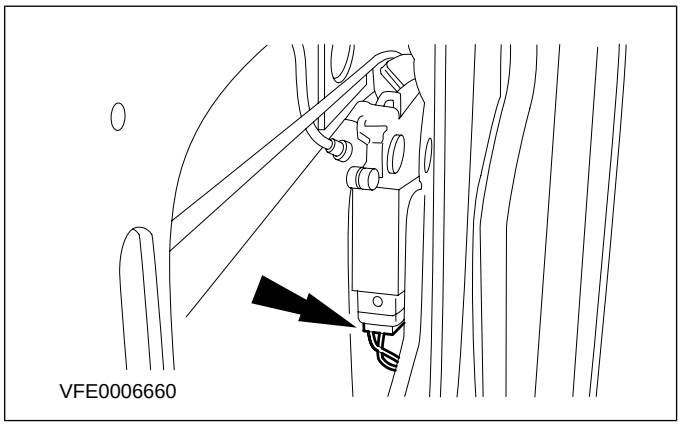


3. **Remove the sliding door lock knob.**



Vehicles with central locking

4. **Disconnect the sliding door lock actuator electrical connector.**



Vehicles without central locking

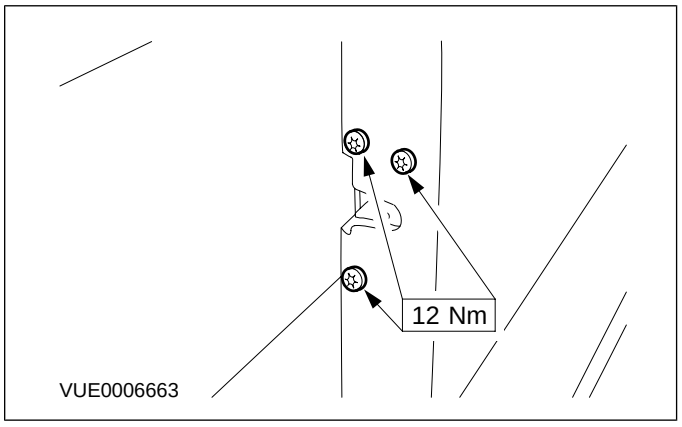
5. **Remove the sliding door lock cylinder.**

   For additional information, refer toSliding Door Lock Cylinderin this section.

All vehicles

6. **NOTE:Make sure the sliding door latch is in the locked position.**

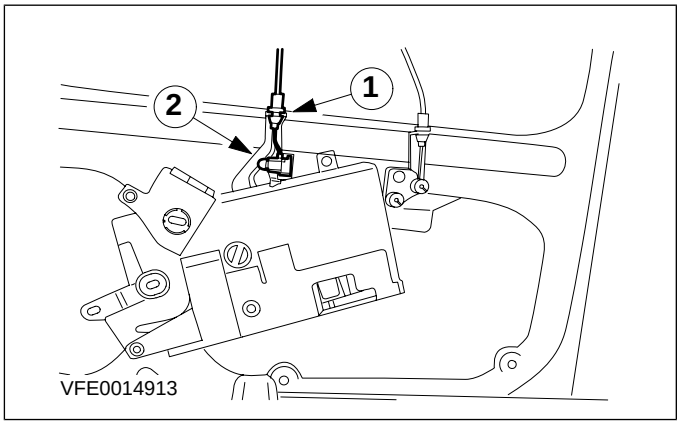
   Remove the sliding door latch retaining bolts.



7. **Disconnect the exterior sliding door handle actuating cable.**
   1. Detach the outer cable.

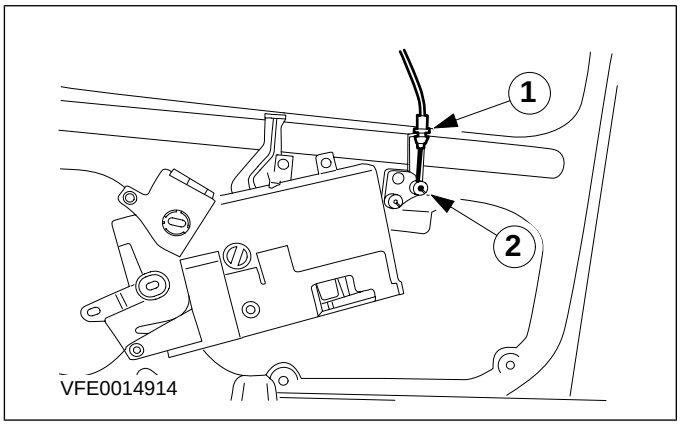
REMOVAL AND INSTALLATION

2. Disconnect the inner cable.

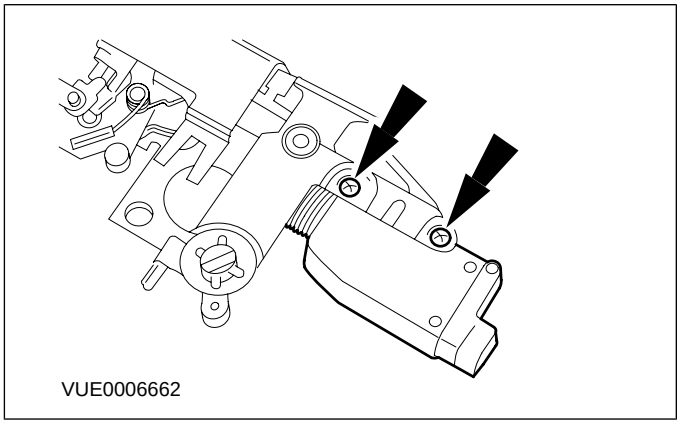


8. Disconnect the sliding door latch remote control cable.

1. Detach the outer cable.
2. Disconnect the inner cable.



9. Remove the sliding door lock actuator.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

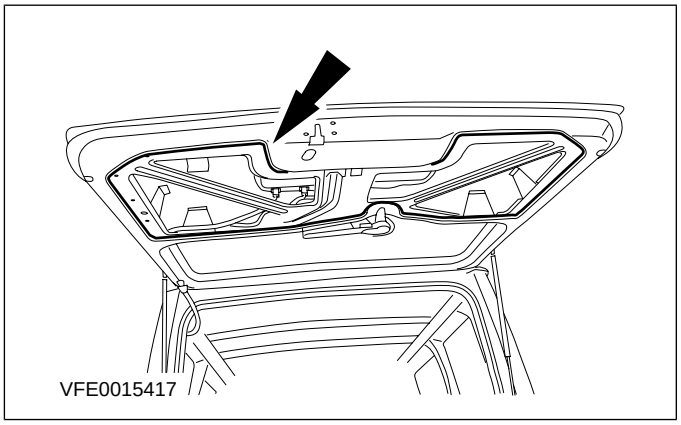
Liftgate Latch (41 666 0)

Removal

All vehicles

1. **Remove the liftgate trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

   Detach the watershield from the liftgate panel.



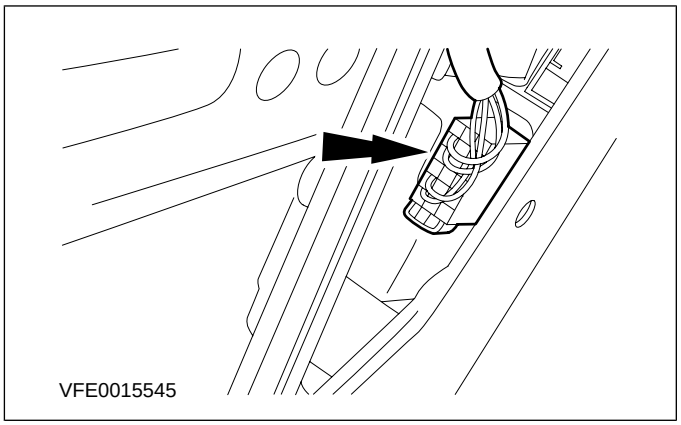
Vehicles without central locking

3. **Remove the liftgate lock cylinder.**

   For additional information, refer toLiftgate Lock Cylinderin this section.

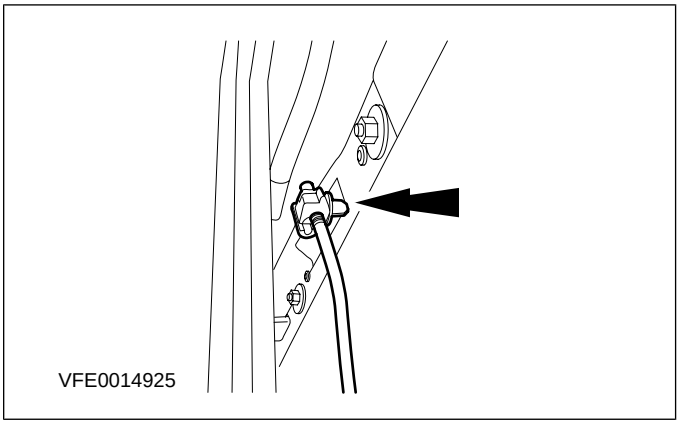
Vehicles with central locking

4. **Disconnect the liftgate lock actuator electrical connector.**

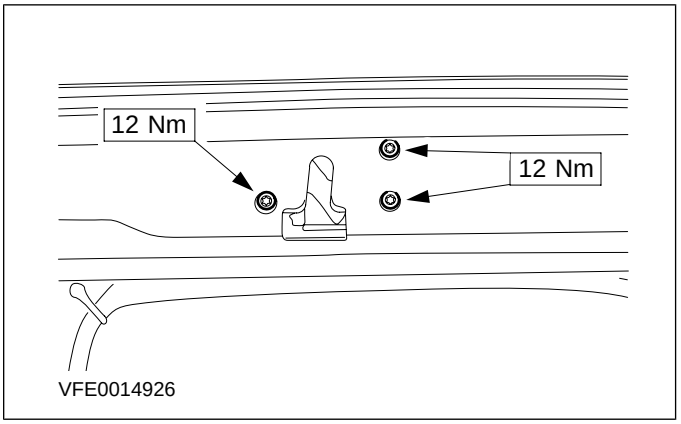


All vehicles

5. **Disconnect the exterior liftgate handle actuating rod.**
   - Open the clip and pull out the actuating rod.



6. **Remove the liftgate latch.**



Installation

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

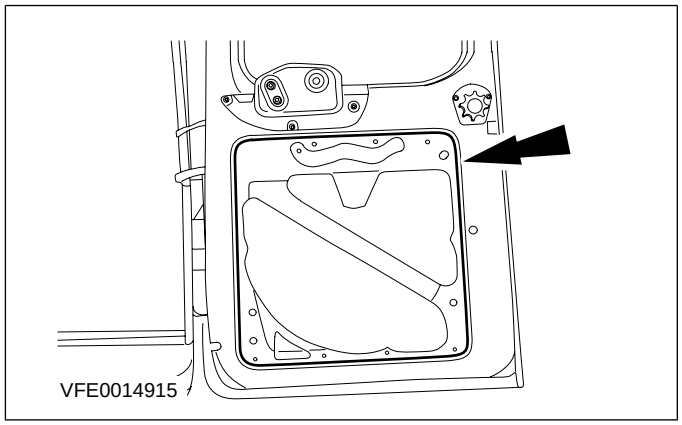
Rear Door Latch — Van/Kombi/Bus (41 352 0)

Removal

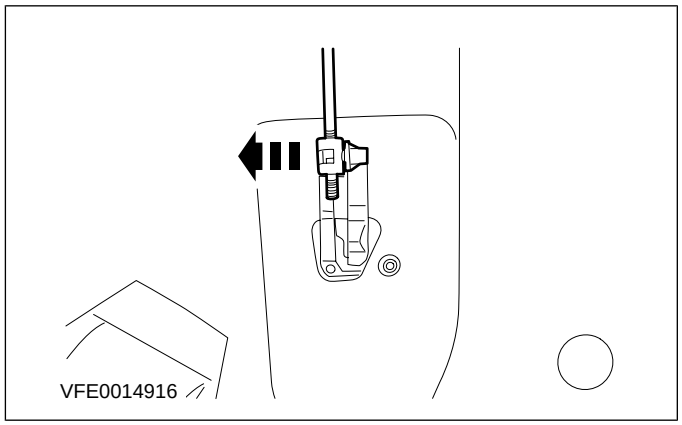
All vehicles

1. **Remove the rear door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

   Detach the watershield from the rear door panel.



3. **Detach the exterior rear door handle actuating rod.**



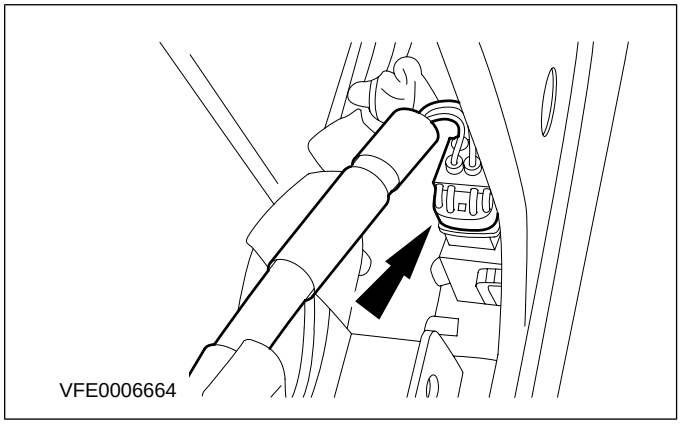
Vehicles without central locking

4. **Remove the rear door lock cylinder.**

   For additional information, refer toRear Door Lock Cylinderin this section.

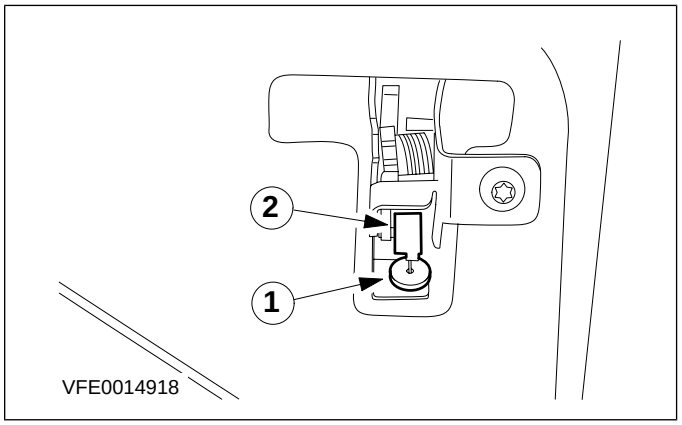
Vehicles with central locking

5. **Disconnect the rear door lock actuator electrical connnector.**



Vehicles with high roof

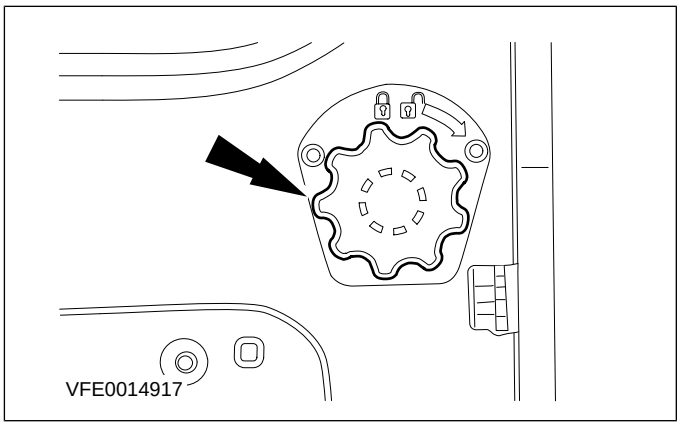
6. **Detach the rear door upper latch cable.**
   1. Detach the outer cable from the bracket.
   2. Detach the inner cable from the lock lever.



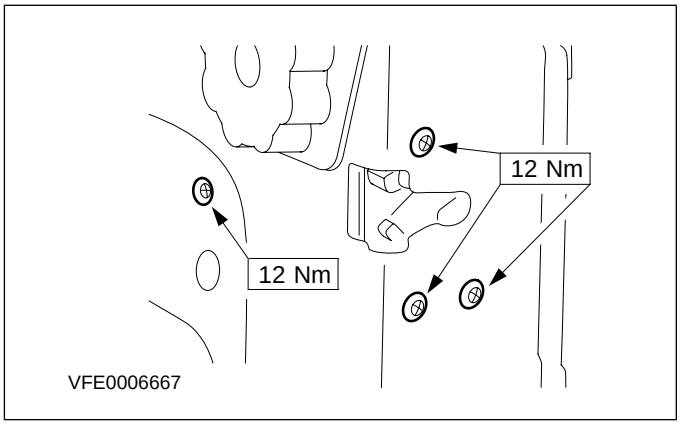
REMOVAL AND INSTALLATION

All vehicles

7. Remove the rear door lock knob (if equipped).



8. Remove the rear door latch.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

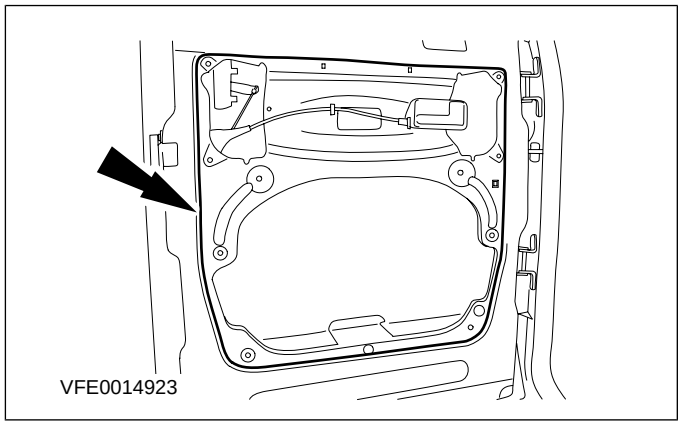
Rear Door Latch — Chassis Double Cab (41 352 0)

Removal

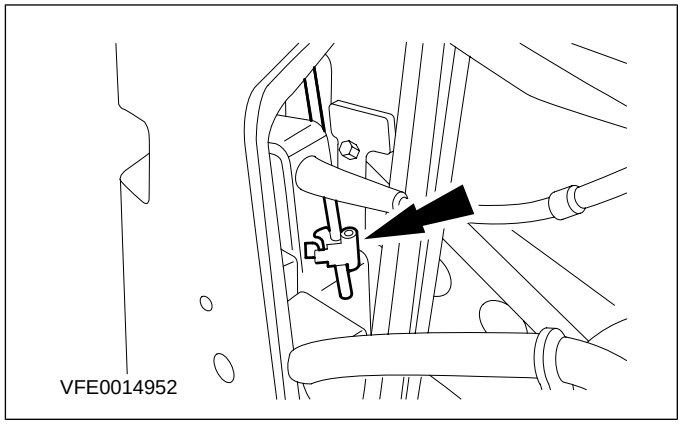
All vehicles

1. **Remove the rear door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

   Detach the watershield from the rear door panel.



3. **Disconnect the exterior rear door handle actuating rod.**
   - Open the clip and pull out the actuating rod.



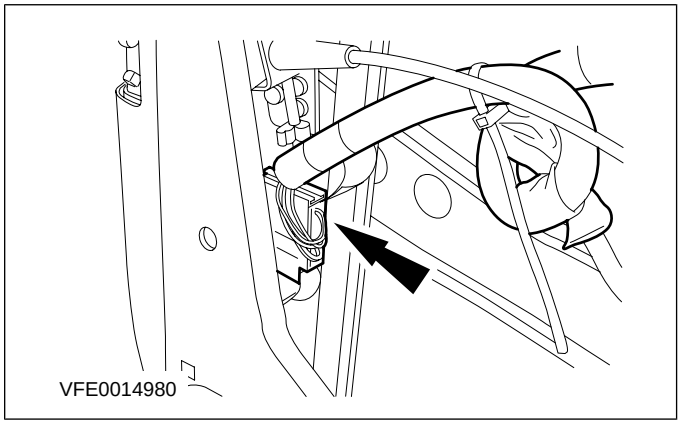
Vehicles without central locking

4. **Remove the rear door lock cylinder.**

   For additional information, refer toRear Door Lock Cylinderin this section.

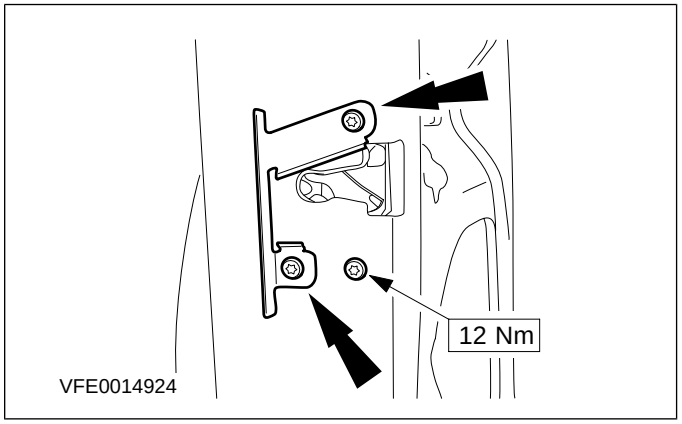
Vehicles with central locking

5. **Disconnect the rear door lock actuator electrical connector.**

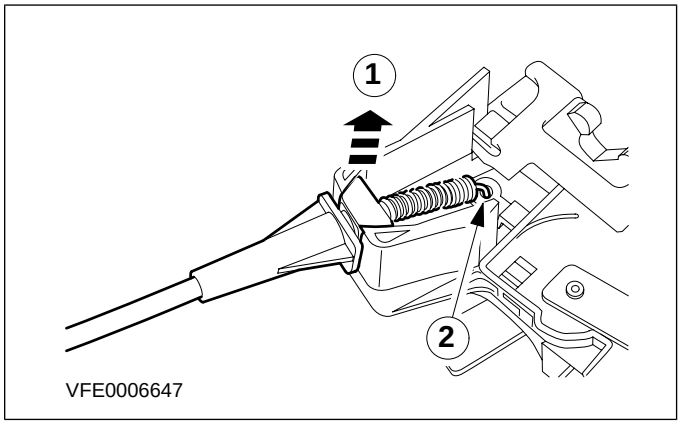


All vehicles

6. **Remove the rear door latch and remote control assembly.**



7. **Disconnect the rear door remote control cable.**
   1. Detach the outer cable.
   2. Disconnect the inner cable.



REMOVAL AND INSTALLATION

Installation

1. To install, reverse the removal procedure.

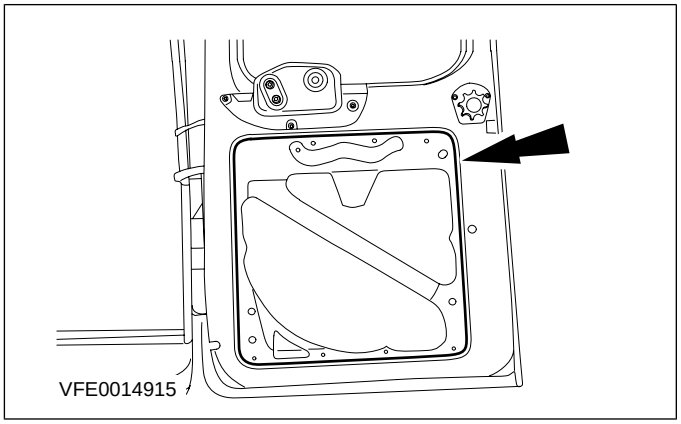
REMOVAL AND INSTALLATION

Rear Door Lower Latch

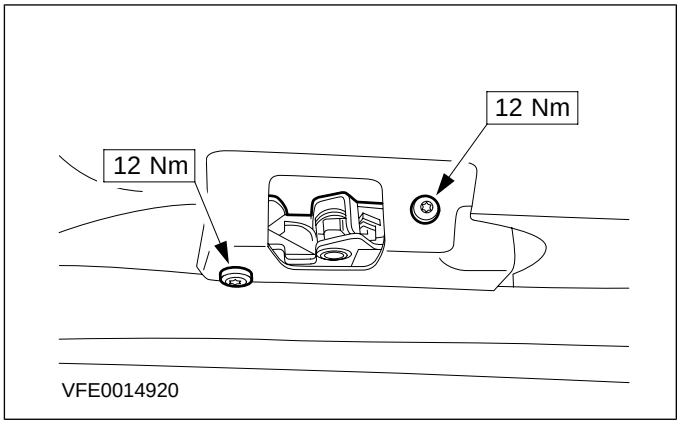
Removal

1. **Remove the rear door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

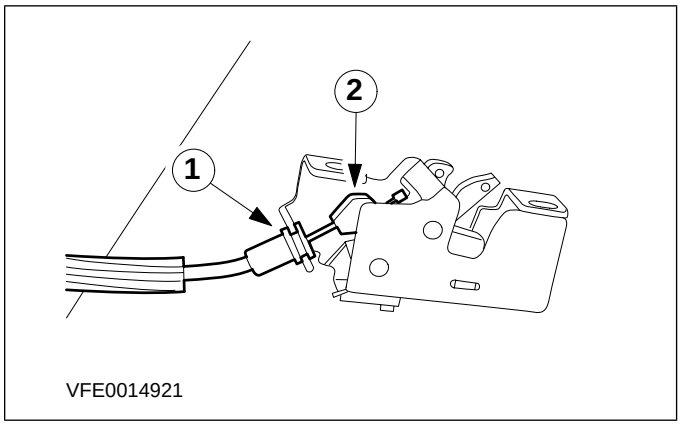
   Detach the watershield from the rear door panel.



3. **Detach the rear door lower latch from the rear door panel.**



4. **Detach the cable and remove the rear door lower latch.**
   1. Detach the outer cable from the bracket.
   2. Disconnect the inner cable from the lock lever.



Installation

1. **To install, reverse the removal procedure.**

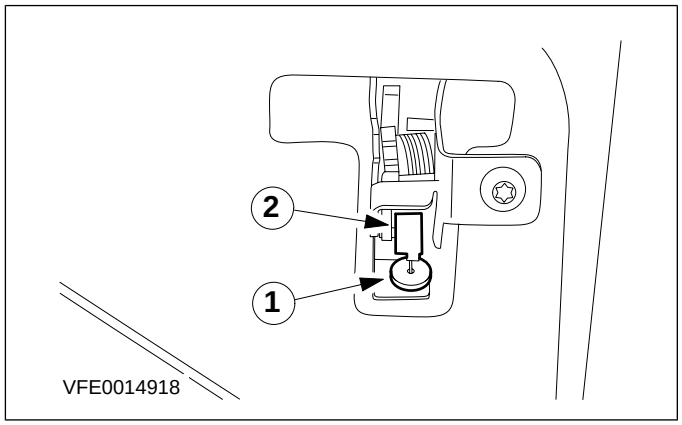
REMOVAL AND INSTALLATION

Rear Door Upper Latch

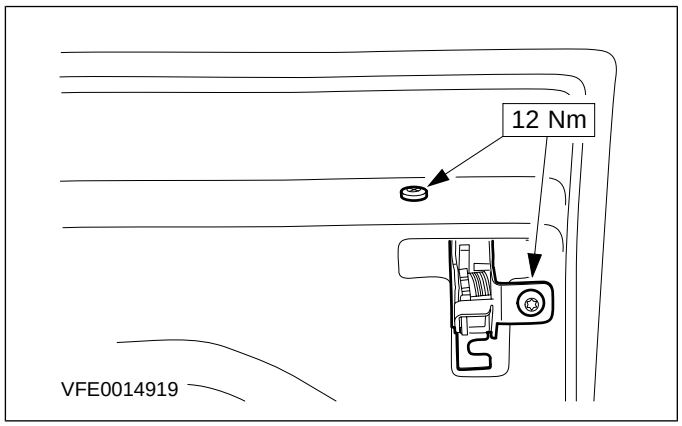
Removal

1. Detach the rear door upper latch cable.

1. Detach the outer cable from the bracket.
2. Disconnect the inner cable from the lock lever.



2. Remove the rear door upper latch.



Installation

1. To install, reverse the removal procedure.

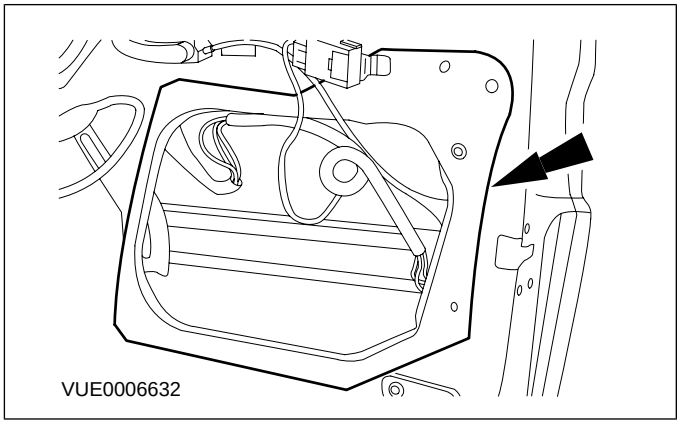
REMOVAL AND INSTALLATION

Exterior Front Door Handle

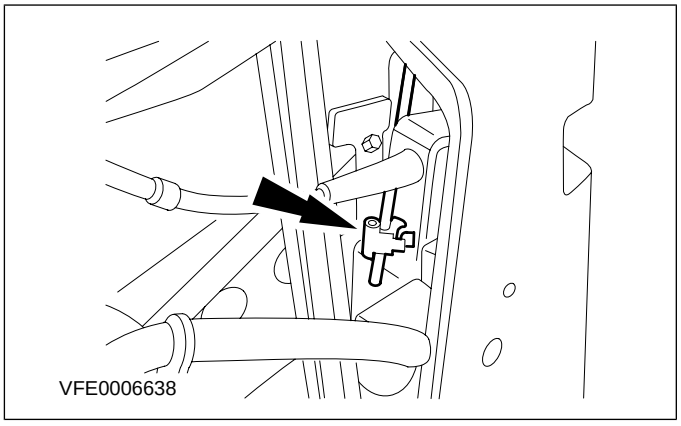
Removal

1. **Remove the front door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

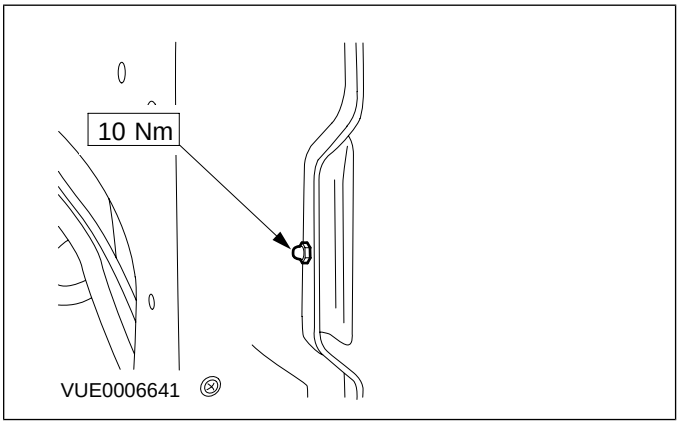
   Detach the watershield from the front door panel.



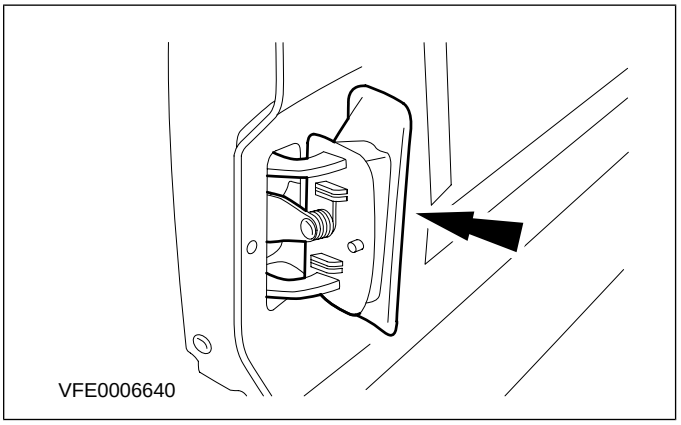
3. **Disconnect the exterior front door handle actuating rod.**
   - Open the clip and pull out the actuating rod.



4. **Remove the exterior front door handle retaining nut.**



5. **Remove the exterior front door handle.**



Installation

1. **To install, reverse the removal procedure.**

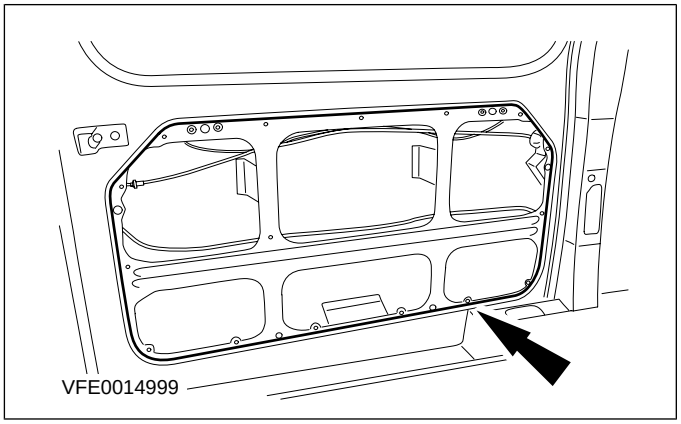
REMOVAL AND INSTALLATION

Exterior Sliding Door Handle

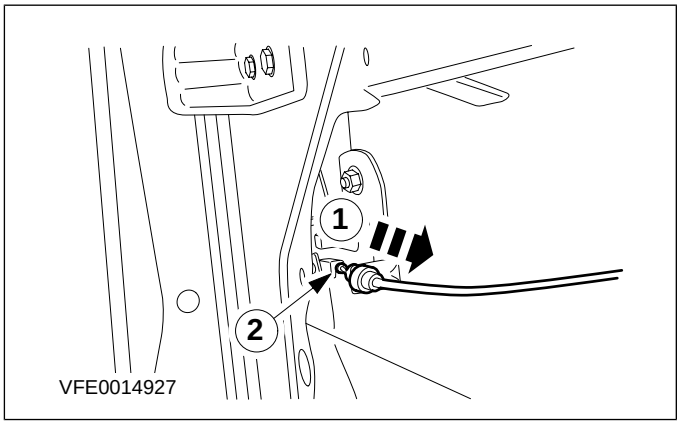
Removal

1. **Remove the sliding door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

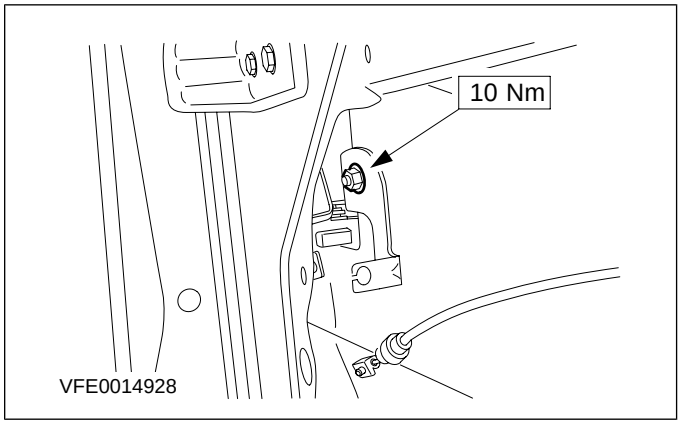
   Detach the watershield from the sliding door panel.



3. **Detach the exterior sliding door handle cable.**
   1. Detach the outer cable from the handle.
   2. Disconnect the inner cable from the lock lever.



4. **Remove the exterior sliding door handle.**



Installation

1. **To install, reverse the removal procedure.**

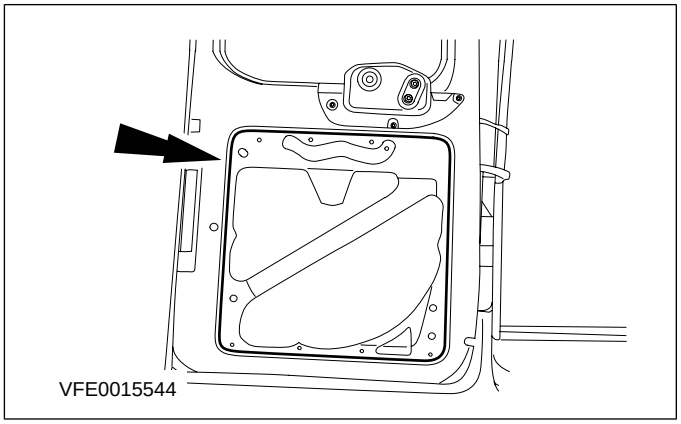
REMOVAL AND INSTALLATION

Exterior Rear Door Handle LH — Van/Kombi/Bus

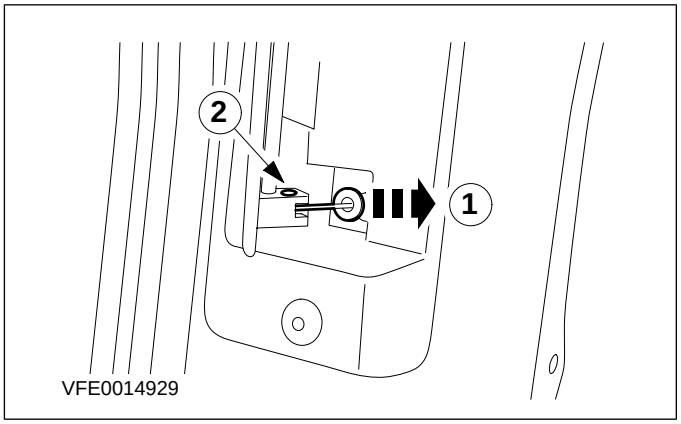
Removal

1. **Remove the rear door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired**

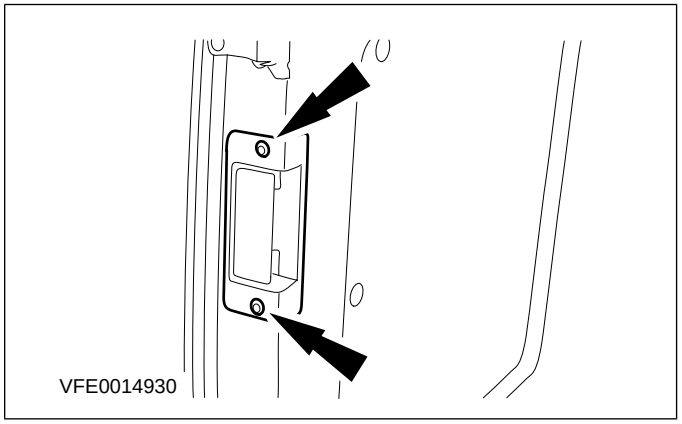
   Detach the watershield from the rear door panel.



3. **Detach the exterior rear door handle cable.**
   1. Detach the outer cable from the handle.
   2. Disconnect the inner cable from the handle.



4. **Remove the exterior rear door handle.**
   - Remove the rivets.



Installation

1. **To install, reverse the removal procedure.**

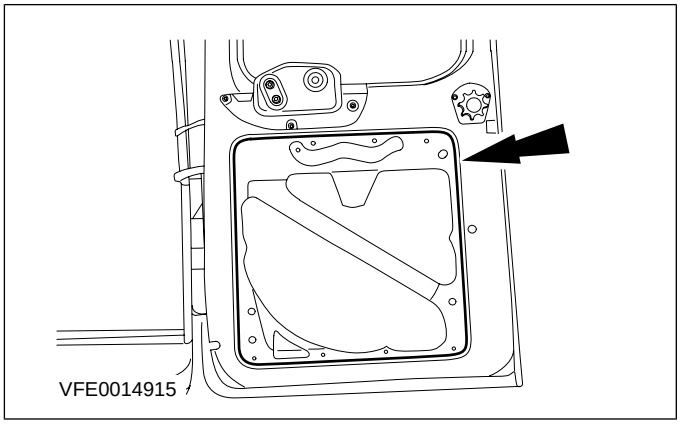
REMOVAL AND INSTALLATION

Exterior Rear Door Handle RH — Van/Kombi/Bus

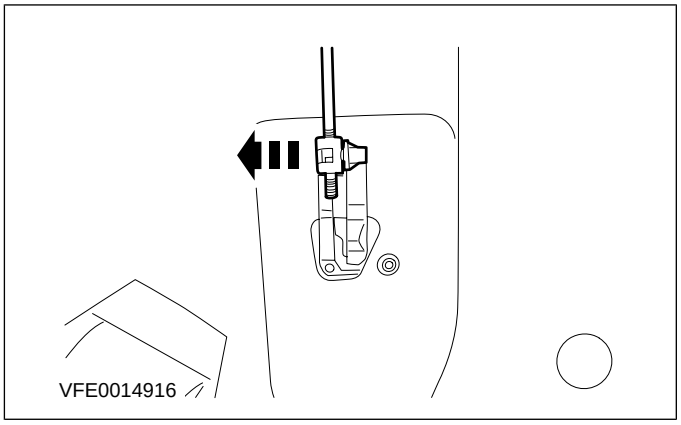
Removal

1. **Remove the rear door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

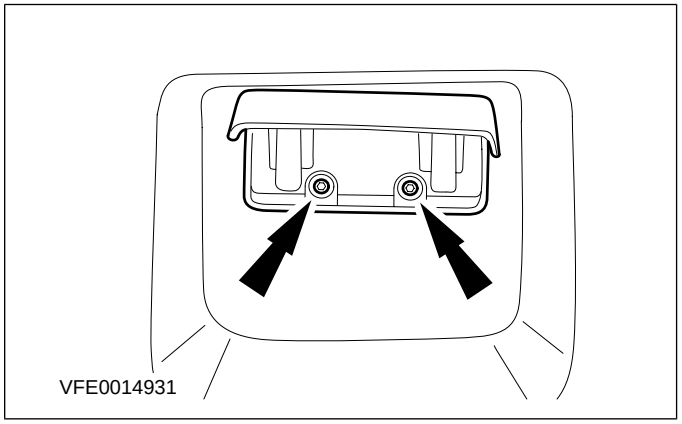
   Detach the watershield from the rear door panel.



3. **Detach the exterior rear door handle actuating rod.**



4. **Remove the exterior rear door handle.**
   - Remove the rivets.



Installation

1. **To install, reverse the removal procedure.**

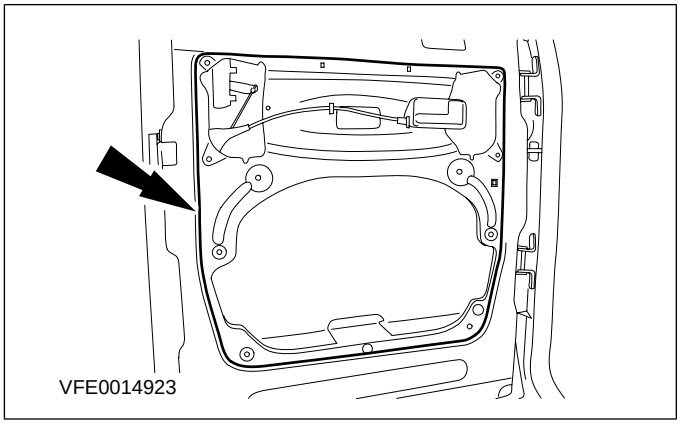
REMOVAL AND INSTALLATION

Exterior Rear Door Handle — Chassis Double Cab

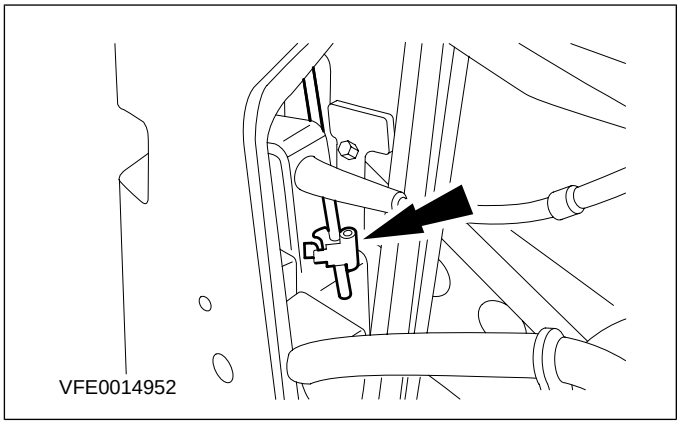
Removal

1. **Remove the rear door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

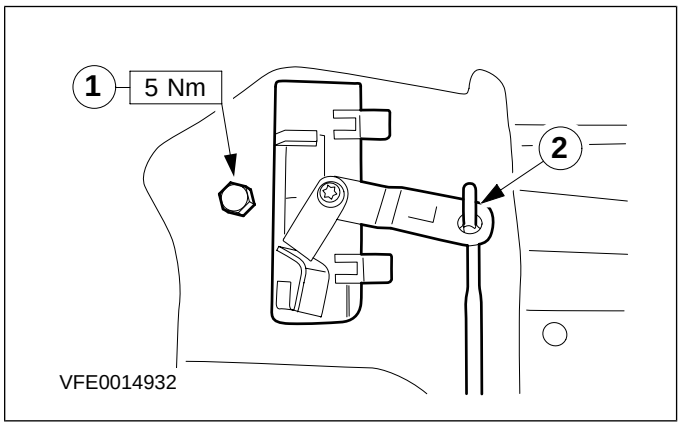
   Detach the watershield from the rear door panel.



3. **Detach the exterior rear door handle actuating rod from the latch.**
   - Open the clip and pull out the actuating rod.



4. **Remove the exterior rear door handle.**
   1. Remove the retaining nut.
   2. Detach the actuating rod.



Installation

1. **To install, reverse the removal procedure.**

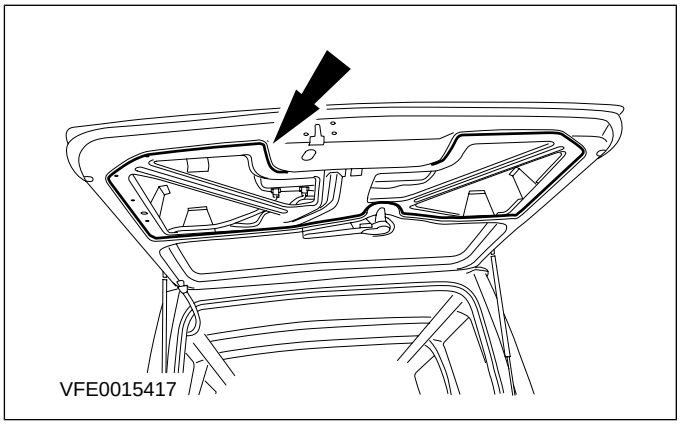
REMOVAL AND INSTALLATION

Liftgate Release Handle

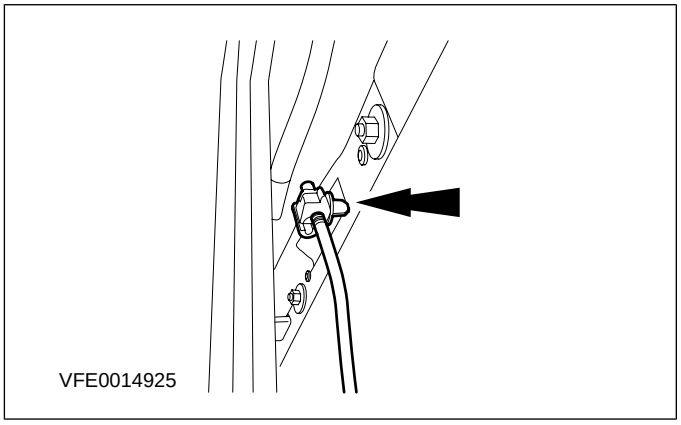
Removal

1. **Remove the liftgate trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

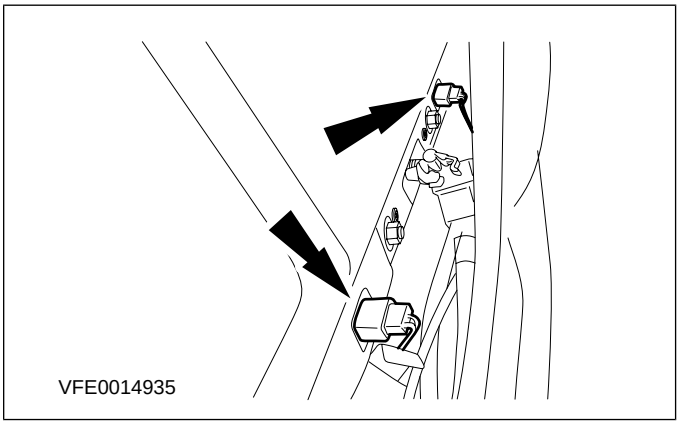
   Detach the watershield from the liftgate panel.



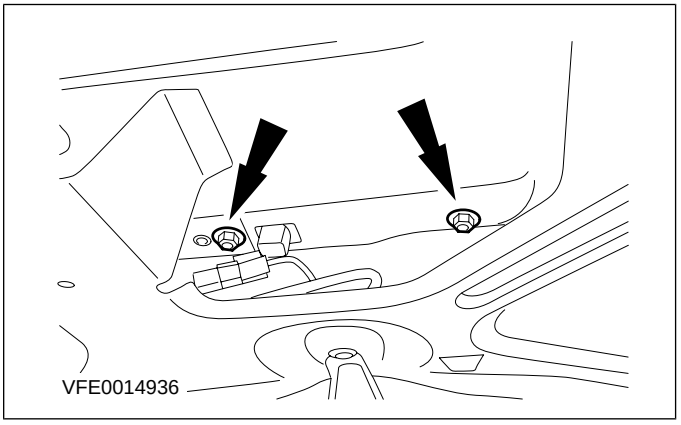
3. **Detach the exterior liftgate handle actuating rod.**
   - Open the clip and pull out the actuating rod.



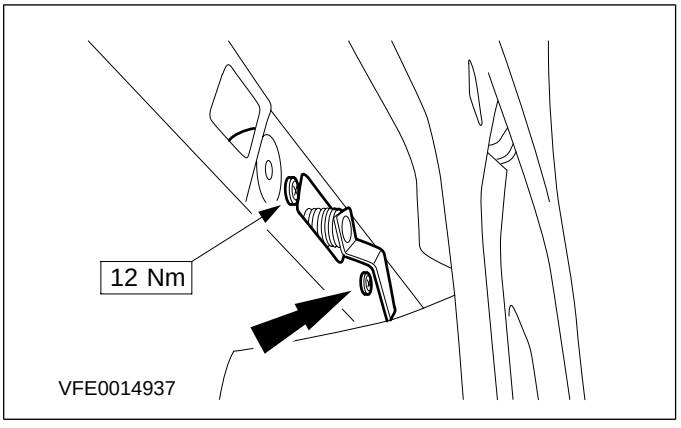
4. **Disconnect the licence plate lamp electrical connectors.**



5. **Remove the licence plate panel (two nuts each side).**



6. **Remove the exterior liftgate handle.**
   - With the handle in the opened position rotate it to one side and remove it.



REMOVAL AND INSTALLATION

Installation

1. To install, reverse the removal procedure.

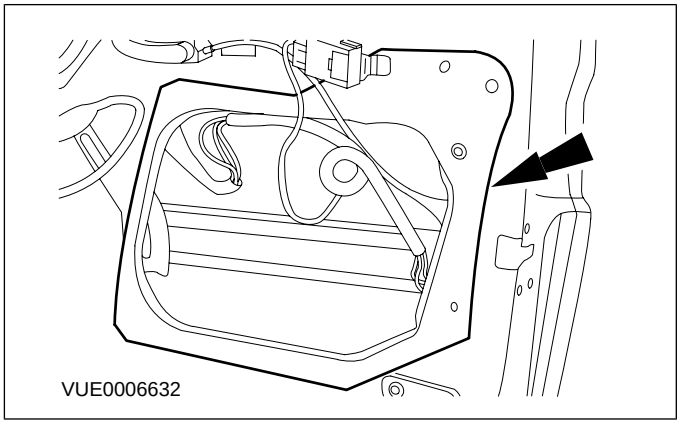
REMOVAL AND INSTALLATION

Front Door Lock Cylinder

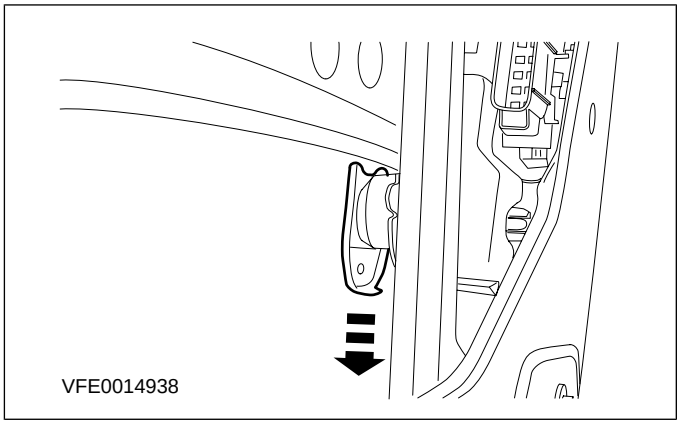
Removal

1. Remove the front door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].
2. NOTE:Do not touch the adhesive surface as re-bonding will be impaired.

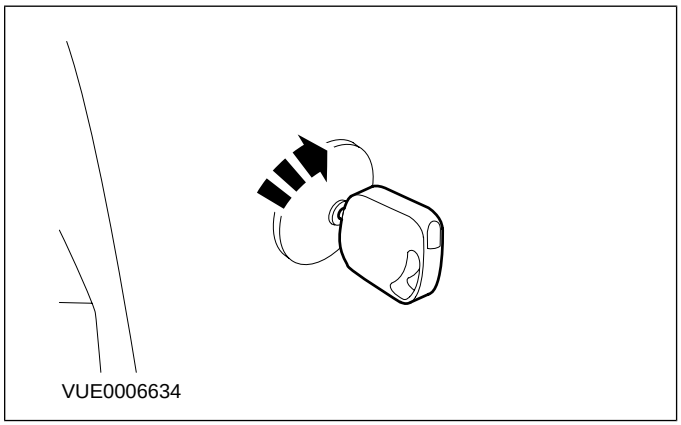
   Detach the watershield from the front door panel.



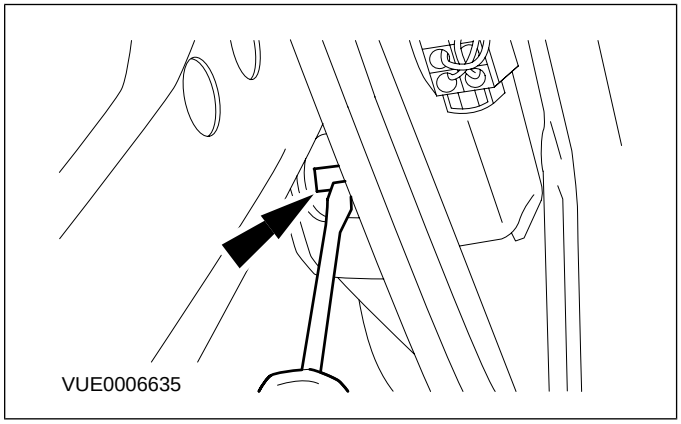
3. Remove the front door lock cylinder retaining clip.



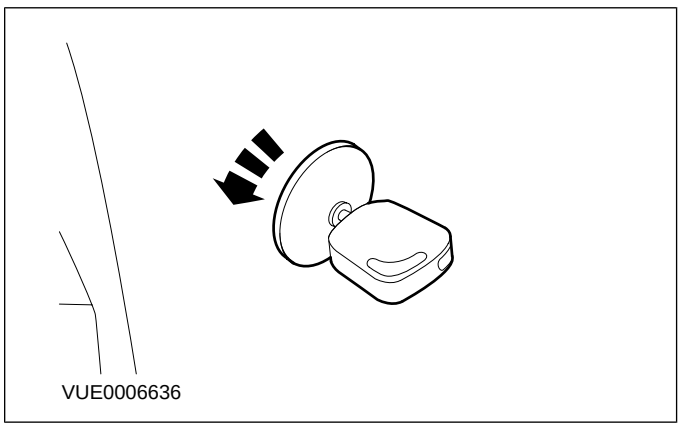
4. Insert the key into the front door lock cylinder and rotate it clockwise.



5. Depress the tang to release the front door lock cylinder.

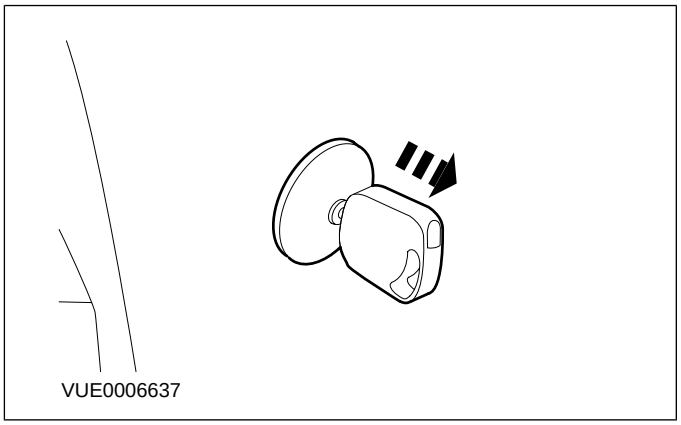


6. Rotate the front door lock cylinder counterclockwise.



REMOVAL AND INSTALLATION

7. Remove the front door lock cylinder.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Sliding Door Lock Cylinder

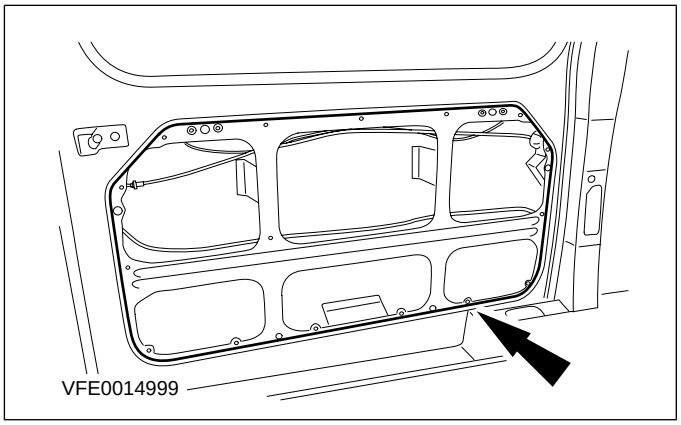
General Equipment

2.5 mm drill bit

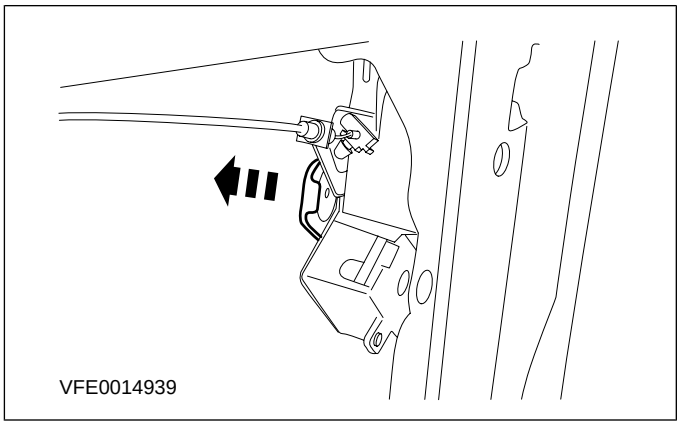
Removal

1. **Remove the sliding door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

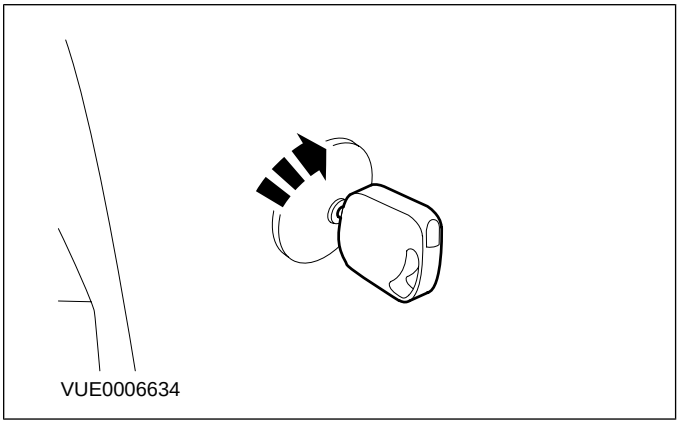
   Detach the watershield from the sliding door panel.



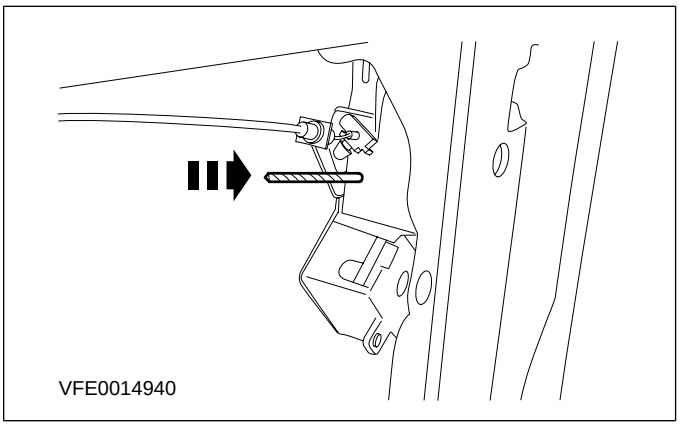
3. **Remove the sliding door lock cylinder retaining clip.**



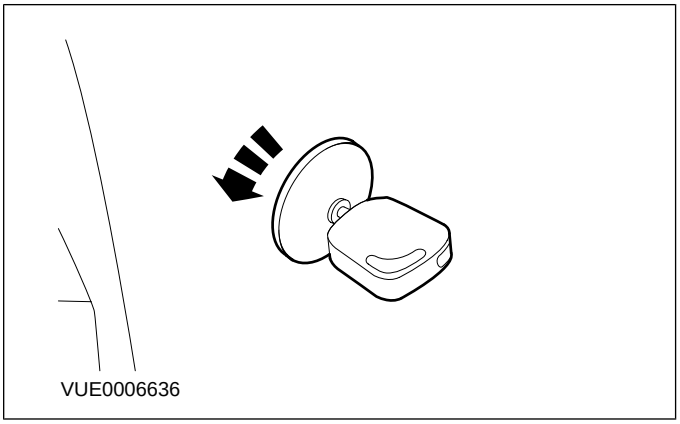
4. **Insert the key into the sliding door lock cylinder and rotate it clockwise.**



5. **Insert a 2.5 mm drill bit into the hole in the sliding door latch to release the sliding door lock cylinder.**

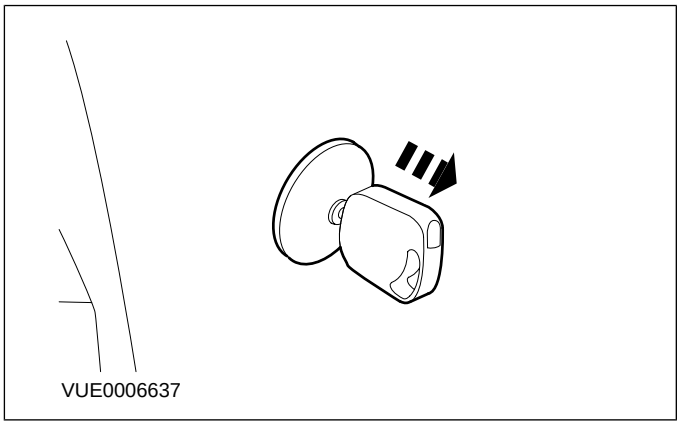


6. **Rotate the sliding door lock cylinder counterclockwise.**



REMOVAL AND INSTALLATION

7. Remove the sliding door lock cylinder.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Rear Door Lock Cylinder — Van/Kombi/Bus

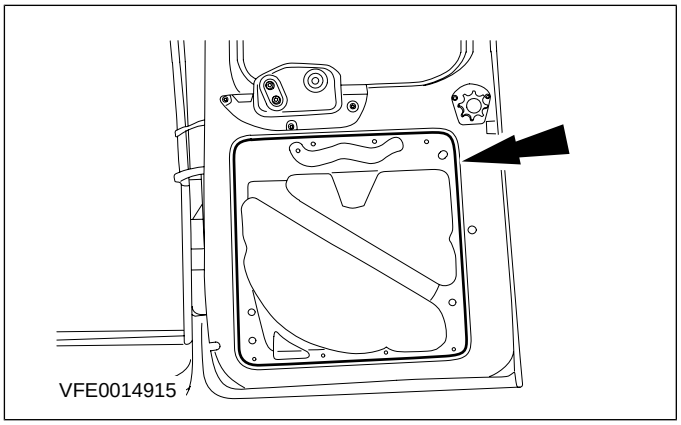
General Equipment

2.5 mm drill bit

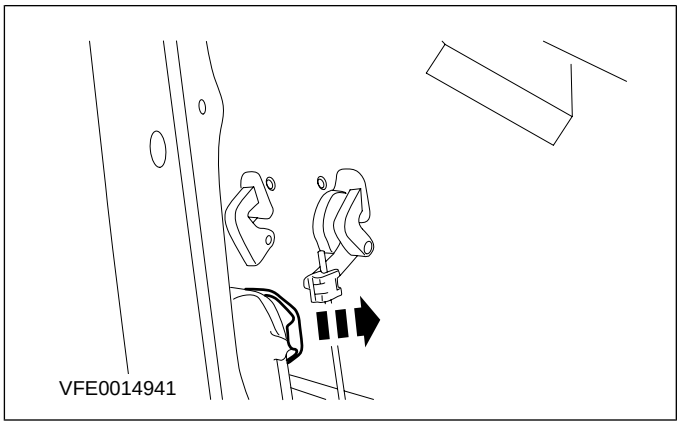
Removal

1. **Remove the rear door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

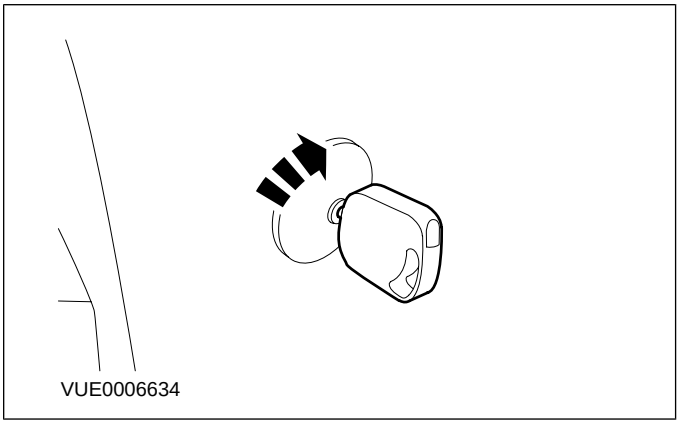
   Detach the watershield from the rear door panel.



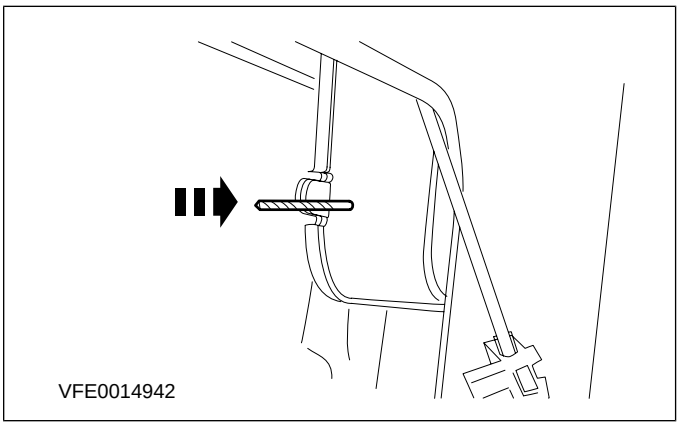
3. **Remove the rear door lock cylinder retaining clip.**



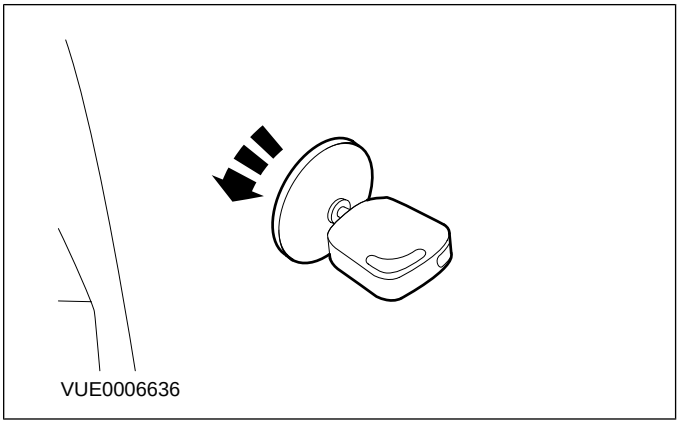
4. **Insert the key into the rear door lock cylinder and rotate it clockwise.**



5. **Insert a 2.5 mm drill bit into the hole in the rear door latch to release the rear door lock cylinder.**

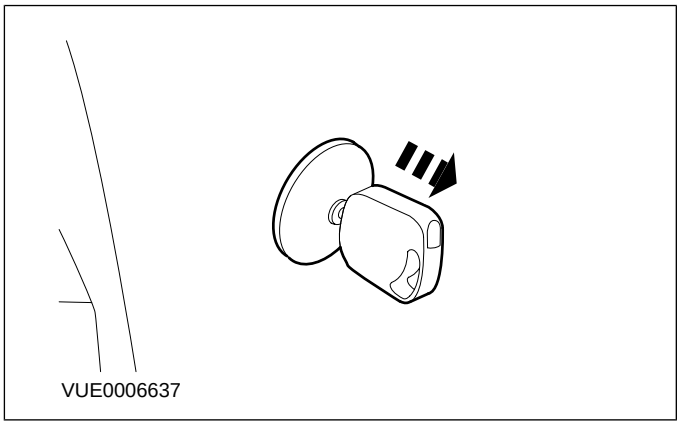


6. **Rotate the rear door lock cylinder counterclockwise.**



REMOVAL AND INSTALLATION

7. Remove the rear door lock cylinder.



Installation

1. To install, reverse the removal procedure.

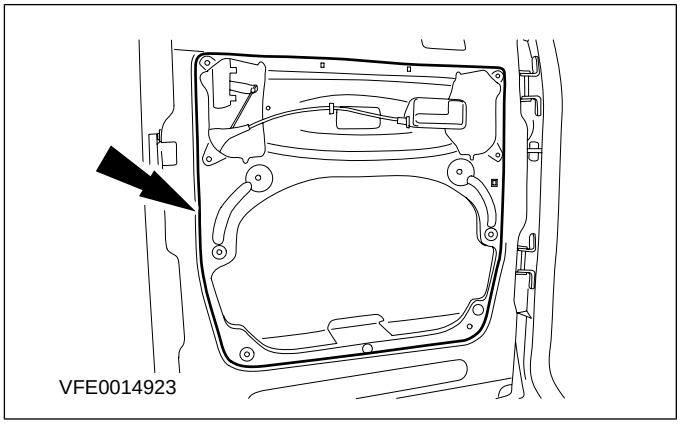
REMOVAL AND INSTALLATION

Rear Door Lock Cylinder — Chassis Double Cab

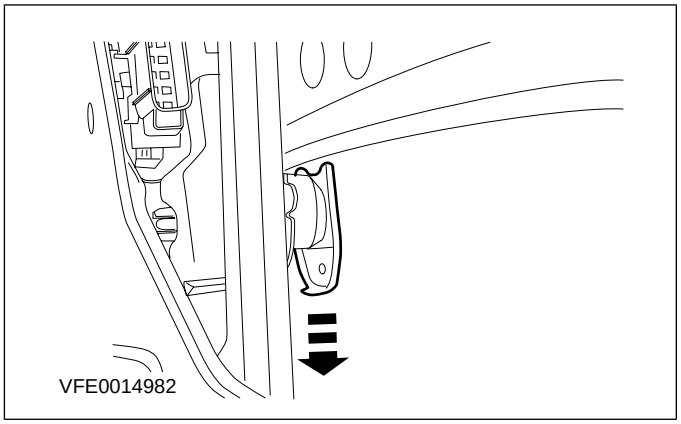
Removal

1. **Remove the rear door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

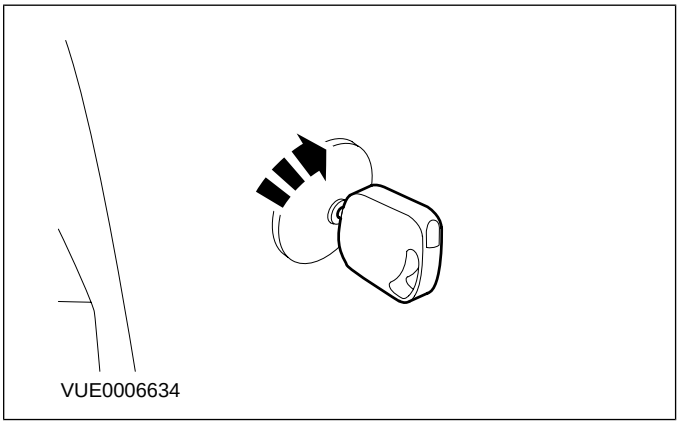
   Detach the watershield from the rear door panel.



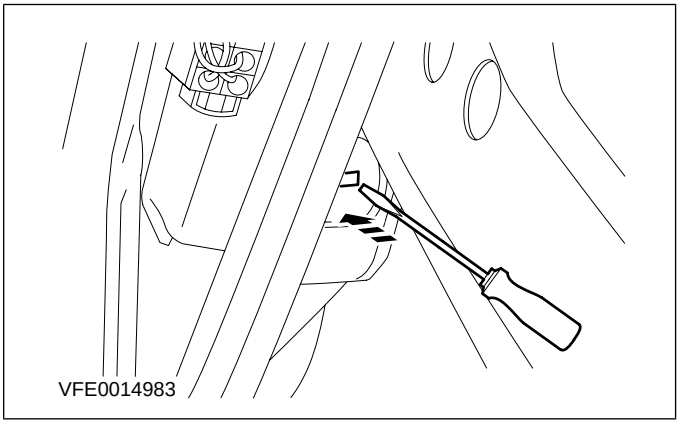
3. **Remove the rear door lock cylinder retaining clip.**



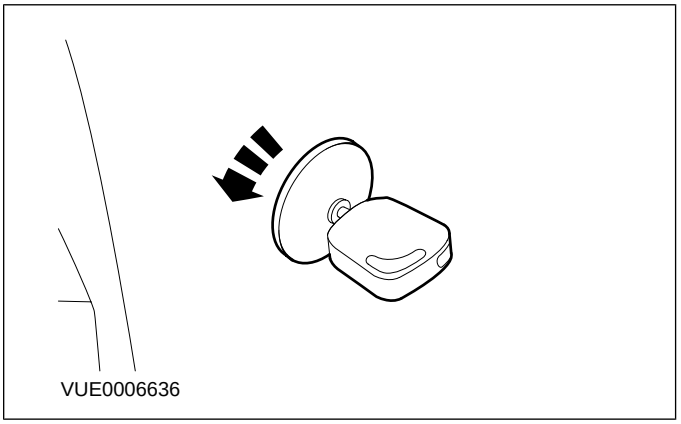
4. **Insert the key into the rear door lock cylinder and rotate it clockwise.**



5. **Depress the tang to release the rear door lock cylinder.**

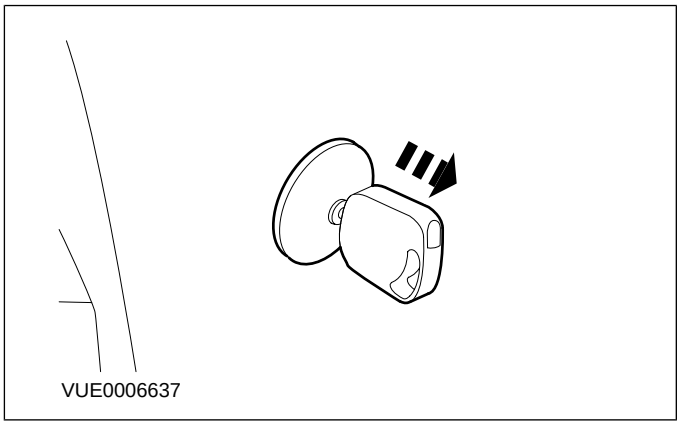


6. **Rotate the rear door lock cylinder counterclockwise.**



REMOVAL AND INSTALLATION

7. Remove the rear door lock cylinder.



Installation

1. To install, reverse the removal procedure.

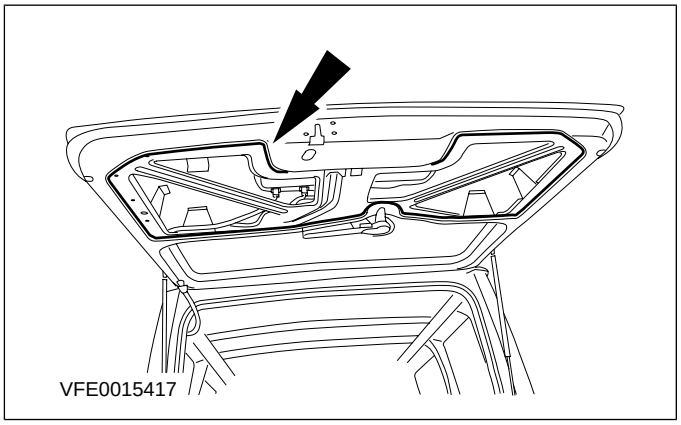
REMOVAL AND INSTALLATION

Liftgate Lock Cylinder (41 664 0)

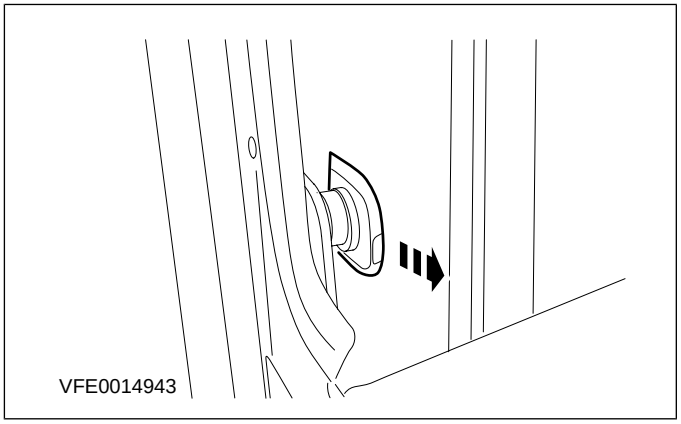
Removal

1. **Remove the liftgate trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

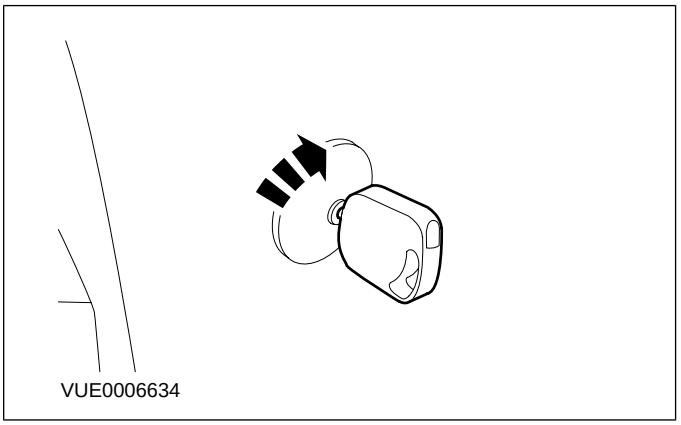
   Detach the watershield from the liftgate panel.



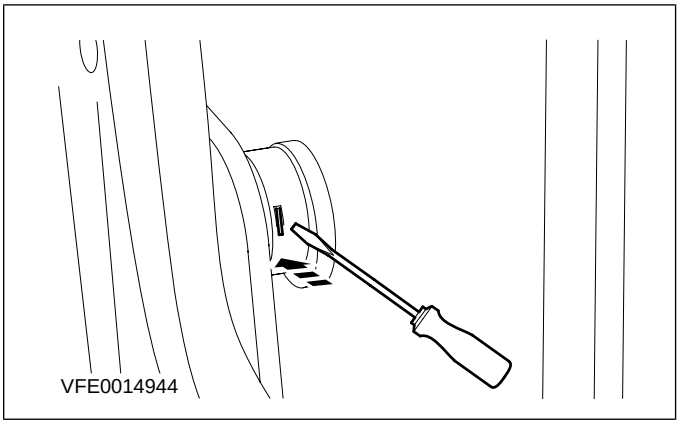
3. **Remove the liftgate lock cylinder retaining clip.**



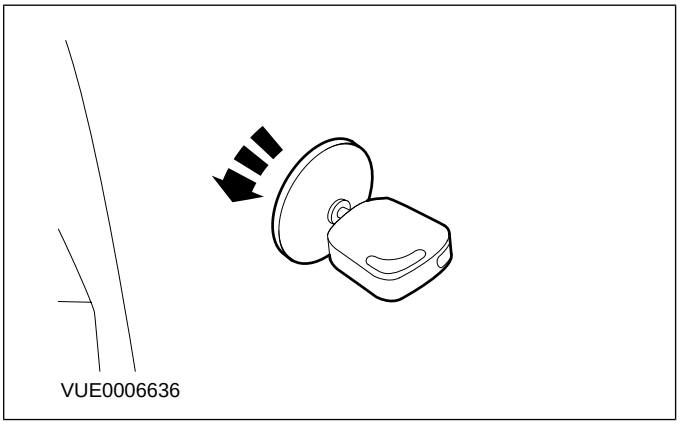
4. **Insert the key into the liftgate lock cylinder and rotate it clockwise.**



5. **Depress the tang to release the liftgate lock cylinder.**

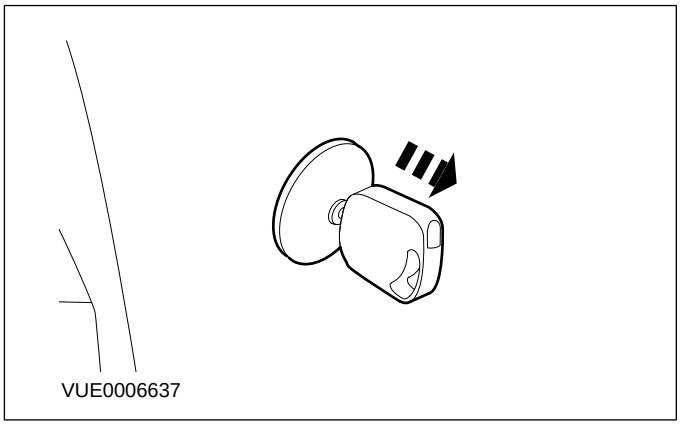


6. **Rotate the liftgate lock cylinder counterclockwise.**



REMOVAL AND INSTALLATION

7. Remove the liftgate lock cylinder.



Installation

1. To install, reverse the removal procedure.

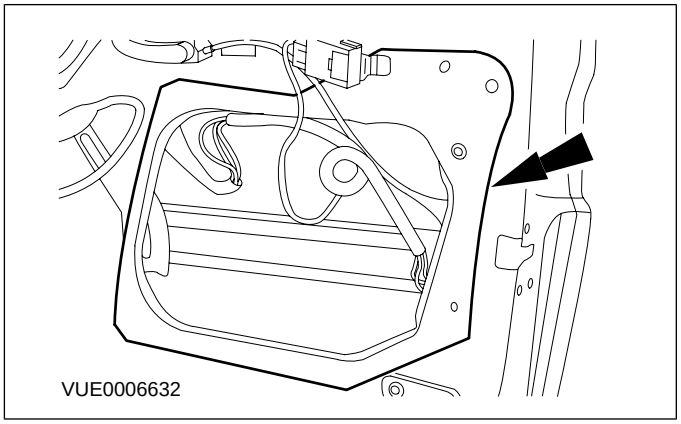
REMOVAL AND INSTALLATION

Front Door Latch Remote Control

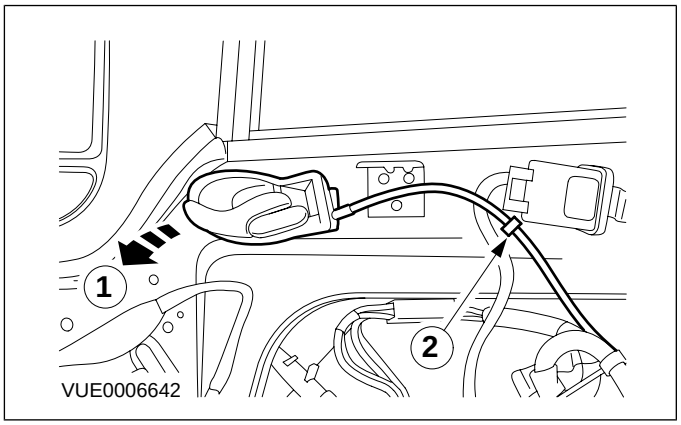
Removal

1. **Remove the front door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

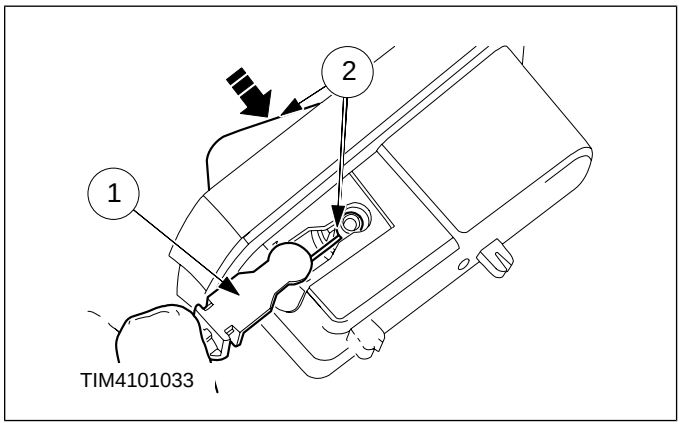
   Detach the watershield from the front door panel.



3. **Detach the front door latch remote control handle.**
   1. Unclip the front door latch remote control handle.
   2. Remove the cable tie.



4. **Disconnect the front door latch remote control cable.**
   1. Detach the outer cable.
   2. Depress the lever when it is in the locked position to align the inner cable with the release slot.



Installation

1. **To install, reverse the removal procedure.**

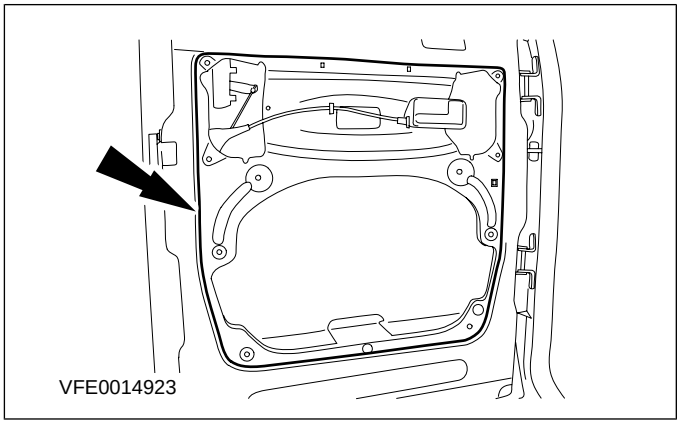
REMOVAL AND INSTALLATION

Rear Door Latch Remote Control — Chassis Double Cab

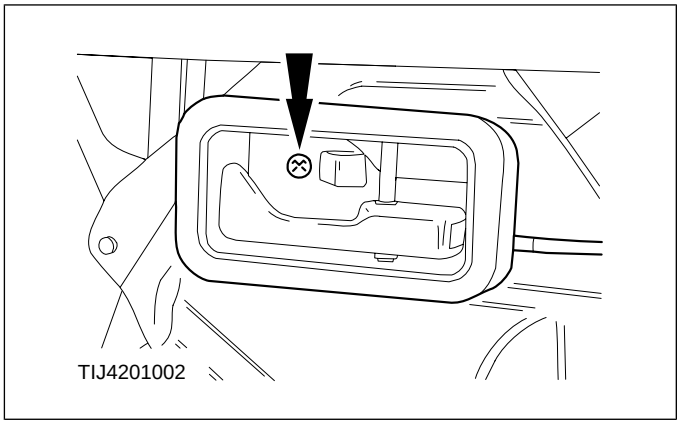
Removal

1. **Remove the rear door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impaired.**

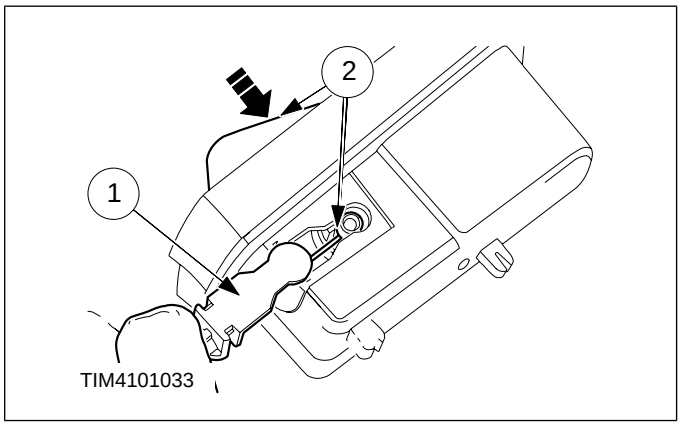
   Detach the watershield from the rear door panel.



3. **Detach the rear door latch remote control handle.**



4. **Detach the rear door latch remote control cable.**
   1. Detach the outer cable.
   2. Depress the lever when it is in the locked position to align the inner cable with the release slot.



Installation

1. **To install, reverse the removal procedure.**

REMOVAL AND INSTALLATION

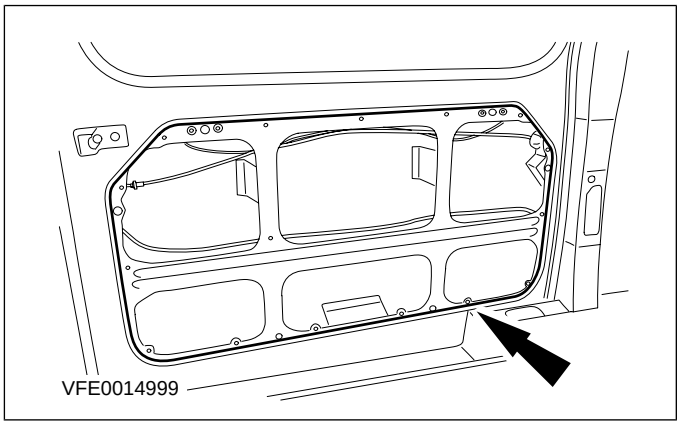
Sliding Door Latch Remote Control

Removal

All vehicles

1. **Remove the sliding door trim panel. For additional information, refer to Section 501-05 [Interior Trim and Ornamentation].**
2. **NOTE:Do not touch the adhesive surface as re-bonding will be impared.**

   Detach the watershield from the sliding door panel.



Vehicles without central locking

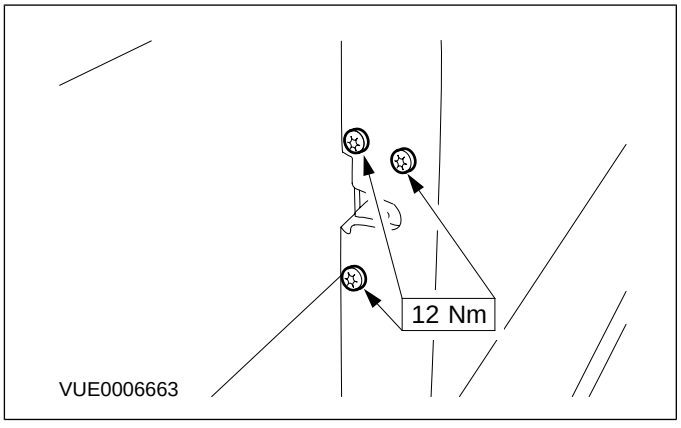
3. **Remove the sliding door lock cylinder.**

   For additional information, refer toSliding Door Lock Cylinderin this section.

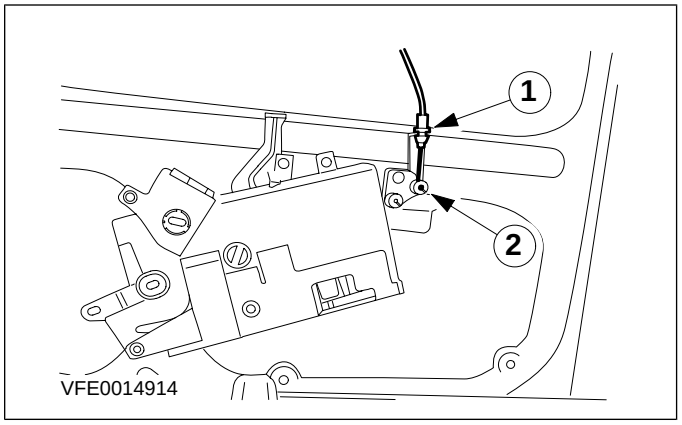
All vehicles

4. **NOTE:Make sure the sliding door latch is in the locked position.**

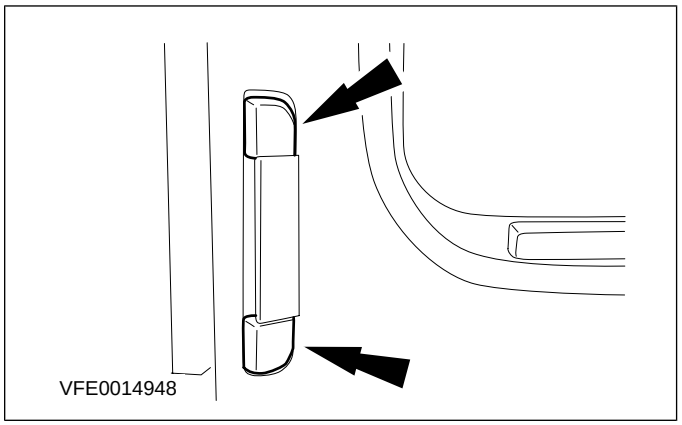
   Remove the sliding door latch retaining bolts.



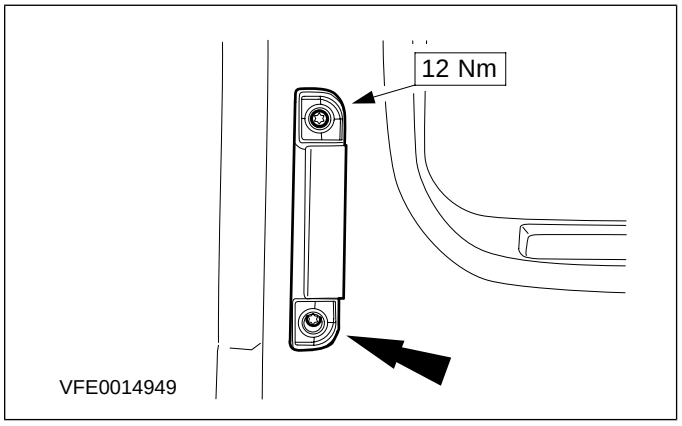
5. **Disconnect the sliding door latch remote control cable.**
   1. Detach the outer cable.
   2. Disconnect the inner cable.



6. **Remove the screw covers.**



7. **Remove the sliding door latch remote control.**



REMOVAL AND INSTALLATION

Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

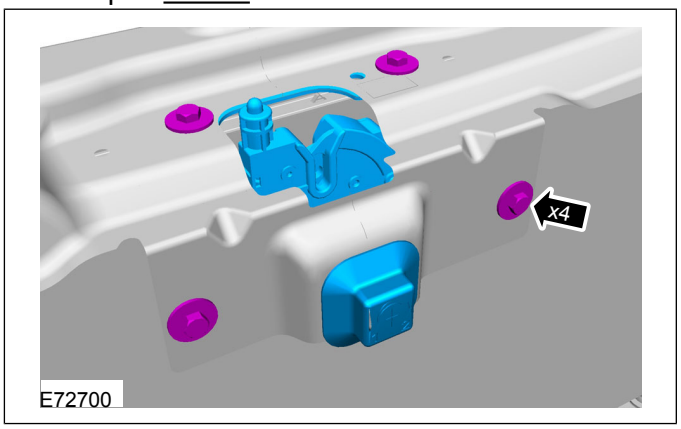
Hood Latch

Removal

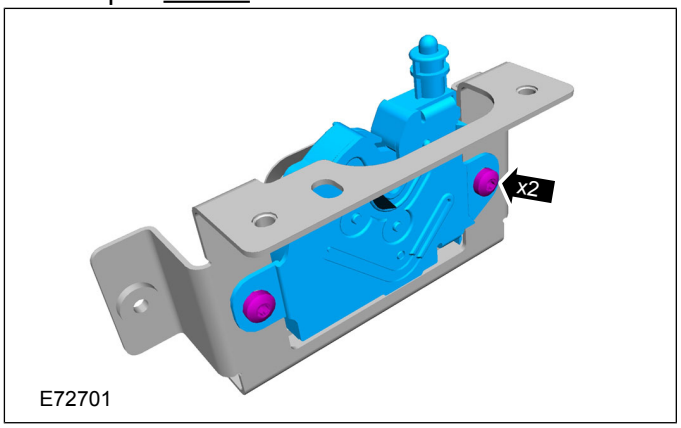
1. Remove the front bumper cover.

   Refer to:Front Bumper Cover (501-19 Bumpers, Removal and Installation).

2. Mark the position of the bolts.
   Torque: 10 Nm



3. Mark the position of the bolts.
   Torque: 10 Nm



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

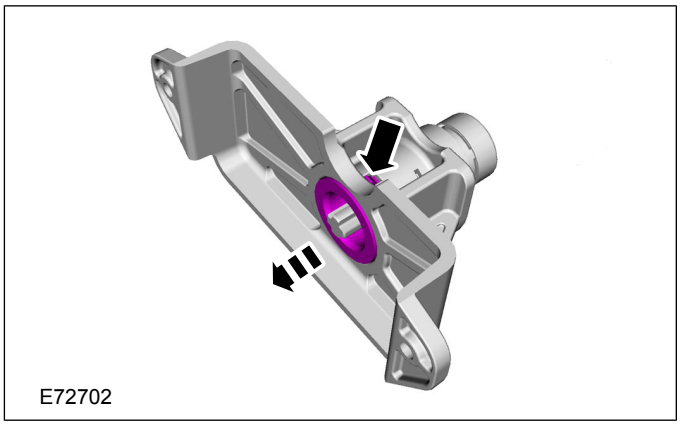
Hood Lock Cylinder

Removal

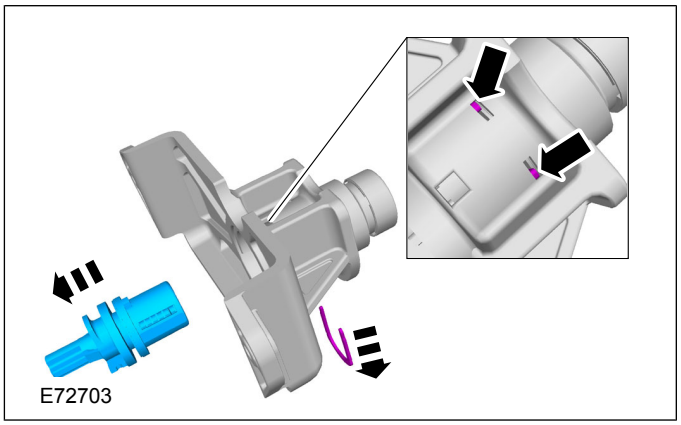
1. Remove the hood latch.

   Refer to:Hood Latch (501-14, Removal and Installation).

2.



3.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Ignition Lock Cylinder

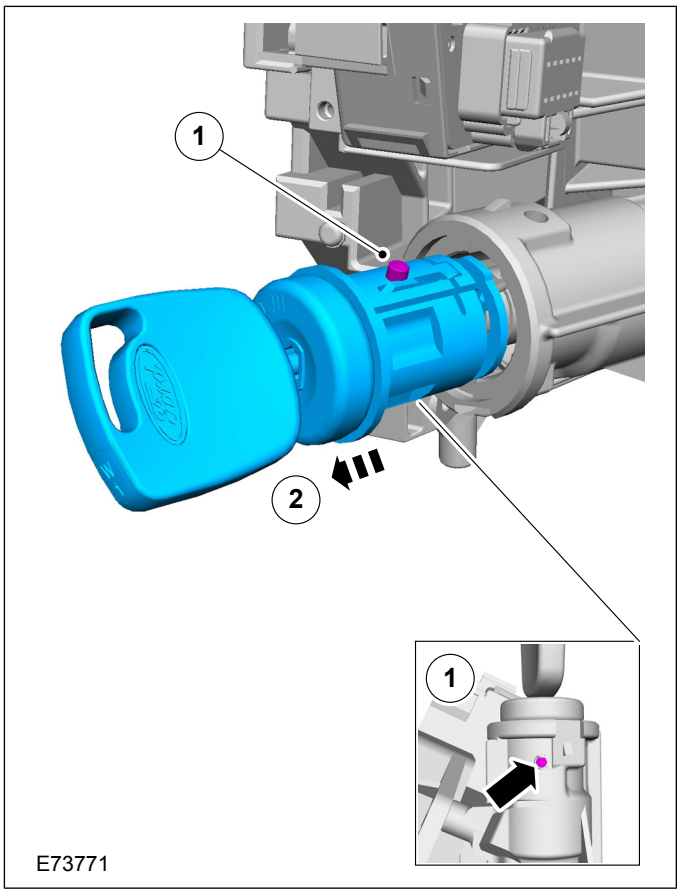
Removal

1. Remove the passive anti-theft system (PATS) transceiver.

   Refer to:Passive Anti-Theft System (PATS) Transceiver (419-01 Anti-Theft - Passive, Removal and Installation).

2. Turn the ignition key to position 2.

3.



Installation

1. To install, reverse the removal procedure.

SECTION 501-16 Wipers and Washers

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 501-16-2

DESCRIPTION AND OPERATION

Wipers and Washers..... 501-16-3
Windshield wash/wipe system..... 501-16-4
Rear window wash/wipe system..... 501-16-5

DIAGNOSIS AND TESTING

Wipers and Washers..... 501-16-6
Inspection and Testing..... 501-16-6
Symptom chart..... 501-16-6
Pinpoint Test..... 501-16-8
Component Tests..... 501-16-54

GENERAL PROCEDURES

Windshield Wiper Blade and Pivot Arm Adjustment..... 501-16-57

REMOVAL AND INSTALLATION

Windshield Wiper Motor..... 501-16-59
Windshield Washer Pump — Van/Kombi/Bus..... 501-16-60
Windshield Washer Pump — Chassis Cab/Chassis Double Cab..... 501-16-61
Windshield Washer Pump and Reservoir — Van/Kombi/Bus..... 501-16-62
Windshield Washer Pump and Reservoir — Chassis Cab/Chassis Double Cab..... 501-16-63
Wiper Linkage Assembly..... 501-16-64

SPECIFICATIONS

Wiper Blade and Pivot Arm Adjustment

Angle between the windshield and the wiper arm	3 degrees

DESCRIPTION AND OPERATION

Wipers and Washers

Rain sensor

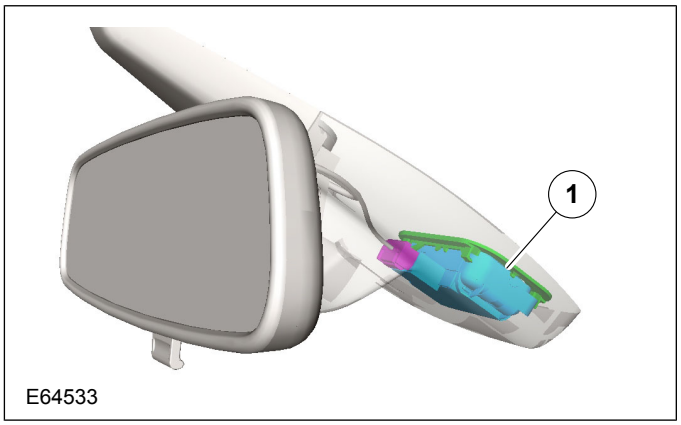
CAUTIONS:

The automatic windshield wipers must be switched off before the vehicle is driven into a car wash.

If the windshield is iced up, the wipers may only be activated by the rain sensor after the windshield has been completely defrosted.

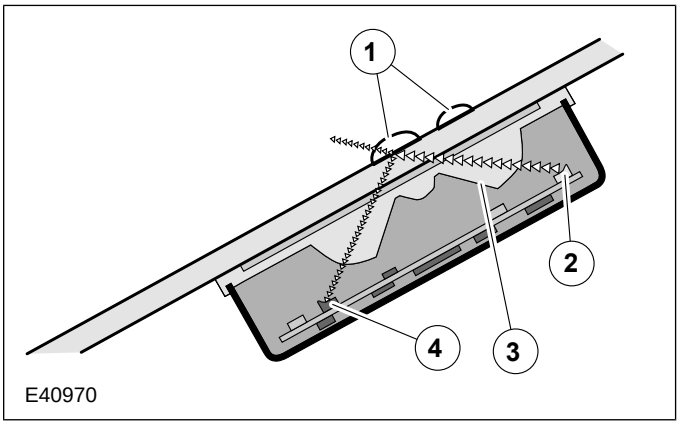
NOTE: The rain sensor is an optical measuring instrument. Contamination such as oil, grease or dust impair its correct operation. Before switching on the automatic windshield wipers, the windshield must be clean in the area of the rain sensor.

The rain sensor (1) is integrated together with the light sensor in a housing which is mounted behind the rear view mirror on the windshield.



The rain sensor comprises an opto-electronic measuring and evaluation circuit. The sensor can calculate the amount of precipitation falling on the windshield and request that the windshield wipers are switched on.

On the basis of the information provided by the rain sensor, the windshield wipers are then set to the required wipe speed by the generic electronic module (GEM).



Item	Description
1	Raindrop
2	LED
3	Lens
4	Photodiode

The rain sensor consists of three components:

- an LED
- a photodiode
- the lens

The LED emits a light beam of known intensity. The emitted beam emerges through the lens and is then reflected by the windshield.

The reflected light beam enters back through the lens and then reaches the photodiode. The corresponding value taken without moisture on the windshield is used as the reference value for the automatic calibration process.

Subsequent deviations from this value cause the windshield wipers to be switched on.

If rain lands on the windshield then the light reflected by the windshield has a lower intensity. This loss of intensity is registered by the photodiode and, proportionally to the loss of intensity, the module switches on the windshield wipers with the required wipe speed (in intermittent or continuous mode).

When the automatic windshield wipers are switched on (wiper switch set to intermittent mode) the rain sensor is switched on and performs an automatic calibration according to the current conditions at the windshield.

DESCRIPTION AND OPERATION

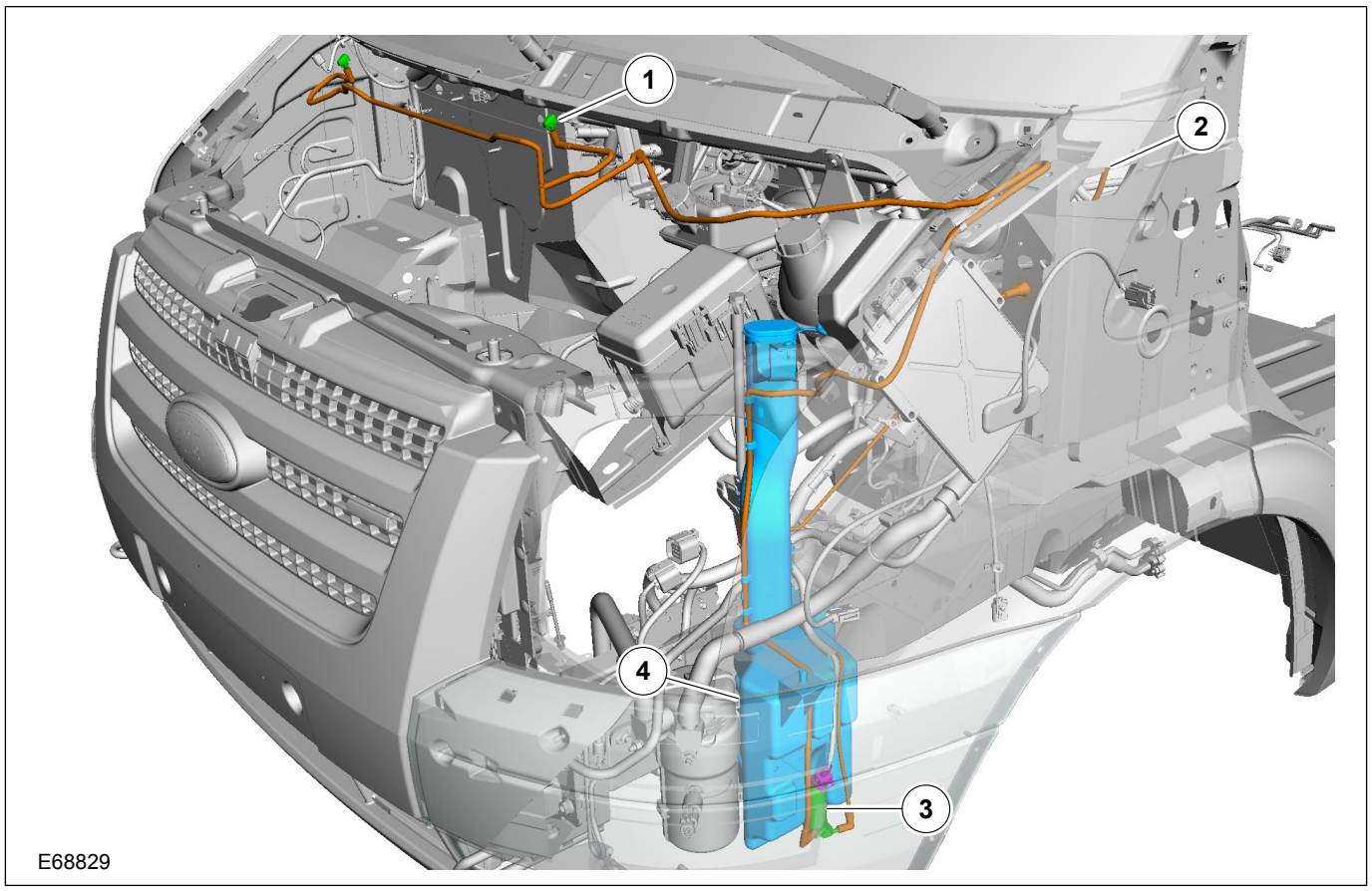
To perform the automatic calibration, the windshield wipers perform a single wipe regardless of whether the windshield is wet or dry. It only takes place if the wiper switch was not in the automatic setting before the ignition was switched on.

If the windshield remains dry after this wipe then the windshield wipers stop until moisture is registered on the windshield above the sensor.

The sensitivity of the rain sensor can be changed by adjusting the control resistor for the intermittent mode of the windshield wipers.

- Switch setting 1: High sensitivity
  - The wipers wipe even if only a small amount of water has been measured on the windshield.
- Switch setting 6: Low sensitivity
  - The wipers only wipe if a large amount of water has been measured on the windshield.

Windshield wash/wipe system



Item	Description
1	Windshield washer nozzle
2	Rear window washer water hose
3	Windshield washer pump
4	Washer fluid reservoir

The windshield wash/wipe system will only operate if the ignition switch is in the position "I" or "II".

Five wash functions are available: "Off", "Flick-wipe", "Speed 1", "Speed 2" and "Intermittent" or "Automatic wipe" (depending on the vehicle specification).

In "Speed 1" or "Speed 2" mode, the wipers are operating continuously at either normal speed or fast speed.

When the intermittent wipe mode is switched on the windshield wipers operate at normal speed with the following wiper delays:

- Wiper delay 1: 1 second
- Wiper delay 2: 3.5 seconds
- Wiper delay 3: 6 seconds
- Wiper delay 4: 9,5 seconds
- Wiper delay 5: 15.5 seconds
- Wiper delay 6: 22 seconds

DESCRIPTION AND OPERATION

NOTE: In the event of a failure, or if the control resistor is not connected the default time for the wiper delay is 8 seconds.

When the windshield washer switch is operated washer fluid is sprayed onto the windshield. After a short delay designed to protect the wiper blades the wipers perform 2 or 3 wipes at low speed.

If when the windshield washer switch is activated the windshield wipers are switched off, then a single wipe is performed 4 seconds after the wipers have returned to the home position after performing the 2 or 3 wipes.

If when the windshield washer switch is activated the wipers are in intermittent mode, and if the selected wiper delay time is longer than 6 seconds, then a single wipe is performed 6 seconds after the wipers have returned to the home position after performing the 2 or 3 wipes. If the selected delay time is less than 6 seconds then no post wipe is required.

The post wipe function on the windshield ensures that any water remaining on the windshield after washing is wiped away. It is only required if the wipers are switched off or they are set to intermittent mode.

Rear window wash/wipe system

The rear window wash/wipe system will only operate if the ignition switch is in the position "II".

The generic electronic module (GEM) changes the wiper delay time of the rear window wiper according to the switch setting of the windshield wipers.

If the wiper switch is in the "OFF" position, or in "intermittent" mode or the "automatic wipe" setting (no wiping or low speed wiping), then the wiper delay time for the rear window is 10 seconds.

If the wiper switch is in the "normal speed" position, "fast speed" position or the "automatic wipe" setting (high speed wiping), then the wiper delay time for the rear window is 6 seconds.

If the switch for the rear window washer is pressed, then washer fluid is sprayed onto the rear window, and the wiper operates continuously at low speed. When the switch is released the rear window wiper performs another 2-3 wipes.

If the switch for the rear window washer fails while switched ON, or if it is continuously operated for longer than 60 seconds, then the switch signal is ignored by the generic electronic module (GEM), the wiper returns to the park position and a trouble code is stored for the switch.

If reverse gear is engaged and the windshield wiper switch is in the normal, high speed or automatic windshield wiper (wiping at high speed) position, the rear window wiper operates continuously until the gearshift lever is moved back to the neutral position.

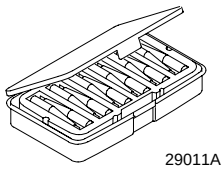
If reverse gear is engaged and the switch for the wipers is set to "OFF", "Intermittent" or the "Automatic wipe" setting (no wiping or low speed wiping), the rear window wiper follows the movement of the windshield wipers. When the wipers leave the park position the rear window wiper also performs a wipe.

DIAGNOSIS AND TESTING

Wipers and Washers

Refer to Wiring Diagrams Section 501-16,for schematic and connector information.

Special Tool(s)

 29011A	Terminal probe kit 29-011A

Inspection and Testing

NOTE: The generic electronic module (GEM) forms part of the central junction box (CJB).

NOTE: If the generic electronic module (GEM) is changed, the new one must be reinitialised. For this purpose, the vehicle-specific data are read out of the module to be replaced using the diagnostic tester and transferred to the new module. REFER to:

Module Configuration (418-01 Module Configuration, General Procedures),
Generic Electronic Module (GEM) (419-10 Multifunction Electronic Modules, Diagnosis and Testing).

NOTE: Before reading out the vehicle-specific data, remake all the electrical connections to the module to be removed, so that communication between the module and the diagnostic tester is ensured.

1. Verify the customer concern.
2. Visually inspect for obvious signs of electrical or mechanical damage.

Visual inspection chart

Mechanical	Electrical
• Wiper blade(s) • Wiper relay arm • Windshield washer reservoir • Hose(s) • Windshield washer nozzle • Check both wiper blades for residue-free wiping in the vicinity of the rain sensor. • Check the adhesive pad between the rain sensor and the windshield for trapped air. • Clean wax residues from the windshield in the vicinity of the rain sensor. • Check the windshield for damage/cracks in the vicinity of the rain sensor. • Check that the rain sensor retaining frame is correctly attached to the windshield.	• Fuse(s) • Connector • Wiring loom • Windshield washer pump • Front/rear window wiper motor • Wash/wipe switch • Central junction box (CJB)

3. Resolve any obvious causes or concerns found during the visual inspection before carrying out any further tests.
4. If the cause of the concern cannot be found by visual inspection, continue with the symptom chart.

Symptom chart

Symptom chart

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• Wipers inoperative	• Fuse • Circuit(s) • Wash/wipe switch • Windshield wiper motor • Rear wiper motor. • Central junction box (CJB)	• GO to Pinpoint Test A.
• Brief wipe is inoperative (slow wipe OK)	• Wash/wipe switch	• RENEW the wash/wipe switch. CHECK system operates correctly
• Windscreen wiper runs continuously	• Circuit(s) • Wash/wipe switch • Central junction box (CJB)	• GO to Pinpoint Test B.
• The rear window wiper runs continuously	• Circuit(s) • Wash/wipe switch • Central junction box (CJB) • Rear wiper motor.	• GO to Pinpoint Test C.
• Slow/fast wipe not working.	• Circuit(s) • Wash/wipe switch • Windshield wiper motor • Central junction box (CJB)	• GO to Pinpoint Test D.
• Intermittent wipe mode of windscreen wiper inoperative, vehicles with and without rain sensor (fast/slow wipe OK)	• Circuit(s) • Wash/wipe switch • Central junction box (CJB) • Rain sensor	• GO to Pinpoint Test E.
• The windshield wiper runs continuously in intermittent mode	• Circuit(s) • Wash/wipe switch • Central junction box (CJB)	• GO to Pinpoint Test F.
• The windshield wiper motor does not return to the park position after being switched off	• Circuit(s) • Windshield wiper motor • Central junction box (CJB)	• GO to Pinpoint Test G.
• The rear window wiper(s) does/do not return to the park position after being switched off	• Circuit(s) • Rear wiper motor.	• GO to Pinpoint Test H.
• The front and rear wash/wipe functions are inoperative (wipe and intermittent function OK)	• Fuse • Circuit(s) • Wash/wipe switch • Central junction box (CJB)	• GO to Pinpoint Test I.
• The front wash/wipe function is inoperative (rear wash/wipe function OK)	• Wash/wipe switch	• RENEW the wash/wipe switch. CHECK system operates correctly
• The rear wash/wipe function is inoperative (front wash/wipe function OK)	• Wash/wipe switch	• RENEW the wash/wipe switch. CHECK system operates correctly
• Windscreen washer system is inoperative	• Circuit(s) • Windshield washer pump • Central junction box (CJB)	• GO to Pinpoint Test J.

DIAGNOSIS AND TESTING

Pinpoint Test

NOTE: Use a digital multimeter for all electrical measurements.

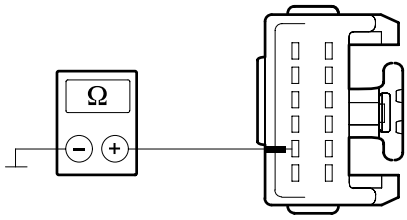
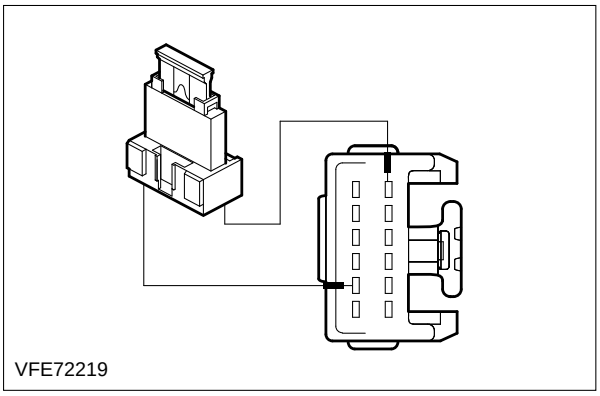
PINPOINT TEST A : WIPERS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: DETERMINE MODEL VERSION	
	1 Determine the model version. • Is the vehicle a drop side body version? → **Yes** GO to A3. → **No** Box van / Bus / Combi: GO to A2.
A2: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 SWITCH ON windshield wipers (slow and fast wipe).
	3 TURN ON the rear wiper.
	4 CHECK the windshield wipers and the rear window wiper. • Are the front and the rear wipers inoperative? → **Yes** GO to A4. → **No** - Windshield wipers inoperative: GO to A9. - The rear window wiper (with tailgate) or both rear wipers (with rear doors) are inoperative: GO to A19. - One rear window wiper (with rear doors) is inoperative: GO to A31. - The rear window wiper is inoperative when the windshield wiper is switched on and reverse gear is engaged (normal rear wipe function OK).GO to A33.
A3: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 SWITCH ON windshield wipers (slow and fast wipe).

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 CHECK windshield wipers. • Is the wiper inoperative at both wipe speeds? → **Yes** GO to A4. → **No** Only one wipe speed inoperative: GO to Pinpoint Test D.
A4: CHECK FUSE F48 (5 A) (SRB)	
	1 Ignition switch in position 0.
	2 Disconnect CHECK fuse F48 (5 A) (SRB).
	3 CHECK CHECK fuse F48 (5 A) (SRB). • Is fuse OK? → **Yes** GO to A5. → **No** RENEW fuse F48 (5 A) (SRB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short circuit using the Wiring Diagrams. CHECK system operates correctly
A5: CHECK THE VOLTAGE SUPPLY TO FUSE F48 (5 A) (SRB) FOR OPEN CIRCUIT	
	1 Connect CHECK fuse F48 (5 A) (SRB).
	2 Measure the voltage between fuse F48 (5 A) (SRB) and ground. • Does the meter display battery voltage? → **Yes** - Drop side body: GO to A9. - Van, bus, combi: GO to A6. → **No** REPAIR the voltage supply to fuse F48 using the Wiring Diagrams. CHECK system operates correctly
A6: CHECK THE GROUND CONNECTION OF THE WASH/WIPE SYSTEM SWITCH FOR OPEN CIRCUIT	
	1 Disconnect Wash/wipe system switch from connector CRW08.

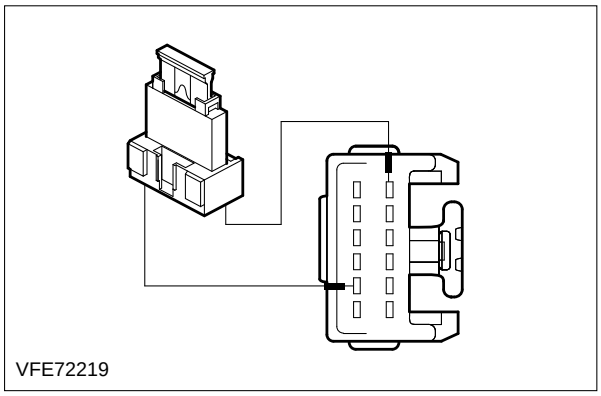
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0038575	2 Measure the resistance between the wash/wipe system switch, connector CRW08, pin 8, circuit GD115E (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** GO to A7. → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and ground connection GP15 using the Wiring Diagrams. CHECK system operates correctly
A7: CHECK THE WASH/WIPE SWITCH	
 VFE72219	1 Connect a fused jumper wire (10 A) to the wash/wipe system switch, connector CRW08, pin 6, circuit CRW10A (BU/GN) and pin 8, circuit GD115E (BK/GY), wiring harness side.
	2 Ignition switch in position II. • Does the front wiper motor run at slow wipe speed? → **Yes** RENEW the wash/wipe switch. CHECK system operates correctly → **No** - Drop side body: GO to A12. - Van, bus, combi: GO to A8.
A8: CHECK CENTRAL JUNCTION BOX (CJB)	
	1 Ignition switch in position 0.
	2 Connect Wash/wipe system switch to connector CRW08.
	3 Disconnect Central junction box (CJB) from connector CBP02D.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	4 Connected a fused jumper wire (10 A) to the central junction box (CJB), connector CBP02D, between pin 3, circuit CRW03A (VT/WH), wiring harness side and ground.
	5 Ignition switch in position II.
	6 CHECK windshield wipers. • Does the front wiper motor run at slow wipe speed? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between the windshield wiper relay and fuse F48 using the Wiring Diagrams. CHECK system operates correctly
A9: CHECK FUSE F58 (30 A) (SRB)	
	1 Ignition switch in position 0.
	2 Disconnect CHECK fuse F58 (30 A) (SRB).
	3 CHECK CHECK fuse F58 (30 A) (SRB). • Is fuse OK? → **Yes** GO to A10. → **No** RENEW fuse F58 (30 A) (SRB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short circuit using the Wiring Diagrams. CHECK system operates correctly
A10: CHECK THE VOLTAGE SUPPLY TO FUSE F58 (30 A) (SRB) FOR OPEN CIRCUIT	
	1 Connect CHECK fuse F58 (30 A) (SRB).
	2 Measure the voltage between fuse F58 (30 A) (SRB) and ground. • Does the meter display battery voltage? → **Yes** - Drop side body: GO to A6. - Van, bus, combi: GO to A11. → **No** RECTIFY the voltage supply to fuse F58 using the Wiring Diagrams. CHECK system operates correctly

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A11: CHECK THE WASH/WIPE SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Wash/wipe system switch from connector CRW08.
 VFE72219	3 Connect a fused jumper wire (10 A) to the wash/wipe system switch, connector CRW08, pin 6, circuit CRW10A (BU/GN) and pin 8, circuit GD115E (BK/GY), wiring harness side.
	4 Ignition switch in position II. • Does the windscreen wiper motor run continuously at slow wipe speed? → **Yes** RENEW the wash/wipe switch. CHECK system operates correctly → **No** GO to A12.
A12: CHECK CENTRAL JUNCTION BOX (CJB)	
	1 Ignition switch in position 0.
	2 Connect Wash/wipe system switch to connector CRW08.
	3 Disconnect Central junction box (CJB) from connector CBP02D.
	4 Connected a fused jumper wire (10 A) to the central junction box (CJB), connector CBP02D, between pin 3, circuit CRW03A (VT/WH), wiring harness side and ground.
	5 Ignition switch in position II.

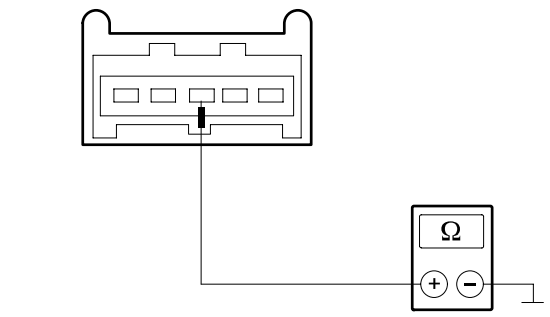
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	6 CHECK windshield wipers. • Does the windscreen wiper motor run continuously at slow wipe speed? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** GO to A13.
A13: CHECK CIRCUIT CRW03A (VT/WH) BETWEEN THE CENTRAL JUNCTION BOX (CJB) AND THE WINDSHIELD WIPER RELAY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Windshield wiper relay from socket R25.
	3 Measure the resistance between the central junction box (CJB), connector CBP02D, pin 3, circuit CRW03A (VT/WH) and the windshield wiper relay, socket R25, pin 2, circuit CRW03A (VT/WH), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to A14. → **No** LOCATE and RECTIFY the break in circuit CRW03A (VT/WH) between the central junction box (CJB) and the windshield wiper relay using the Wiring Diagrams. CHECK system operates correctly
A14: CHECK THE VOLTAGE AT THE WINDSHIELD WIPER RELAY	
	1 Measure the voltage between the windshield wiper relay, socket R25, pin 4, wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A15. → **No** LOCATE and REPAIR the break in the circuit between the windshield wiper relay and fuse F58 using the Wiring Diagrams. CHECK system operates correctly

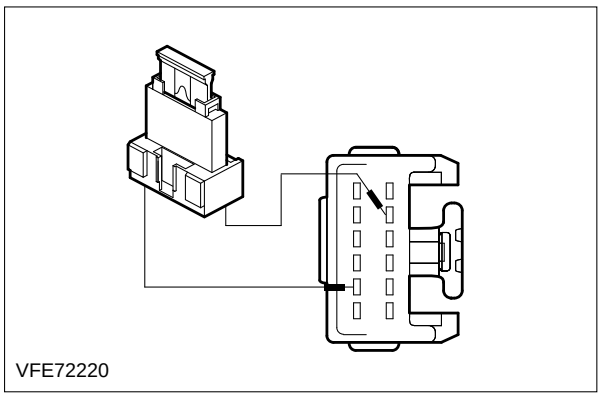
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A15: CHECK THE VOLTAGE AT THE WINDSHIELD WIPER RELAY	
	1 Measure the voltage between the windshield wiper relay, socket R25, pin 1, wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A16. → **No** LOCATE and REPAIR the break in the circuit between the windshield wiper relay, pin 1, and fuse F48 using the Wiring Diagrams. CHECK system operates correctly
A16: CHECK THE CIRCUIT BETWEEN THE WINDSHIELD WIPER RELAY AND THE WINDSHIELD WIPER SPEED RELAY FOR OPEN CIRCUIT	
	1 Disconnect Windshield wiper speed relay from socket R23.
	2 Measure the resistance between the windshield wiper relay, socket R25, pin 3, wiring harness side and the windshield wiper speed relay, socket R23, pin 3, wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to A18. → **No** GO to A17.
A17: CHECK THE WINDSHIELD WIPER RELAY	
	1 Check the windshield wiper relay according to the component test at the end of this section. • Is the windshield wiper relay OK? → **Yes** LOCATE and REPAIR the open circuit between the power supply relay and the windshield wiper speed relay using the Wiring Diagrams. CHECK system operates correctly → **No** RENEW the windshield wiper relay . CHECK system operates correctly
A18: CHECK GROUND CONNECTION OF WINDSHIELD WIPER MOTOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0032241	2 Measure the resistance between front window wiper motor: – Platform truck: Connector CRW01, pin 3, circuit GD131C (BK/GY) (RHD vehicles: circuit GD129E (BK/GY)), wiring harness side and ground. – Van, bus, combi with rear doors: Connector CRW01, pin 3, circuit GD129E (BK/YE), wiring harness side and ground. – Van, bus, combi with tailgate: Connector CRW01, pin 3, circuit GD129E (BK/GY) (RHD vehicles: (circuit GD131V (BK/GY)), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the front windscreen wiper motor CHECK system operates correctly → **No** - Platform truck: LOCATE and RECTIFY the break in the circuit between the windshield wiper motor and soldered connection S1D131D (RHD vehicles: soldered connection S1D129C) using the Wiring Diagrams. CHECK system operates correctly - Van, bus, combi with rear doors: LOCATE and RECTIFY the break in the circuit between the windshield wiper motor and soldered connection S1D129C using the Wiring Diagrams. CHECK system operates correctly - Van, bus, combi with tailgate: LOCATE and RECTIFY the break in the circuit between the windshield wiper motor and ground connection GP31 using the Wiring Diagrams. CHECK system operates correctly
A19: CHECK FUSE F38 (20 A) (SRB)	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F38 (20 A) (SRB).
	3 CHECK Fuse F38 (20 A) (SRB). • Is fuse OK? → **Yes** GO to A20. → **No** RENEW fuse F38 (20 A) (SRB) and CHECK the operation of the system. If the fuse blows again, LOCATE and RECTIFY the short circuit using the Wiring Diagrams. CHECK system operates correctly

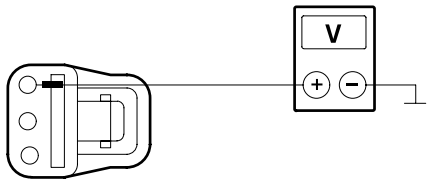
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A20: CHECK THE VOLTAGE SUPPLY TO FUSE F38 (20 A) (SRB) FOR OPEN CIRCUIT	
	1 Connect Fuse F38 (20 A) (SRB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F38 (20 A) (SRB) and ground. • Does the meter display battery voltage? → **Yes** GO to A21. → **No** REPAIR the voltage supply to fuse F38 using the Wiring Diagrams. CHECK system operates correctly
A21: CHECK THE WASH/WIPE SWITCH	
NOTE: The fused jumper wire must be connected for at least 20 seconds to check whether the rear wiper motor is operating in intermittent wipe mode.	
	1 Ignition switch in position 0.
	2 Disconnect Wash/wipe system switch from connector CRW08.
 VFE72220	3 Connect a fused jumper wire (10 A) to the wash/wipe system switch, connector CRW08, pin 5, circuit CRW20A (GY/YE) and pin 8, circuit GD115E (BK/GY), wiring harness side.
	4 Ignition switch in position II. • Is the rear window wiper motor running in intermittent wipe mode? → **Yes** RENEW the wash/wipe switch. CHECK system operates correctly → **No** GO to A22.
A22: CHECK CIRCUIT CRW20A (GY/YE) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Ignition switch in position 0.

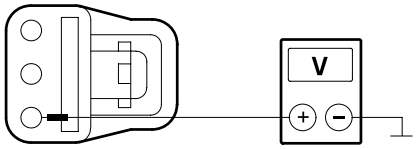
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Central junction box (CJB) from connector CBP02F.
	3 Measure the resistance between the wash/wipe system switch, connector CRW08, pin 5, circuit CRW20A (GY/YE), wiring harness side and the central junction box (CJB), connector CBP02F, pin 13, circuit CRW20A (GY/YE), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to A23. → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
A23: CHECK CENTRAL JUNCTION BOX (CJB)	
	1 Connect Wash/wipe system switch to connector CRW08.
	2 Connect Central junction box (CJB) to connector CBP02F.
	3 Disconnect Central junction box (CJB) from connector CBP02D.
	4 Connected a fused jumper wire (10 A) to the central junction box (CJB), connector CBP02D, between pin 15, circuit CRW02A (GY/BU), wiring harness side and ground.
	5 Ignition switch in position II.
	6 CHECK the rear window wiper. • Do the rear wipers operate? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** GO to A24.
A24: CHECK CIRCUIT CRW02A (GY/BU) BETWEEN THE CENTRAL JUNCTION BOX (CJB) AND THE REAR WINDOW WIPER RELAY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Rear window wiper relay from socket R24.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Measure the resistance between the central junction box (CJB), connector CBP02D, pin 15, circuit CRW02A (GY/BU), wiring harness side and the rear window wiper relay, socket R24, pin 2, circuit CRW02A (GY/BU), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** - Vehicles with tailgate: GO to A25. - Vehicles with rear doors: GO to A26. → **No** LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and the rear window wiper relay using the Wiring Diagrams. CHECK system operates correctly
A25: CHECK THE VOLTAGE SUPPLY TO THE REAR WIPER MOTOR FOR OPEN CIRCUIT	
NOTE: Minimum duration of measurement is 20 seconds.	
	1 Connect Rear window wiper relay to socket R24.
	2 Connect Central junction box (CJB) to connector CBP02D.
	3 Disconnect Rear wiper motor from connector CRW02L.
	4 Ignition switch in position II.
	5 TURN ON the rear wiper.
 VFE0032240	6 Measure the voltage between the rear window wiper motor, connector CRW02L, pin 3, circuit CB138F (GY/BU), wiring harness side and ground. • Is battery voltage measured approximately every 10 seconds? → **Yes** GO to A30. → **No** GO to A26.
A26: NARROW DOWN THE CAUSE OF THE FAULT	
	1 Connect Only vehicles with rear doors: Rear window wiper relay to socket R24.
	2 Connect Only vehicles with rear doors: Central junction box (CJB) to connector CBP02D.

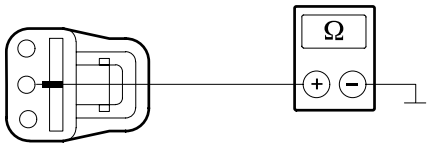
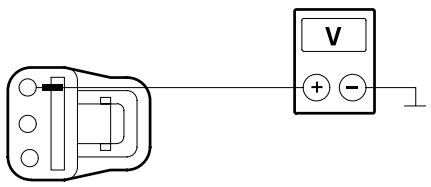
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Disconnect Only vehicles with rear doors: Rear left wiper motor from connector CRW02.
	4 Ignition switch in position II.
 VFE0016222	5 Measure the voltage between wiper motor: – Vehicles with tailgate: rear, connector CRW02L, pin 1, circuit CB138K (GY/BU), wiring harness side and ground. – Vehicles with rear doors: rear left, connector CRW02, pin 1, circuit CB138K (GY/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to A27. → **No** LOCATE and RECTIFY the break in the circuit between fuse F38 and soldered connection S2B138A using the Wiring Diagrams. CHECK system operates correctly
A27: CHECK THE CIRCUIT BETWEEN THE REAR WINDOW WIPER MOTOR AND THE REAR WINDOW WIPER RELAY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Rear window wiper relay from socket R24.
	3 Measure the resistance between the rear window wiper relay: – Vehicles with tailgate: Socket R24, pin 3, wiring harness side and rear window wiper motor CRW02L, pin 1, circuit CB138K (GY/BU), wiring harness side and ground. – Vehicles with rear doors: Socket R24, pin 3, wiring harness side and left-hand rear window wiper motor, connector CRW02, pin 1, circuit CB138K (GY/BU). • Is a resistance of less than 2 ohms registered? → **Yes** GO to A28. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2B138A and the rear window wiper relay using the Wiring Diagrams. CHECK system operates correctly
A28: CHECK THE CIRCUIT BETWEEN THE REAR WINDOW WIPER RELAY AND THE REAR WINDOW WIPER MOTOR/SOLDERED CONNECTION S2B138B FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

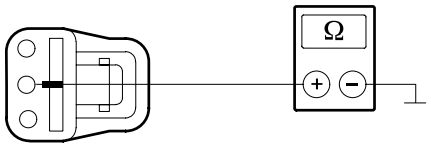
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the rear window wiper relay: – Vehicles with tailgate: Socket R24, pin 3, wiring harness side and the rear window wiper motor, connector CRW02L, pin 5, circuit CB138G (GY/BU), wiring harness side. – Vehicles with rear doors: Socket R24, pin 3, wiring harness side and left-hand rear window wiper motor, connector CRW02, pin 5, circuit CB138G (GY/BU), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to A29. → **No** - Vehicles with tailgate: LOCATE and RECTIFY the break in the circuit between the rear wiper relay and the rear wiper motor using the Wiring Diagrams. CHECK system operates correctly - Vehicles with rear doors: LOCATE and RECTIFY the break in the circuit between the rear wiper relay and soldered connection S2B138B using the Wiring Diagrams. CHECK system operates correctly
A29: CHECK THE VOLTAGE AT THE WINDSHIELD WIPER RELAY	
	1 Measure the voltage between the windshield wiper relay, socket R24, pin 1, wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the rear wiper relay. CHECK system operates correctly → **No** LOCATE and REPAIR the break in the circuit between the rear wiper relay, pin 1, and fuse F48 using the Wiring Diagrams. CHECK system operates correctly
A30: CHECK THE GROUND CONNECTION OF THE REAR WIPER MOTOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0032242	2 Measure the resistance between the rear window wiper motor, connector CRW02L, pin 2, circuit A_GD149N (BK/GY), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** INSTALL a new rear wiper motor. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between the rear wiper motor and ground connection GP49 using the Wiring Diagrams. CHECK system operates correctly
A31: CHECK THE VOLTAGE SUPPLY TO THE AFFECTED REAR WIPER MOTOR FOR OPEN CIRCUIT	
NOTE: Minimum duration of measurement is 20 seconds.	
	1 Ignition switch in position 0.
	2 Disconnect Affected rear wiper motor. – left: from connector CRW02 – right: from connector CRW13
	3 Ignition switch in position II.
	4 TURN ON the rear wiper.
 VFE0032240	5 Measure the voltage between rear window wiper motor: – left: Connector CRW02, pin 3, circuit CB138G (GY/BU), wiring harness side and ground. – right: Connector CRW13, pin 3, circuit CB138E (GY/BU), wiring harness side and ground. • Is battery voltage measured approximately every 10 seconds? → **Yes** GO to A32. → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2B138B and the affected rear wiper motor using the Wiring Diagrams. CHECK system operates correctly
A32: CHECK THE GROUND CONNECTION OF THE AFFECTED REAR WIPER MOTOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

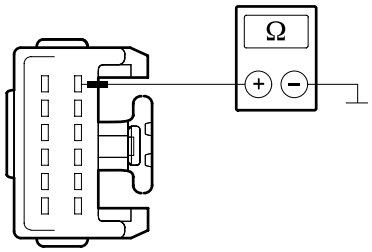
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0032242	2 Measure the resistance between rear window wiper motor: – left: Connector CRW02, pin 2, circuit GD149C (BK/GY), wiring harness side and ground. – right: connector CRW13, pin 2, circuit GD151E (BK/GN), wiring harness side and ground. • Is the resistance less than 2 ohms? → **Yes** RENEW the affected rear window wiper motor. CHECK system operates correctly → **No** - Left: LOCATE and RECTIFY the break in the circuit between the rear wiper motor and ground connection GP49 using the Wiring Diagrams. CHECK system operates correctly - Right: LOCATE and RECTIFY the break in the circuit between the rear wiper motor and soldered connection S4D151C using the Wiring Diagrams. CHECK system operates correctly
A33: NARROW DOWN THE CAUSE OF THE FAULT	
	1 Ignition switch in position II.
	2 Engage reverse gear.
	3 CHECK the reversing lamps. • Do the reversing lamps illuminate? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** REFER to:Reversing Lamps (417-01 Exterior Lighting, Diagnosis and Testing).

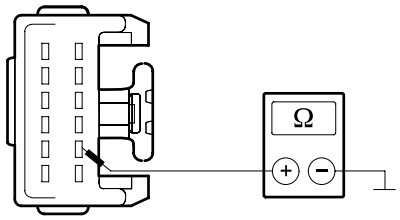
PINPOINT TEST B : THE WINDSCREEN WIPER RUNS CONTINUOUSLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position 0.
	2 Disconnect Wash/wipe system switch from connector CRW08.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Ignition switch in position II. • Is the windshield wiper motor on continually? → **Yes** - The windshield wiper motor is running continually at the slow wipe speed: GO to B2. - The windshield wiper motor is running continually at the fast wipe speed: GO to B5. → **No** RENEW the wash/wipe switch. CHECK system operates correctly
B2: CHECK CIRCUIT CRW10A (BU/GN) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02F.
 VFE0038549	3 Measure resistance between wash/wipe system switch, connector CRW08, pin 6, circuit CRW10A (BU/GN), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to B3. → **No** LOCATE and RECTIFY the short to ground in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
B3: CHECK THE CJB	
	1 Disconnect Central junction box (CJB) from connector CBP02D.
	2 Ignition switch in position II. • Does the front wiper motor run continuously at slow wipe speed? → **Yes** GO to B4. → **No** INSTALL a new CJB. CHECK system operates correctly

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B4: CHECK CIRCUIT CRW03A (VT/WH) BETWEEN THE CENTRAL JUNCTION BOX (CJB) AND THE WINDSHIELD WIPER RELAY FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Windshield wiper relay from socket R25.
	3 Measure the resistance between the central junction box (CJB), connector CBP02D, pin 3, circuit CRW03A (VT/WH), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** RENEW the windshield wiper relay . CHECK system operates correctly → **No** LOCATE and RECTIFY the short to ground in the circuit between the central junction box (CJB) and the windshield wiper relay using the Wiring Diagrams. CHECK system operates correctly
B5: CHECK CIRCUIT CRW08A (VT/OG) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02F.
 VFE0038550	3 Measure resistance between wash/wipe system switch, connector CRW08, pin 2, circuit CRW08A (VT/OG), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to B6. → **No** LOCATE and RECTIFY the short to ground in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
B6: CHECK THE CJB	
	1 Disconnect Central junction box (CJB) from connector CBP02D.

DIAGNOSIS AND TESTING

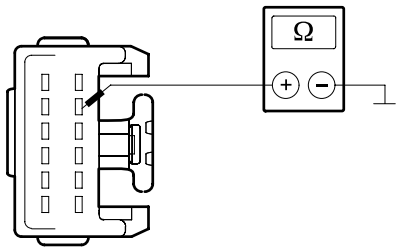
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Ignition switch in position II. • Does the front wiper motor run continuously at fast wipe speed? → **Yes** GO to B7. → **No** INSTALL a new CJB. CHECK system operates correctly
B7: CHECK CIRCUIT CRW15A (VT/RD)/(BN/WH) BETWEEN THE WINDSHIELD WIPER SPEED RELAY AND THE WINDSHIELD WIPER MOTOR FOR SHORT TO BATTERY VOLTAGE	
	1 Disconnect Windshield wiper speed relay from socket R23.
	2 Ignition switch in position II. • Does the front wiper motor run continuously at fast wipe speed? → **Yes** - Box van / Bus / Combi: LOCATE and RECTIFY the short to battery voltage in circuit CRW15A (BN/WH) between the windshield wiper speed relay and the windshield wiper motor using the Wiring Diagrams. CHECK system operates correctly - Platform truck: LOCATE and RECTIFY the short to battery voltage in circuit CRW15A (VT/RD) between the windshield wiper speed relay and the windshield wiper motor using the Wiring Diagrams. CHECK system operates correctly → **No** RENEW the windshield wiper speed relay . CHECK system operates correctly

DIAGNOSIS AND TESTING

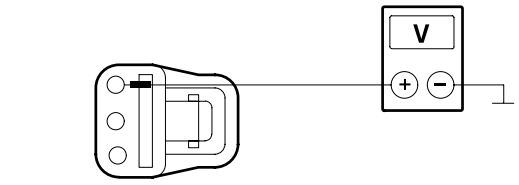
PINPOINT TEST C : THE REAR WINDOW WIPER RUNS CONTINUOUSLY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II. • Does/do the rear window wiper motor(s) run continuously in intermittent wipe mode? → **Yes** GO to C2. → **No** - The rear window wiper motor(s) runs/run continuously (not in intermittent mode) when the front windscreen wiper is switched off: GO to C4. - The rear window wiper motor(s) runs/run (not in intermittent mode) when the front windscreen wiper is switched on: INSTALL a new CJB. CHECK system operates correctly - Vehicles with rear doors: Individual rear window wiper motor runs continuously (not in intermittent mode). RENEW the affected rear window wiper motor. CHECK system operates correctly
C2: CHECK THE WASH/WIPE SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Wash/wipe system switch from connector CRW08.
	3 Ignition switch in position II. • Does/do the rear window wiper motor(s) run continuously in intermittent wipe mode? → **Yes** GO to C3. → **No** RENEW the wash/wipe switch. CHECK system operates correctly
C3: CHECK CIRCUIT CRW20A (GY/YE) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02F.

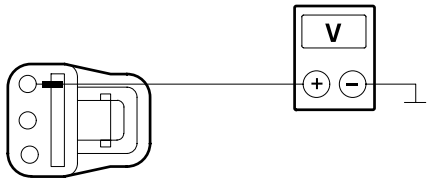
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0038551	3 Measure resistance between wash/wipe system switch, connector CRW08, pin 5, circuit CRW20A (GY/YE), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** LOCATE and RECTIFY the short to ground in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
C4: CHECK THE CJB	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02D.
	3 Ignition switch in position II. • Does the rear window wiper motor run continuously (not in intermittent mode)? → **Yes** GO to C5. → **No** INSTALL a new CJB. CHECK system operates correctly
C5: CHECK CIRCUIT CRW02A (GY/BU) BETWEEN THE CENTRAL JUNCTION BOX (CJB) AND THE REAR WINDOW WIPER RELAY FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Rear window wiper relay from socket R24.
	3 Ignition switch in position II. • Does/do the rear window wiper motor(s) run continuously (not in intermittent mode)? → **Yes** GO to C6. → **No** LOCATE and RECTIFY the short to ground in circuit CRW02A (GY/BU) between the central junction box (CJB) and the rear window wiper relay using the Wiring Diagrams. CHECK system operates correctly

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C6: NARROW DOWN THE CONDITIONS UNDER WHICH THE FAULT OCCURS	
	1 Ignition switch in position II.
	2 Measure the voltage between the rear window wiper relay, socket R24, pin 5, wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuits connected to the rear window wiper relay, socket R24, pin 5 using the Wiring Diagrams. CHECK system operates correctly → **No** - Vehicles with tailgate: GO to C7. - Vehicles with rear doors: GO to C8.
C7: CHECK THE REAR WINDOW WIPER RELAY	
	1 Ignition switch in position 0.
	2 Connect Rear window wiper relay to socket R24.
	3 Disconnect Rear wiper motor from connector CRW02L.
	4 Ignition switch in position II.
 VFE0032240	5 Measure the voltage between the rear window wiper motor, connector CRW02L, pin 3, circuit, wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the rear wiper relay. CHECK system operates correctly → **No** INSTALL a new rear wiper motor. CHECK system operates correctly
C8: ELIMINATE THE REAR LEFT WIPER MOTOR AS CAUSE FOR THE SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Connect Rear window wiper relay to socket R24.
	3 Disconnect Rear left wiper motor from connector CRW02.
	4 Ignition switch in position II.

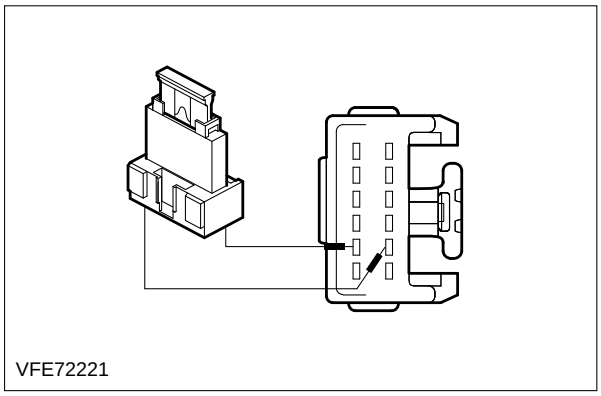
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	5 CHECK the rear right wiper motor. • Is the rear right wiper motor on continually? → **Yes** GO to C9. → **No** RENEW the rear left window wiper motor. CHECK system operates correctly
C9: ELIMINATE THE REAR RIGHT WIPER MOTOR AS CAUSE FOR THE SHORT TO BATTERY VOLTAGE	
	1 Ignition switch in position 0.
	2 Disconnect Right wiper motor from connector CRW13.
	3 Ignition switch in position II.
 VFE0032240	4 Measure the voltage between the rear right window wiper motor, connector CRW13, pin 3, circuit R_CB138E (GY/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the rear wiper relay. CHECK system operates correctly → **No** RENEW rear right wiper motor. CHECK system operates correctly

PINPOINT TEST D : SLOW/FAST WIPE NOT WORKING.

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 SWITCH ON the slow wipe speed.
	3 SWITCH ON the fast wiper speed.
	4 CHECK windshield wipers. • Do the windscreen wipers operate at slow speed? → **Yes** Fast wipe speed inoperative. GO to D2. → **No** Slow wipe speed inoperative. GO to D8.

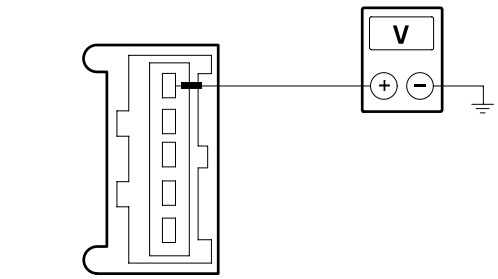
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D2: CHECK THE WASH/WIPE SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Wash/wipe system switch from connector CRW08.
 VFE72221	3 Connect a fused jumper wire (10 A) to the wash/wipe system switch, connector CRW08, pin 2, circuit CRW08A (VT/OG) and pin 8, circuit GD115E (BK/GY), wiring harness side.
	4 Ignition switch in position II. • Do the windscreen wipers operate at fast speed? → **Yes** RENEW the wash/wipe switch. CHECK system operates correctly → **No** GO to D3.
D3: CHECK CIRCUIT CRW08A (VT/OG) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02F.
	3 Measure the resistance between the wash/wipe system switch, connector CRW08, pin 2, circuit CRW08A (VT/OG), wiring harness side and the central junction box (CJB), connector CBP02F, pin 6, circuit CRW08A (VT/OG), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to D4. → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly

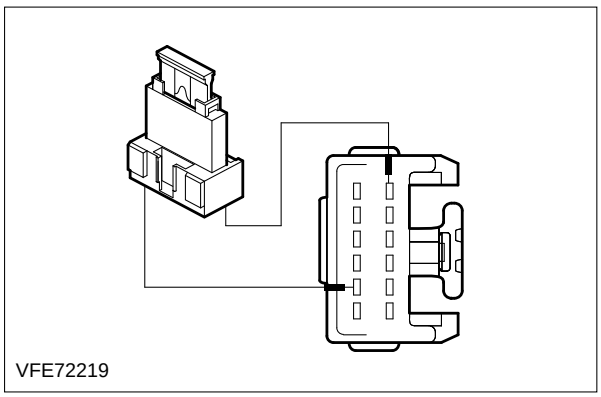
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D4: CHECK CENTRAL JUNCTION BOX (CJB)	
	1 Connect Wash/wipe system switch to connector CRW08.
	2 Connect Central junction box (CJB) to connector CBP02F.
	3 Disconnect Central junction box (CJB) from connector CBP02D.
	4 Connected two fused jumper wires (10 A) to the central junction box (CJB), connector CBP02D, pin 2, circuit ZA221A (OG/GY) and pin 3, circuit CRW03A (VT/WH), wiring harness side and ground.
	5 Ignition switch in position II.
	6 CHECK windshield wipers. • Do the windscreen wipers operate at fast speed? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** GO to D5.
D5: CHECK CIRCUIT ZA221A (OG/GY) BETWEEN THE CENTRAL JUNCTION BOX (CJB) AND THE WINDSHIELD WIPER SPEED RELAY FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Windshield wiper speed relay from socket R23.
	3 Measure the resistance between the central junction box (CJB), connector CBP02D, pin 2, circuit ZA221A (OG/GY), wiring harness side and the windshield wiper speed relay, socket R23, pin 2, circuit ZA221A (OG/GY), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to D6. → **No** LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and the windshield wiper speed relay using the Wiring Diagrams. CHECK system operates correctly

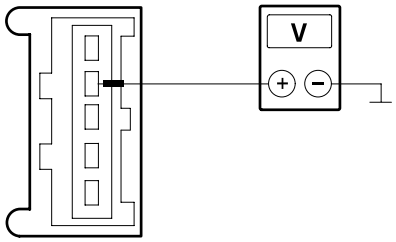
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D6: CHECK THE VOLTAGE SUPPLY TO THE FRONT WIPER MOTOR FOR OPEN CIRCUIT	
	1 Connect Central junction box (CJB) to connector CBP02D.
	2 Connect Windshield wiper speed relay to socket R23.
	3 Disconnect Front wiper motor from connector CRW01.
	4 Ignition switch in position II.
	5 SWITCH ON the fast wiper speed.
 E0011611	6 Measure the voltage between the windshield wiper motor, connector CRW01, pin 5, circuit CRW15A (BN/WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the front wiper motor CHECK system operates correctly → **No** GO to D7.
D7: CHECK CIRCUIT CRW15A (BN/WH)/(VT/RD) BETWEEN THE WINDSHIELD WIPER SPEED RELAY AND THE WINDSHIELD WIPER MOTOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Windshield wiper speed relay from socket R23.
	3 Measure the resistance between the windshield wiper speed relay, socket R23, pin 5, circuit CRW15A (BN/WH), wiring harness side and the windshield wiper motor, connector CRW01, pin 5, circuit CRW15A (BN/WH), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the windshield wiper speed relay . CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between the windshield wiper speed relay and the windshield wiper motor using the Wiring Diagrams. CHECK system operates correctly
D8: CHECK THE WASH/WIPE SWITCH	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Wash/wipe system switch from connector CRW08.
 VFE72219	3 Connect a fused jumper wire (10 A) to the wash/wipe system switch, connector CRW08, pin 6, circuit CRW10A (BU/GN) and pin 8, circuit GD115E (BK/GY), wiring harness side.
	4 Ignition switch in position II. • Do the windscreen wipers operate at slow speed? → **Yes** RENEW the wash/wipe switch. CHECK system operates correctly → **No** GO to D9.
D9: CHECK CIRCUIT CRW10A (BU/GN) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02F.
	3 Measure the resistance between the wash/wipe system switch, connector CRW08, pin 6, circuit CRW10A (BU/GN), wiring harness side and the central junction box (CJB), connector CBP02F, pin 20, circuit CRW10A (BU/GN), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to D10. → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
D10: CHECK CENTRAL JUNCTION BOX (CJB)	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Connect Central junction box (CJB) to connector CBP02F.
	3 Connect Wash/wipe system switch to connector CRW08.
	4 Disconnect Central junction box (CJB) from connector CBP02D.
	5 Connected a fused jumper wire (10 A) to the central junction box (CJB), connector CBP02D, between pin 3, circuit CRW03A (VT/WH), wiring harness side and ground.
	6 Ignition switch in position II.
	7 CHECK windshield wipers. • Do the windshield wipers operate at slow speed? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** GO to D11.
D11: CHECK THE VOLTAGE SUPPLY TO THE FRONT WIPER MOTOR FOR OPEN CIRCUIT	
	1 Connect Central junction box (CJB) to connector CBP02D.
	2 Disconnect Front wiper motor from connector CRW01.
	3 SWITCH ON the slow wipe speed.
	4 Ignition switch in position II.
 VFE0015933	5 Measure the voltage between the front wiper motor, connector CRW01, pin 4, circuit CRW16A (GY/BN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the front wiper motor CHECK system operates correctly → **No** GO to D12.
D12: CHECK CIRCUIT CRW16A (GY/BN) BETWEEN THE WINDSHIELD WIPER SPEED RELAY AND THE WINDSHIELD WIPER MOTOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Windshield wiper speed relay from socket R23.
	3 Measure the resistance between the windshield wiper speed relay, socket R23, pin 4, circuit CRW16A (GY/BN), wiring harness side and the windshield wiper motor, connector CRW01, pin 4, circuit CRW16A (GY/BN), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** RENEW the windshield wiper speed relay . CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between the windshield wiper speed relay and the windshield wiper motor using the Wiring Diagrams. CHECK system operates correctly

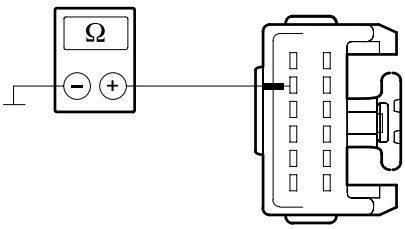
PINPOINT TEST E : INTERMITTENT WIPE MODE OF WINDSCREEN WIPER INOPERATIVE, VEHICLES WITH AND WITHOUT RAIN SENSOR (FAST/SLOW WIPE OK)

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 SWITCH ON the slow wipe speed.
	3 SWITCH OFF slow wipe speed.
	4 CHECK windshield wipers. • Does the windscreen wiper return to the park position? → **Yes** GO to E2. → **No** GO to Pinpoint Test G.
E2: NARROW DOWN THE CONDITIONS UNDER WHICH THE FAULT OCCURS	
NOTE: For vehicles with rain sensor, wet the windshield several times with water in the vicinity of the rain sensor, in order to check whether the windshield wiper motor runs in intermittent wipe mode.	
	1 SWITCH ON intermittent mode at the wash/wipe system switch.

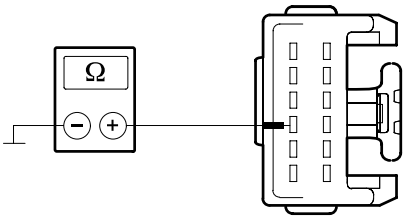
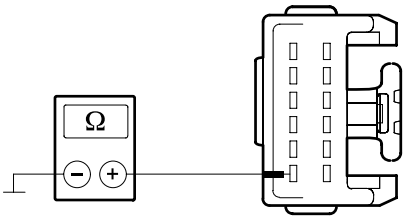
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 CHECK windshield wipers. • Does the windshield wiper motor perform a different wipe cycle than the one set with the wash/wipe switch? → **Yes** GO to E5. → **No** - Windshield wiper intermittent mode is inoperative: GO to E3. - Vehicles with rain sensor: Does the windshield wiper motor perform a wipe cycle every six seconds? GO to E12.
E3: CHECK THE WASH/WIPE SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Wash/wipe system switch from connector CRW08.
	3 CHECK the wash/wipe system switch according to the component check at the end of this section. • Is the wash/wipe switch OK? → **Yes** GO to E4. → **No** RENEW the wash/wipe switch. CHECK system operates correctly
E4: CHECK CIRCUIT VRW11A (GN/BN) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Disconnect Central junction box (CJB) from connector CBP02F.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Measure the resistance between the wash/wipe system switch, connector CRW08, pin 12, circuit VRW11A (GN/BN), wiring harness side and the central junction box (CJB), connector CBP02F, pin 17, circuit VRW11A (GN/BN), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
E5: CHECK CIRCUIT CRW19A (BU/OG) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02F.
 VFE0038562	3 Measure resistance between wash/wipe system switch, connector CRW08, pin 11, circuit CRW19A (BU/OG), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to E6. → **No** LOCATE and RECTIFY the short to ground in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly

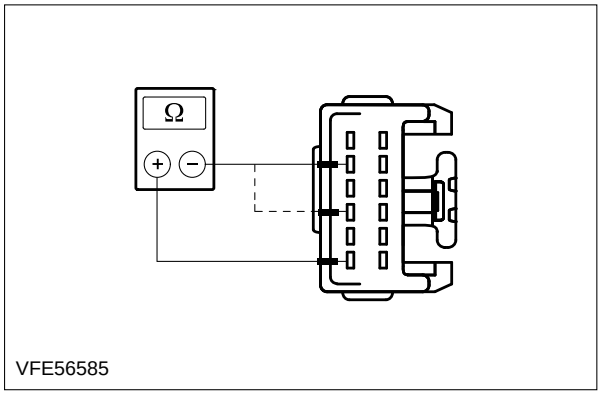
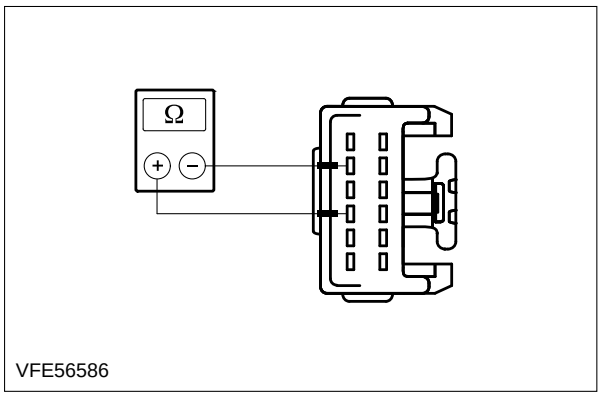
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E6: CHECK CIRCUIT CRW18A (VT/WH) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
 VFE0038563	1 Measure resistance between wash/wipe system switch, connector CRW08, pin 9, circuit CRW18A (VT/WH), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to E7. → **No** LOCATE and RECTIFY the short to ground in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
E7: CHECK CIRCUIT CRW17A (GN/VT) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
 VFE0038564	1 Measure resistance between wash/wipe system switch, connector CRW08, pin 7, circuit CRW17A (GN/VT), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to E8. → **No** LOCATE and RECTIFY the short to ground in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly

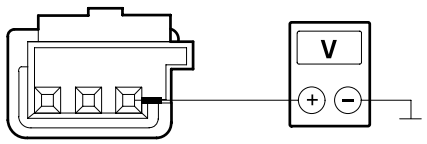
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E8: CHECK CIRCUIT CRW19A (BU/OG) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Measure the resistance between the wash/wipe system switch, connector CRW08, pin 11, circuit CRW19A (BU/OG), wiring harness side and the central junction box (CJB), connector CBP02F, pin 8, circuit CRW19A (BU/OG), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to E9. → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
E9: CHECK CIRCUIT CRW18A (VT/WH) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Measure the resistance between the wash/wipe system switch, connector CRW08, pin 9, circuit CRW18A (VT/WH), wiring harness side and the central junction box (CJB), connector CBP02F, pin 18, circuit CRW18A (VT/WH), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to E10. → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly

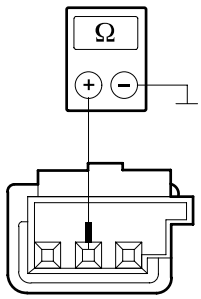
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E10: CHECK CIRCUIT CRW17A (GN/VT) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Measure the resistance between the wash/wipe system switch, connector CRW08, pin 7, circuit CRW17A (GN/VT), wiring harness side and the central junction box (CJB), connector CBP02F, pin 7, circuit CRW17A (GN/VT), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to E11. → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
E11: CHECK CONTROL WIRES BETWEEN WASH/WIPE SYSTEM SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR MUTUAL SHORT CIRCUIT	
VFE56585	1 Measure the resistance between the wash/wipe system switch, connector CRW08, pin 7, circuit CRW17A (GN/VT) and pin 11, circuit CRW19A (BU/OG) and between pin 7, circuit CRW17A (GN/VT) and pin 9, circuit CRW18A (VT/WH), wiring harness side.
VFE56586	2 Measure resistance between wash/wipe system switch, connector CRW08, pin 9, circuit CRW18A (VT/WH) and pin 11, circuit CRW19A (BU/OG), wiring harness side. • Is a resistance of more than 10,000 ohms measured in all of the measurements? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** LOCATE and RECTIFY the short in the circuits between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly

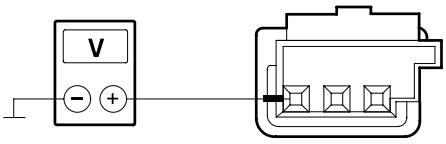
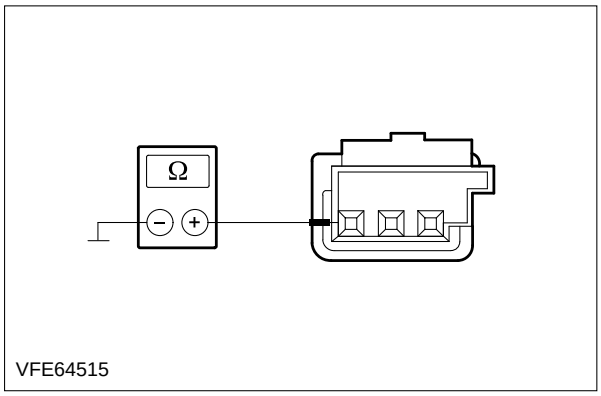
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E12: CHECK FUSE F63 (5 A) (CJB).	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F63 (5 A) (CJB).
	3 CHECK Fuse F63 (5 A) (CJB). • Is fuse OK? → **Yes** GO to E13. → **No** RENEW fuse F63 (5 A) (CJB) and CHECK the operation of the system. If fuse blows again, LOCATE and RECTIFY the short to ground using the Wiring Diagrams. CHECK system operates correctly
E13: CHECK THE VOLTAGE SUPPLY TO FUSE F63 (5 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F63 (5 A) (CJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F63 (5 A) (CJB) and ground. • Does the meter display battery voltage? → **Yes** GO to E14. → **No** INSTALL a new CJB. CHECK system operates correctly
E14: CHECK VOLTAGE SUPPLY TO RAIN SENSOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Rain sensor from connector CRW06.
	3 Ignition switch in position II.
 VFE0038444	4 Measure the voltage between rain sensor: – Van, bus, combi: Connector CRW06, pin 1, circuit SBP63G (WH/RD), wiring harness side and ground. – Platform truck: Connector CRW06, pin 1, circuit SBP63F (WH/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to E16. → **No** GO to E15.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E15: CHECK CENTRAL JUNCTION BOX (CJB)	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02D.
	3 Measure the resistance between central junction box (CJB): – Van, bus, combi: connector CBP02D, pin 11, circuit SBP63A (WH/RD), wiring harness side and rain sensor, connector CRW06, pin 1, circuit SBP63G (WH/RD), wiring harness side. – Platform truck: connector CBP02D, pin 11, circuit SBP63A (WH/RD), wiring harness side and rain sensor, connector CRW06, pin 1, circuit SBP63F (WH/RD), wiring harness side. • Is the resistance less than 2 ohms? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and the rain sensor using the Wiring Diagrams. CHECK system operates correctly
E16: CHECK THE GROUND CONNECTION OF THE RAIN SENSOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
 VFE0038446	2 Measure the resistance between the rain sensor, connector CRW06, pin 2, circuit B_GD138AF(BK/WH), wiring harness side and ground. • Is the resistance less than 2 ohms? → **Yes** GO to E17. → **No** LOCATE AND RECTIFY the break in the circuit between the rain sensor and ground connection GP38 using the Wiring Diagrams. CHECK system operates correctly
E17: CHECK SIGNAL CABLE OF RAIN SENSOR FOR SHORT TO BATTERY VOLTAGE	
	1 Disconnect Central junction box (CJB) from connector CBP02C.
	2 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0038449	3 Measure the voltage between rain sensor: – Van, bus, combi: Connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side and ground. – Drop side body: Connector CRW06, pin 3, circuit VRW26E (GY/RD), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** LOCATE and RECTIFY the short to battery voltage in the circuit between the central junction box (CJB) and the rain sensor using the Wiring Diagrams. CHECK system operates correctly → **No** GO to E18.
E18: CHECK SIGNAL CABLE OF RAIN SENSOR FOR SHORT TO GROUND	
	1 Ignition switch in position 0.
 VFE64515	2 Measure the resistance between rain sensor: – Van, bus, combi: Connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side and ground. – Drop side body: Connector CRW06, pin 3, circuit VRW26E (GY/RD), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to E19. → **No** LOCATE and RECTIFY the short to ground in the circuit between the central junction box (CJB) and the rain sensor using the Wiring Diagrams. CHECK system operates correctly

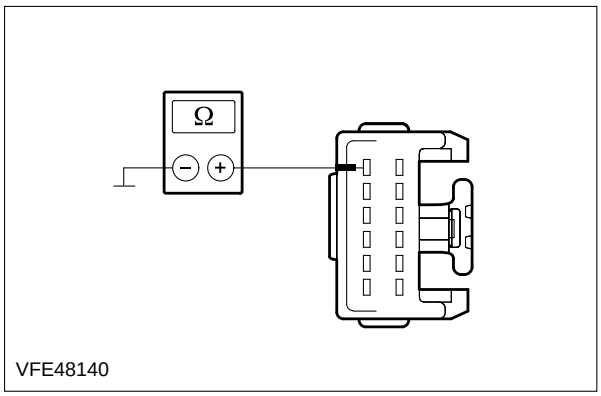
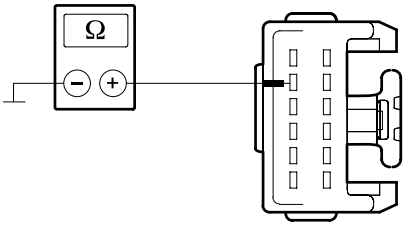
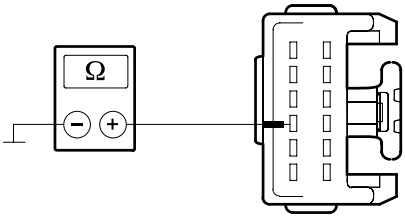
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
E19: CHECK SIGNAL CABLE OF RAIN SENSOR FOR OPEN CIRCUIT	
	1 Measure the resistance between central junction box (CJB): – Van, bus, combi: connector CBP02C, pin 37, circuit VRW26A (BN/YE), wiring harness side and rain sensor, connector CRW06, pin 3, circuit VRW26C (BN/YE), wiring harness side. – Drop side body: connector CBP02C, pin 37, circuit VRW26B (GY/RD), wiring harness side and rain sensor, connector CRW06, pin 3, circuit VRW26E (GY/RD), wiring harness side. • Is the resistance less than 2 ohms? → **Yes** RENEW the rain sensor. CHECK system operates correctly If the concern is not rectified, INSTALL A NEW central junction box (CJB). CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and the rain sensor using the Wiring Diagrams. CHECK system operates correctly

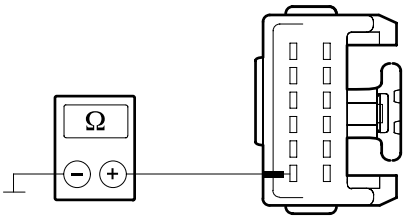
PINPOINT TEST F : THE WINDSHIELD WIPER RUNS CONTINUOUSLY IN INTERMITTENT MODE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F1: CHECK THE WASH/WIPE SWITCH	
	1 Ignition switch in position 0.
	2 Disconnect Wash/wipe system switch from connector CRW08.
	3 CHECK the wash/wipe system switch according to the component check at the end of this section. • Is the wash/wipe switch OK? → **Yes** GO to F2. → **No** RENEW the wash/wipe switch. CHECK system operates correctly
F2: CHECK CIRCUIT VRW11A (GN/BN) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
	1 Disconnect Central junction box (CJB) from connector CBP02F.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE48140	2 Measure resistance between wash/wipe system switch, connector CRW08, pin 12, circuit VRW11A (GN/BN), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to F3. → **No** LOCATE and RECTIFY the short to ground in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
F3: CHECK CIRCUIT CRW19A (BU/OG) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
 VFE0038562	1 Measure resistance between wash/wipe system switch, connector CRW08, pin 11, circuit CRW19A (BU/OG), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to F4. → **No** LOCATE and RECTIFY the short to ground in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
F4: CHECK CIRCUIT CRW18A (VT/WH) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
 VFE0038563	1 Measure resistance between wash/wipe system switch, connector CRW08, pin 9, circuit CRW18A (VT/WH), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** GO to F5. → **No** LOCATE and RECTIFY the short to ground in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly

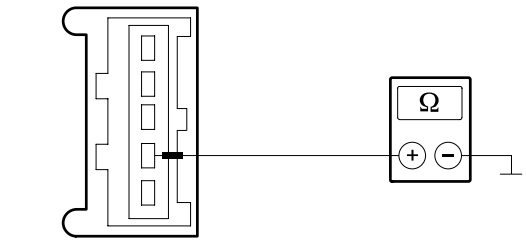
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
F5: CHECK CIRCUIT CRW17A (GN/VT) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR SHORT TO GROUND	
 VFE0038564	1 Measure resistance between wash/wipe system switch, connector CRW08, pin 7, circuit CRW17A (GN/VT), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** LOCATE and RECTIFY the short to ground in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly

PINPOINT TEST G : THE WINDSHIELD WIPER MOTOR DOES NOT RETURN TO THE PARK POSITION AFTER BEING SWITCHED OFF

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G1: CHECK CIRCUIT ZA222A (OG/WH) BETWEEN FRONT WIPER MOTOR AND CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Ignition switch in position 0.
	2 Disconnect Front wiper motor from connector CRW01.
	3 Disconnect Central junction box (CJB) from connector CBP02C.
	4 Measure the resistance between the front wiper motor, connector CRW01, pin 2, circuit ZA222A (OG/WH), wiring harness side and the central junction box (CJB), connector CBP02C, pin 21, circuit ZA222A (OG/WH), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to G2. → **No** LOCATE and RECTIFY the break in the circuit between the windshield wiper motor and the central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly

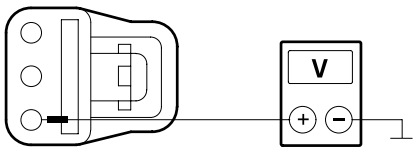
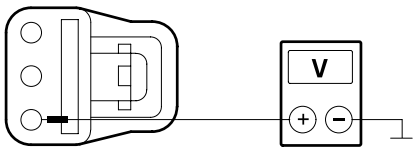
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
G2: CHECK CIRCUIT ZA222A (OG/WH) BETWEEN CENTRAL JUNCTION BOX (CJB) AND FRONT WIPER MOTOR FOR SHORT TO GROUND	
 VFE0026310	1 Measure the resistance between the front wiper motor, connector CRW01, pin 2, circuit ZA222A (OG/WH), wiring harness side and ground. • Is a resistance of more than 10,000 ohms measured? → **Yes** CHECK the front wiper motor according to the component test at the end of this section and RENEW as necessary. CHECK system operates correctly If the concern is not rectified, INSTALL A NEW central junction box (CJB). CHECK system operates correctly → **No** LOCATE and RECTIFY the short to ground in the circuit between central junction box (CJB) and the front wiper motor using the Wiring Diagrams. CHECK system operates correctly

PINPOINT TEST H : THE REAR WINDOW WIPER(S) DOES/DO NOT RETURN TO THE PARK POSITION AFTER BEING SWITCHED OFF

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
H1: DETERMINE THE FAULT CONDITION	
	1 Ignition switch in position II.
	2 TURN ON the rear wiper.
	3 SWITCH OFF the rear wiper.
	4 CHECK the rear window wiper. • Does the rear (left) wiper return to the park position? → **Yes** Vehicles with rear doors: Rear right window wiper does not return to the park position. GO to H2. → **No** Vehicles with rear doors or tailgate: Rear left window wiper does not return to the park position. GO to H3.
H2: CHECK THE VOLTAGE SUPPLY TO THE REAR RIGHT WIPER MOTOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Rear right wiper motor from connector CRW13.

DIAGNOSIS AND TESTING

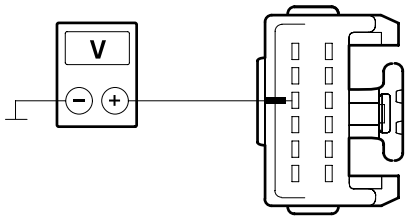
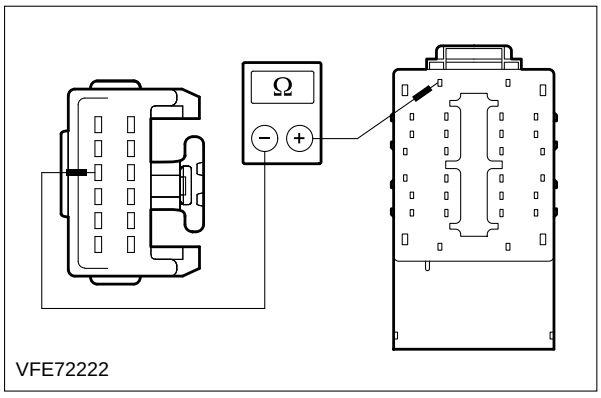
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Ignition switch in position II.
 VFE0016222	4 Measure the voltage between the rear right window wiper motor, connector CRW13, pin 1, circuit CB138K (GY/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW rear right wiper motor. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2B138A and the rear right wiper motor using the Wiring Diagrams. CHECK system operates correctly
H3: CHECK THE VOLTAGE SUPPLY TO THE REAR (LEFT) WIPER MOTOR FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Rear wiper motor.. – Vehicles with rear doors: left from connector CRW02 – Vehicles with tailgate: from connector CRW02L
	3 Ignition switch in position II.
 VFE0016222	4 Measure the voltage between rear (left) window wiper motor: – Vehicles with rear doors: Connector CRW02, pin 1, circuit CB138M (GY/BU), wiring harness side and ground. – Vehicles with tailgate: Connector CRW02L, pin 1, circuit A_CB138N (GY/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the rear (left) window wiper motor. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between soldered connection S2B138A and the rear (left) wiper motor using the Wiring Diagrams. CHECK system operates correctly

DIAGNOSIS AND TESTING

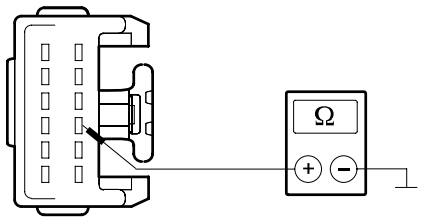
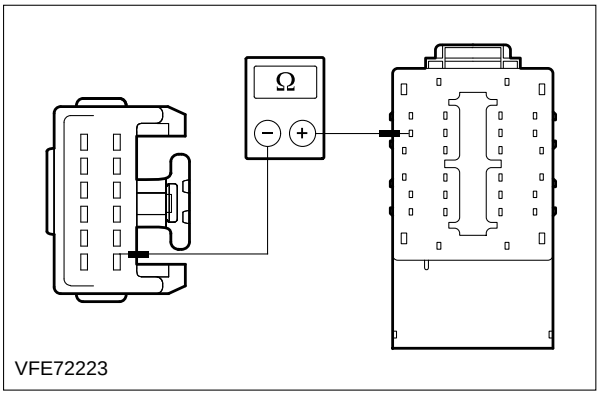
PINPOINT TEST I : THE FRONT AND REAR WASH/WIPE FUNCTIONS ARE INOPERATIVE (WIPE AND INTERMITTENT FUNCTION OK)

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I1: CHECK FUSE F67 (10 A) (CJB).	
	1 Ignition switch in position 0.
	2 Disconnect Fuse F67 (10 A) (CJB).
	3 CHECK Fuse F67 (10 A) (CJB). • Is fuse OK? → **Yes** GO to I2. → **No** RENEW fuse F67 (10 A) (CJB) CHECK system operates correctly If the fuse blows again, LOCATE and RECTIFY the short circuit using the Wiring Diagrams. CHECK system operates correctly
I2: CHECK THE VOLTAGE SUPPLY TO FUSE F67 (10 A) (CJB) FOR OPEN CIRCUIT	
	1 Connect Fuse F67 (10 A) (CJB).
	2 Ignition switch in position II.
	3 Measure the voltage between fuse F67 (10A) (CJB) • Does the meter display battery voltage? → **Yes** GO to I3. → **No** INSTALL a new CJB. CHECK system operates correctly
I3: CHECK THE VOLTAGE SUPPLY TO THE WASH/WIPE SYSTEM SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Wash/wipe system switch from connector CRW08.
	3 Ignition switch in position II.

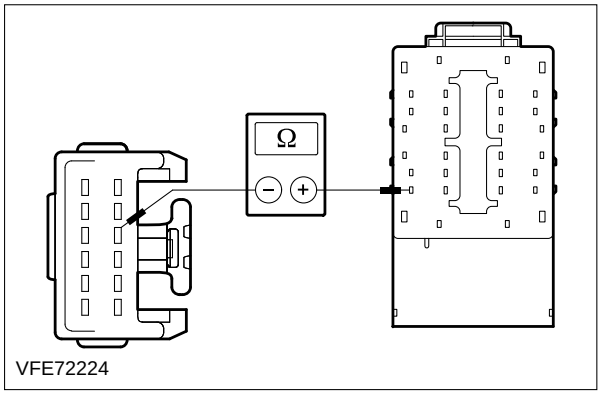
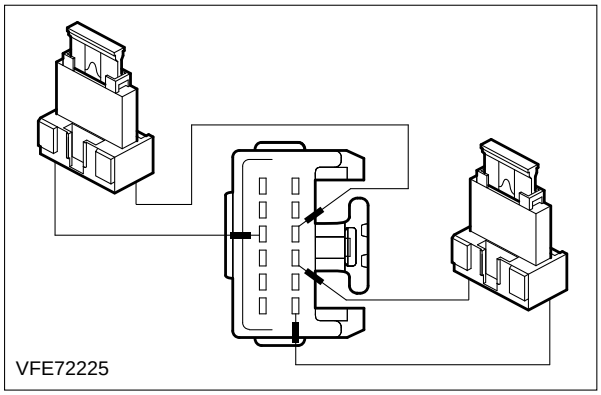
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0038573	4 Measure voltage between wash/wipe system switch: – Van, bus, combi: Connector CRW08, pin 10, circuit SBP67A (BU/RD), wiring harness side and ground. – Drop side body: Connector CRW08, pin 10, circuit SBP67A (RD/BU), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to I5. → **No** GO to I4.
I4: CHECK THE CJB	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02E.
 VFE72222	3 Measure the resistance between central junction box (CJB): – Van, bus, combi: connector CBP02E, pin 30, circuit SBP67A (BU/RD), wiring harness side and wash/wipe system switch, connector CRW08, pin 10, circuit SBP67A (BU/RD), wiring harness side. – Drop side body: connector CBP02E, pin 30, circuit SBP67A (RD/BU), wiring harness side and wash/wipe system switch, connector CRW08, pin 10, circuit SBP67A (RD/BU), wiring harness side. • Is the resistance less than 2 ohms? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between the central junction box (CJB) and the wash/wipe system switch using the Wiring Diagrams. CHECK system operates correctly
I5: CHECK THE GROUND CONNECTION OF THE WASH/WIPE SYSTEM SWITCH FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

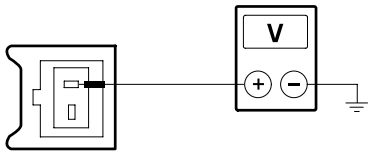
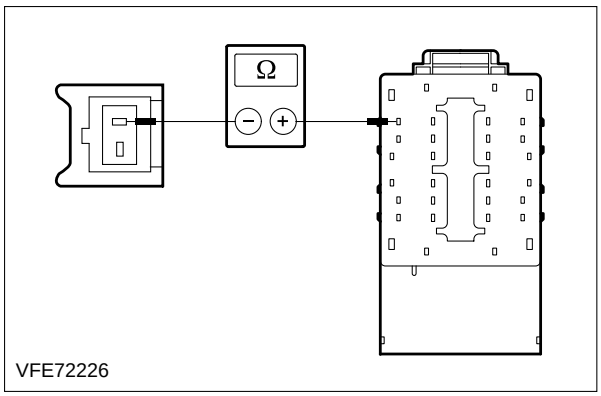
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 VFE0038540	2 Measure resistance between wash/wipe system switch: – Van, bus, combi: connector CRW08, pin 3, circuit B_GD115C (BK/GY), wiring harness side and ground. – Drop side body: connector CRW08, pin 3, circuit B_GD115C (BK/RD), wiring harness side and ground. • Is a resistance of less than 2 ohms registered? → **Yes** GO to I6. → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and soldered connection S2D115B using the Wiring Diagrams. CHECK system operates correctly
I6: CHECK CIRCUIT CRW07A (GY/BN) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Disconnect Central junction box (CJB) from connector CBP02E.
 VFE72223	2 Measure the resistance between the wash/wipe system switch, connector CRW08, pin 1, circuit CRW07A (GY/BN), wiring harness side and the central junction box (CJB), connector CBP02E, pin 21, circuit CRW07A (GY/BN), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to I7. → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly

DIAGNOSIS AND TESTING

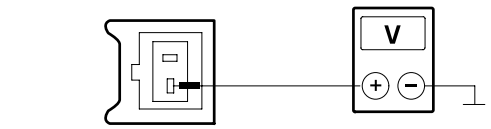
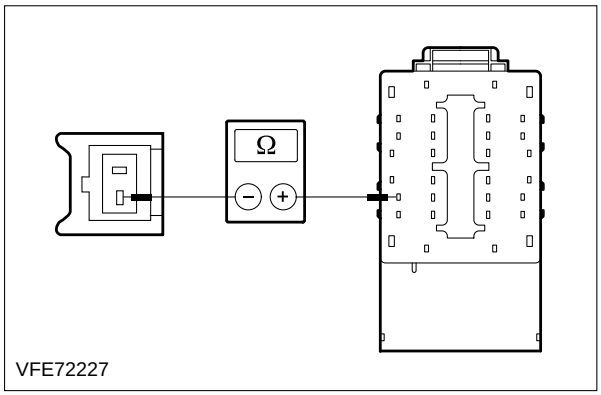
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
I7: CHECK CIRCUIT CRW12A (GY/OG) BETWEEN WASH/WIPE SWITCH AND CENTRAL JUNCTION BOX (CJB) FOR BREAKS	
	1 Measure the resistance between the wash/wipe system switch, connector CRW08, pin 4, circuit CRW12A (GY/OG), wiring harness side and the central junction box (CJB), connector CBP02E, pin 5, circuit CRW12A (GY/OG), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** GO to I8. → **No** LOCATE and RECTIFY the break in the circuit between the wash/wipe system switch and central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly
I8: CHECK THE WASH/WIPE SWITCH	
	1 Connect Central junction box (CJB) to connector CBP02E.
	2 Two fused jumper wires (10 A) at the wash/wipe system switch: – Van, bus, combi: Connect connector CRW08, pin 3, B_GD115C (BK/GY) and pin 1, circuit CRW07A (GY/BN), wiring harness side. – Van, bus, combi: Connect connector CRW08, pin 10, SBP67A (BU/RD) and pin 4, circuit CRW12A (GY/OG), wiring harness side. – Drop side body: Connect connector CRW08, pin 3, B_GD115C (BK/RD) and pin 1, circuit CRW07A (GY/BN), wiring harness side. – Drop side body: Connect connector CRW08, pin 10, SBP67A (RD/BU) and pin 4, circuit CRW12A (GY/OG), wiring harness side.
	3 Ignition switch in position II. • Is the front wash/wipe function operative? → **Yes** RENEW the wash/wipe switch. CHECK system operates correctly → **No** INSTALL a new CJB. CHECK system operates correctly

DIAGNOSIS AND TESTING

PINPOINT TEST J : WINDSCREEN WASHER SYSTEM IS INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
J1: CHECK THE VOLTAGE SUPPLY TO THE WASHER PUMP FOR OPEN CIRCUIT (PIN 1)	
NOTE: Wash/wipe system switch in the OFF position	
	1 Ignition switch in position 0.
	2 Disconnect Front/rear washer pump from connector CRW14.
	3 Ignition switch in position II.
 VFE0008568	4 Measure the voltage between the washer pump, connector CRW14, pin 1, circuit CRW14A (BU/WH), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** GO to J3. → **No** GO to J2.
J2: CHECK CIRCUIT CRW14A (BU/WH) BETWEEN THE WASHER PUMP AND THE CENTRAL JUNCTION BOX (CJB) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02B.
 VFE72226	3 Measure the resistance between the washer pump, connector CRW14, pin 1, circuit CRW14A (BU/WH), wiring harness side and the central junction box (CJB), connector CBP02B, pin 25, circuit CRW14A (BU/WH), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between the washer pump and the central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly

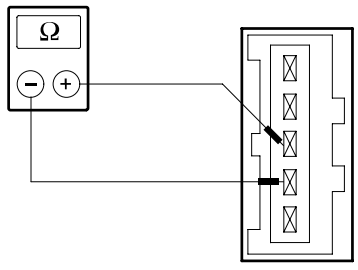
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
J3: CHECK THE VOLTAGE SUPPLY TO THE WASHER PUMP FOR OPEN CIRCUIT (PIN 2)	
 VFE0015948	1 Measure the voltage between the washer pump, connector CRW14, pin 2, circuit ZA220A (OG/GN), wiring harness side and ground. • Does the meter display battery voltage? → **Yes** RENEW the washer pump. CHECK system operates correctly → **No** GO to J4.
J4: CHECK CIRCUIT ZA220A (OG/GN) BETWEEN THE WASHER PUMP AND THE CENTRAL JUNCTION BOX (CJB) FOR OPEN CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Central junction box (CJB) from connector CBP02B.
 VFE72227	3 Measure the resistance between the washer pump, connector CRW14, pin 2, circuit ZA220A (OG/GN), wiring harness side and the central junction box (CJB), connector CBP02B, pin 9, circuit ZA220A (OG/GN), wiring harness side. • Is a resistance of less than 2 ohms registered? → **Yes** INSTALL a new CJB. CHECK system operates correctly → **No** LOCATE and RECTIFY the break in the circuit between the washer pump and the central junction box (CJB) using the Wiring Diagrams. CHECK system operates correctly

Component Tests

Windshield Wiper Motor

1. CHECK the front wiper motor in the park position:
   - Measure the resistance at the front wiper motor, between pin 2 and pin 3.
   - Is the resistance less than 2 ohms?
     - If yes, the wiper motor is OK.
     - If not, RENEW the wiper motor.

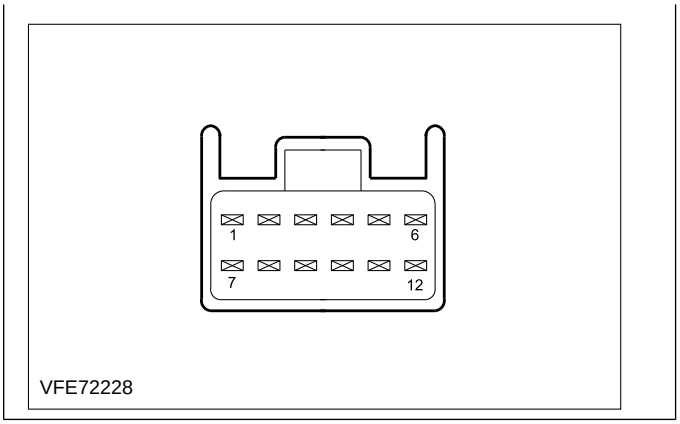


VFE0032287

DIAGNOSIS AND TESTING

Wash/wipe switch

Pin assignment:



Circuit to test	Connect ohmmeter to the following terminal pins	Set the switch to the following position	The switch is OK if
Intermittent	8 and 12	Intermittent	closed circuit
Variable intermittent	8 and 7	Intermittent level 1	closed circuit
	8 and 9	Intermittent level 1	open circuit
	8 and 11	Intermittent level 1	open circuit
Variable intermittent	8 and 7	Intermittent level 2	closed circuit
	8 and 9	Intermittent level 2	closed circuit
	8 and 11	Intermittent level 2	open circuit
Variable intermittent	8 and 7	Intermittent level 3	open circuit
	8 and 9	Intermittent level 3	closed circuit
	8 and 11	Intermittent level 3	open circuit
Variable intermittent	8 and 7	Intermittent level 4	open circuit
	8 and 9	Intermittent level 4	closed circuit
	8 and 11	Intermittent level 4	closed circuit
Variable intermittent	8 and 7	Intermittent level 5	closed circuit
	8 and 9	Intermittent level 5	closed circuit
	8 and 11	Intermittent level 5	closed circuit
Variable intermittent	8 and 7	Intermittent level 6	closed circuit
	8 and 9	Intermittent level 6	open circuit
	8 and 11	Intermittent level 6	closed circuit

Windshield wiper relay

1. Check the normally open contact in the unswitched state:
   - Measure the resistance at the windshield wiper relay between pin 3 and pin 5, component side.
   - Is a resistance of more than 10,000 Ohm measured? If yes, go to 2. If no, RENEW the power supply relay.
2. Check the normally open contact in the switched state:

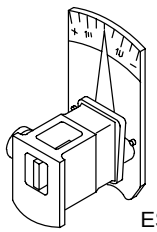
DIAGNOSIS AND TESTING

- Using a fused test cable (1 A), connect pin 1 of the windshield wiper relay, component side, with the battery positive pole.
- Using a test cable, connect pin 2 of the windshield wiper relay, component side, with the battery negative pole.
- Measure the resistance at the windshield wiper relay between pin 3 and pin 5, component side.
- Is a resistance of less than 2 Ohm registered? If yes, the windshield wiper relay is OK. If no, INSTALL a new windshield wiper relay.

GENERAL PROCEDURES

Windshield Wiper Blade and Pivot Arm Adjustment

Special Tool(s)

 ES32006	Aligner, Wiper Arm 501-027 (32-006)

General Equipment

Aero-Wiper Measuring and Adjusting Tools AWPE 02 (Order No. 511 5124 001 00)

Vehicles without beam blade wipers

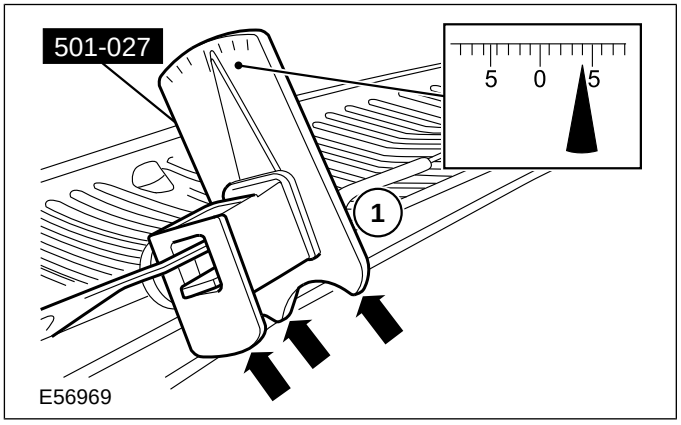
1. **⚠CAUTION:Make sure that the wiper motor is in the park position.**

   Remove the wiper blade.

2. **Insert the wiper arm in the special tool and place the special tool on the windshield.**

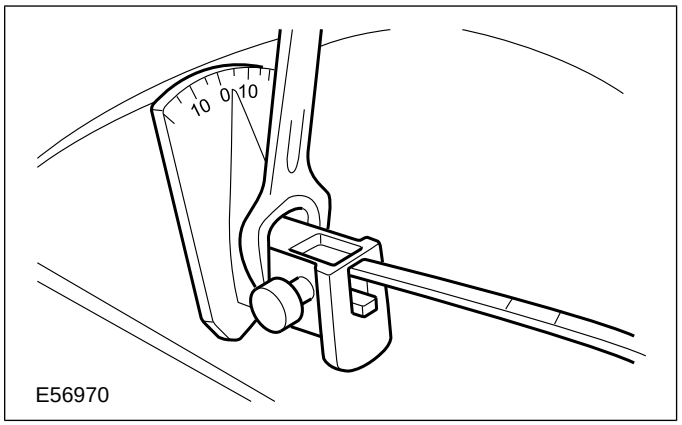
3. **NOTE:All three support points of the special tool must be in contact with the glass.**

   Using the special tool, read off the angle between the wiper arm and the windshield.



4. **NOTE:Lift the special tool away from the glass when correcting the angle, in order to prevent damage.**

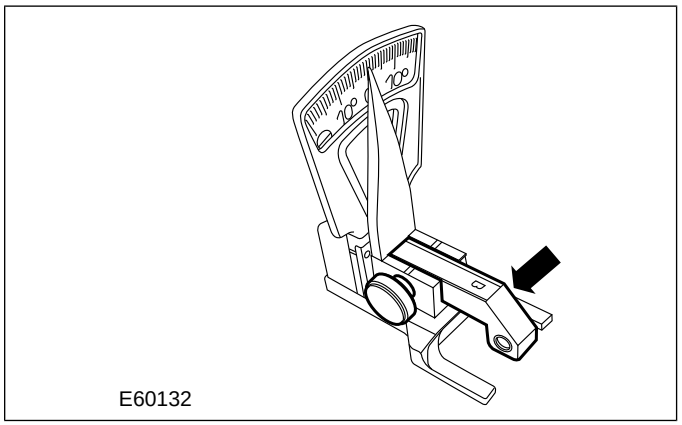
   Using an open-ended wrench on the special tool, adjust the wiper arm. For additional information, refer to Specifications.



5. **Remove the special tool.**
6. **Install the wiper blade.**

Vehicles with beam blade wipers

1. **Connect the adapter "B" with the angle measuring instrument.**
   - Tighten the knurled screw finger tight.

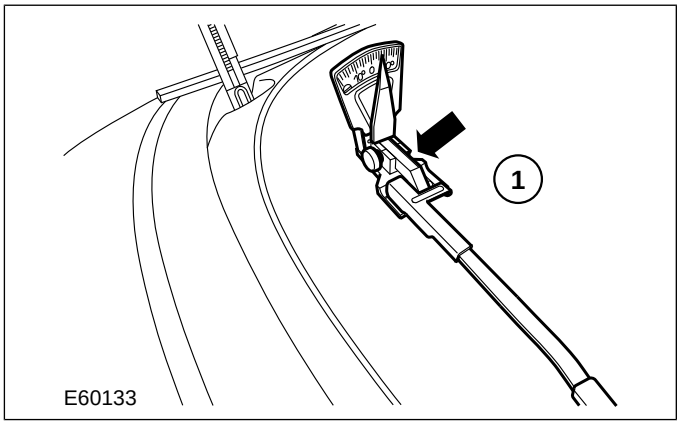


2. **⚠CAUTION:Make sure that the wiper motor is in the park position.**

   Remove the wiper blade.

GENERAL PROCEDURES

3. **Insert the wiper arm in the angle measuring instrument and place the angle measuring instrument on the windshield.**



4. **NOTE:All three support points of the angle measuring instrument must be in contact with the glass.**

   Using the angle measuring instrument, read off the angle between the wiper arm and the windshield.

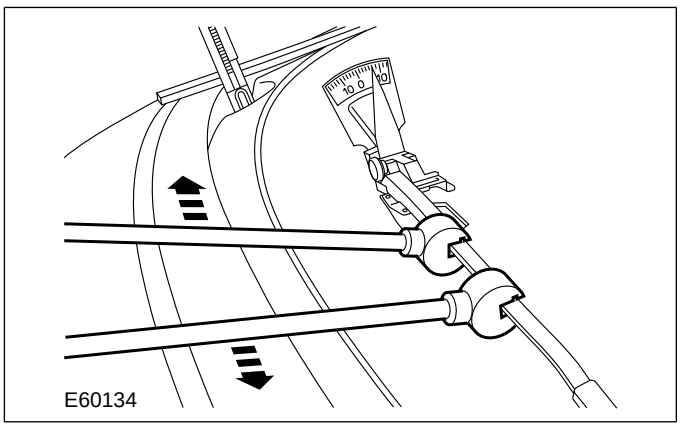
5. **CAUTIONS:**

   Make sure that no mechanical force is applied to the wiper blade holder while adjusting the angle.

   The wiper arm must not be adjusted by more than three degrees. If a bigger adjustment is necessary, check the wiper arm for damage, replace if necessary.

NOTE: Lift the angle measuring instrument away from the glass when correcting the angle, in order to prevent damage.

Using the adjusting tool and the counter holder, adjust the wiper arm. For additional information, refer to Specifications.



6. **Remove the angle measuring instrument.**

7. **Install the wiper blade.**

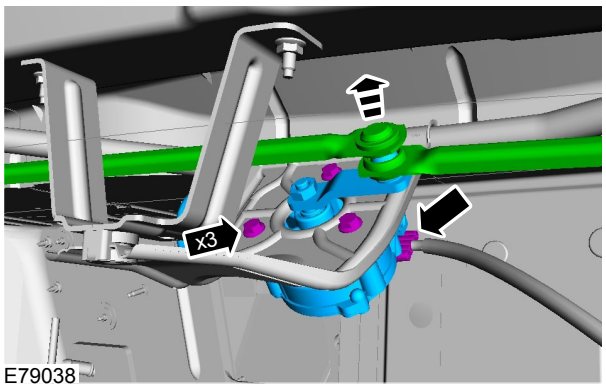
REMOVAL AND INSTALLATION

Windshield Wiper Motor

Removal

NOTE: Removal steps in this procedure may contain installation details.

1. **CAUTION:Make sure that the windshield wiper motor is in the park position.**
   - Torque: 12 Nm



Installation

1. **CAUTION:Move the windshield wiper motor to park position before installing the windshield wiper arms.**

   To install, reverse the removal procedure.

2. Adjust the windshield wiper arms.

   Refer to:Windshield Wiper Blade and Pivot Arm Adjustment (501-16 Wipers and Washers, General Procedures).

REMOVAL AND INSTALLATION

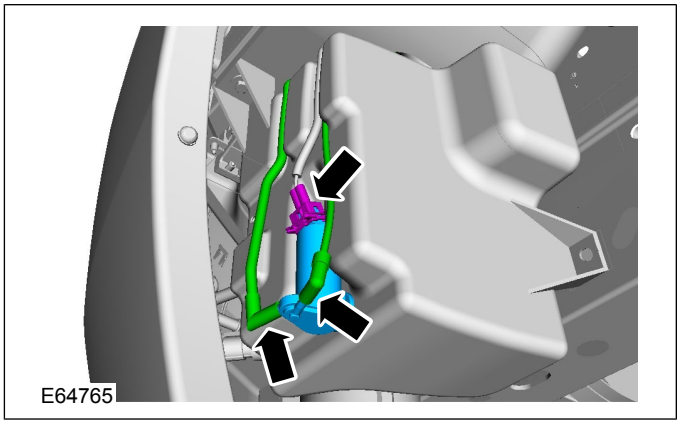
Windshield Washer Pump — Van/Kombi/Bus

Removal

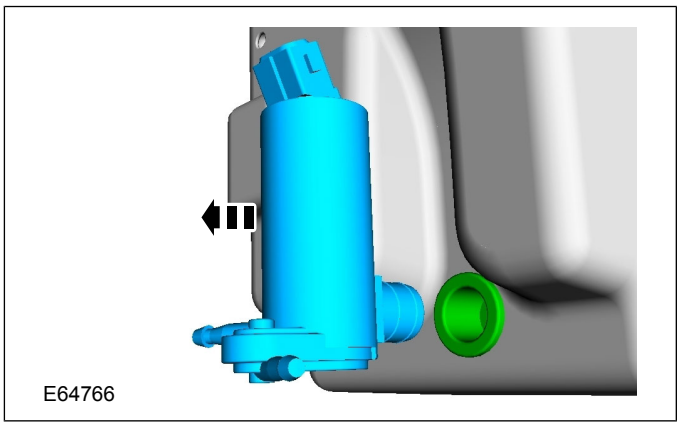
1. Empty the front windscreen washer reservoir.
2. Raise the vehicle for access

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

3.



4.



Installation

1. **NOTE:**Coat the rubber grommet on the windshield washer pump with soap prior to installation.

   To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

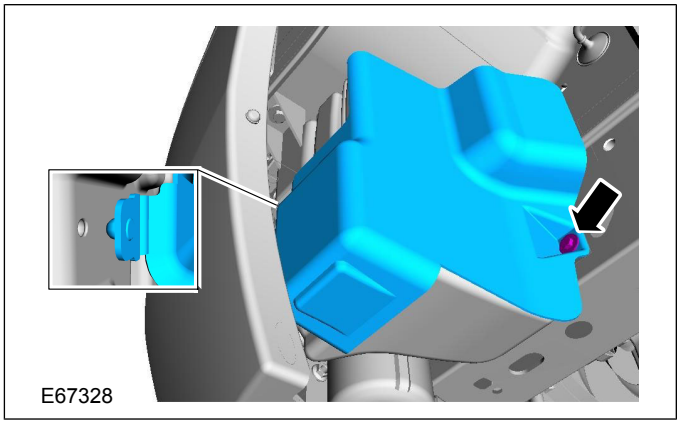
Windshield Washer Pump — Chassis Cab/Chassis Double Cab

Removal

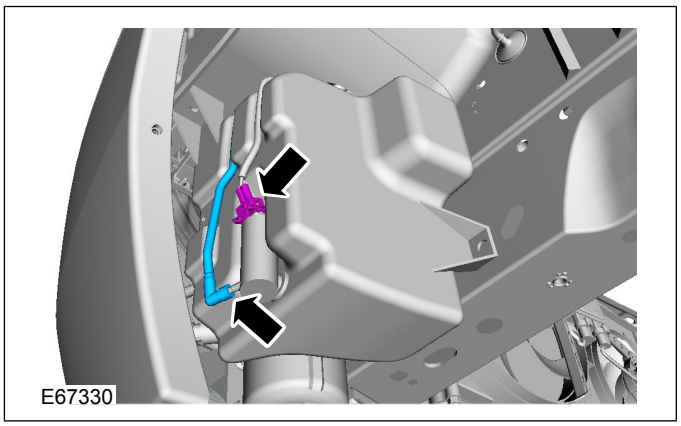
1. Empty the front windscreen washer reservoir.
2. Raise the vehicle for access

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).

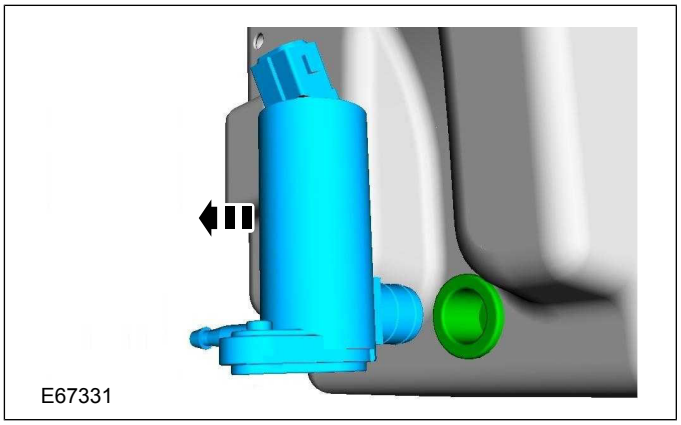
3.



4.



5.



Installation

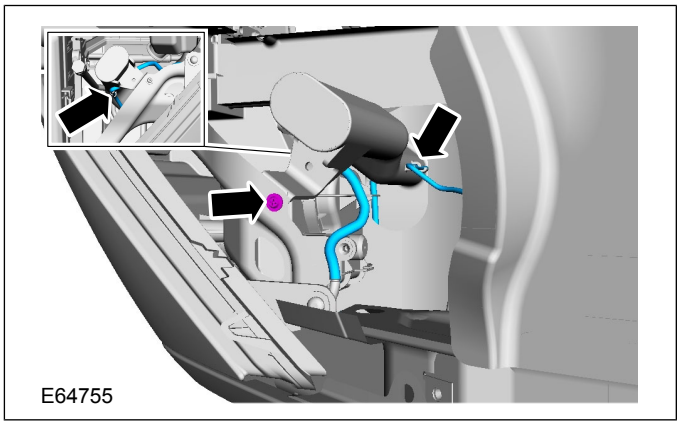
1. **NOTE:**Coat the rubber grommet on the windshield washer pump with soap prior to installation.

   To install, reverse the removal procedure.

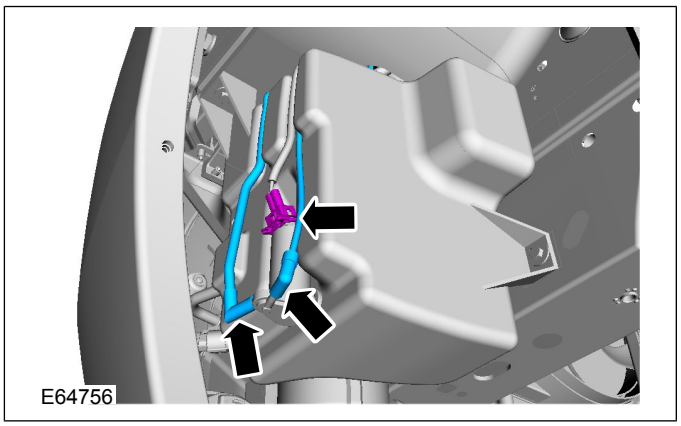
REMOVAL AND INSTALLATION

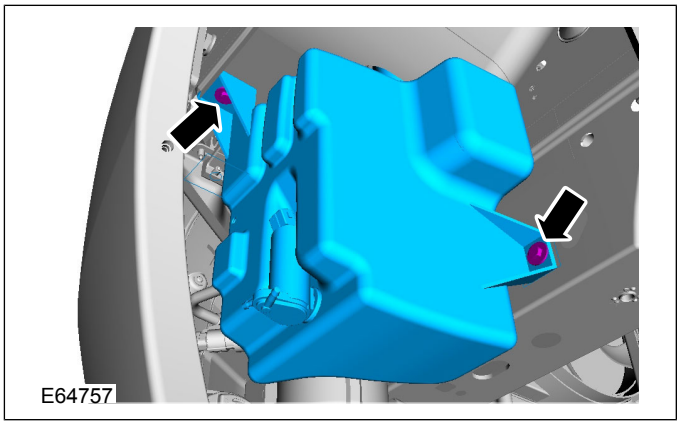
Windshield Washer Pump and Reservoir — Van/Kombi/Bus

Removal

1. Empty the front windscreen washer reservoir.
2. 

3. Raise the vehicle for access

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).
4. 

5. 

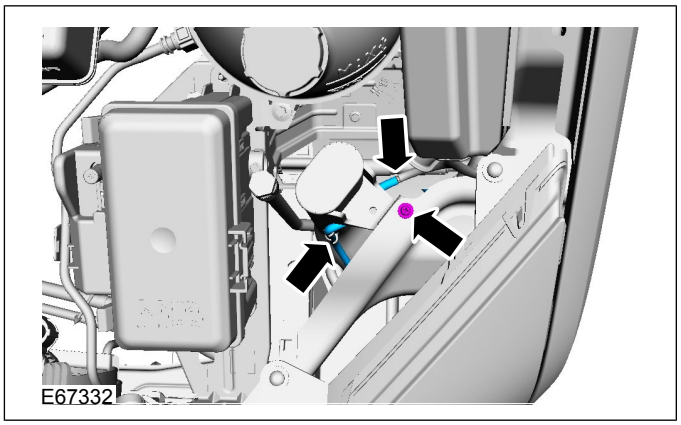
Installation

1. To install, reverse the removal procedure.

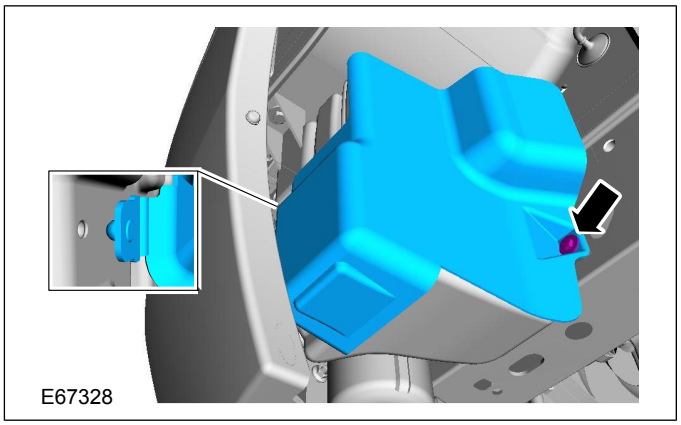
REMOVAL AND INSTALLATION

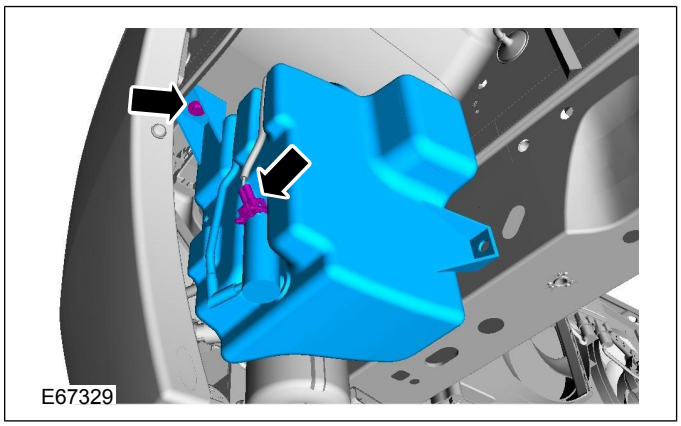
Windshield Washer Pump and Reservoir — Chassis Cab/Chassis Double Cab

Removal

1. Empty the front windscreen washer reservoir.
2. 

3. Raise the vehicle for access

   Refer to:Lifting (100-02 Jacking and Lifting, Description and Operation).
4. 

5. 

Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Wiper Linkage Assembly

1. Information not available at this time.

SECTION 501-17 Roof Opening Panel

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

REMOVAL AND INSTALLATION

Escape Hatch..... 501-17-2

REMOVAL AND INSTALLATION

Escape Hatch

General Equipment

Hot air gun
Direct glazing cutter for bonded glass
Mixing/applicator gun
Direct glazing adhesive oven
Glazing suction cups

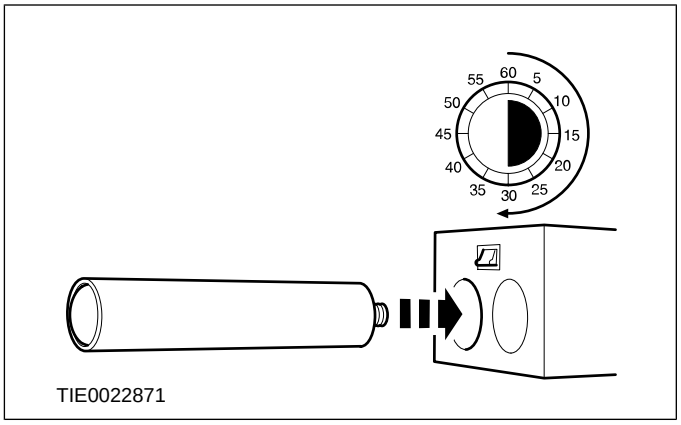
Materials

Name	Specification
Windshield Adhesive Kit	WSK-M11P57-A1

Removal

CAUTION:Care must be taken to avoid damage to the roof panel when removing and installing the escape hatch.

1. **Remove the polyurethane (PU) adhesive cap and heat the PU adhesive for a minimum of 30 minutes.**

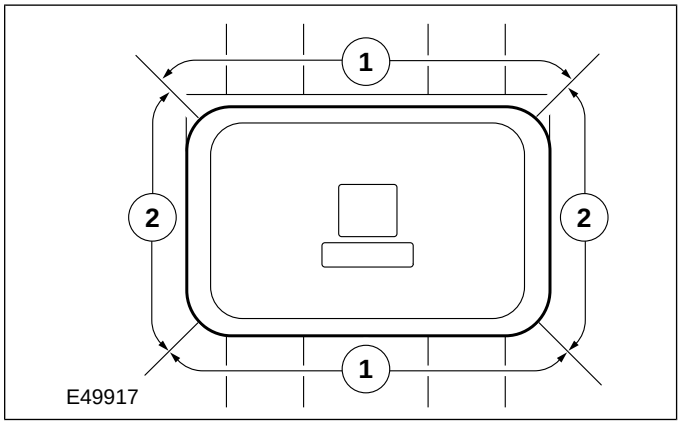


2. **WARNING:Wear safety glasses and protective gloves when working with the direct glazing cutter as the cutting operation may produce splinters. When using the direct glazing cutter also wear ear protectors. Failure to follow these instructions may result in personal injury.**

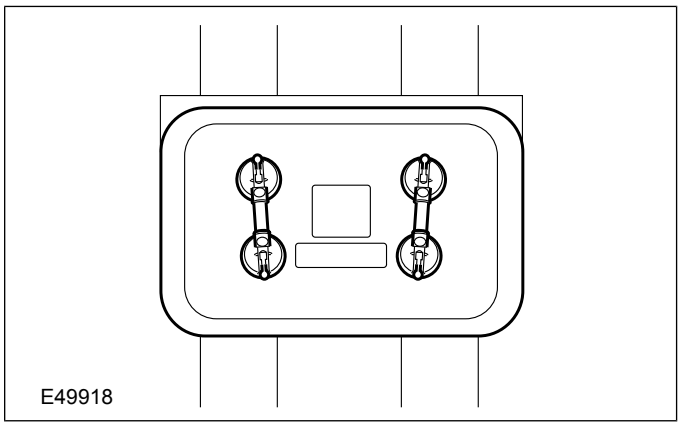
CAUTION:Make sure that the cutting blades are changed where the cutting depth changes to prevent damage to the body and trim panels.

From outside the vehicle, using a suitable direct glazing cutter for bonded glass, cut the PU adhesive to the given maximum depths.

1. 20 mm.
2. 35 mm.



3. **Using glazing suction cups, remove the escape hatch.**



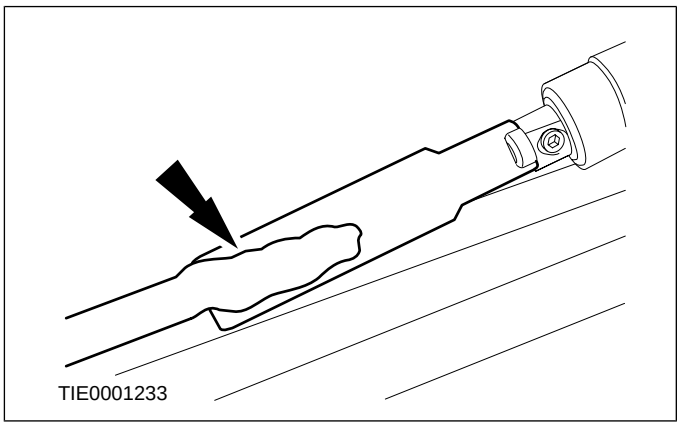
Installation

CAUTION:Care must be taken to avoid damage to the roof panel when removing and installing the escape hatch.

1. **CAUTION:Do not touch the adhesive surface as re-bonding will be impaired.**

REMOVAL AND INSTALLATION

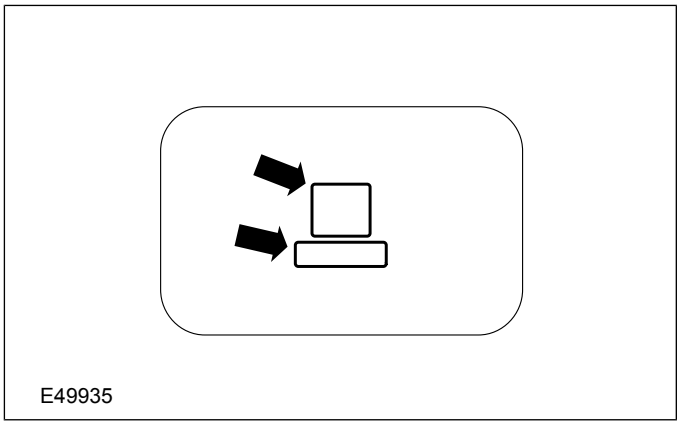
Carefully trim the remaining PU adhesive from the escape hatch flange to leave approximately 1 mm of trimmed PU adhesive adhered to the flange.



2. **Check the escape hatch flange for damaged sheet metal, rust or foreign material which may have caused, or may cause, glass breakage.**
3. **⚠CAUTION:To make sure that the PU adhesive cures, it is essential that all bonding surfaces are free of moisture.**

   Using a hot air gun, apply warm air (25°C) to the escape hatch flange and glass bond line to remove all traces of moisture.
4. **Prepare the glass, escape hatch flange and trimmed PU adhesive in accordance with the instructions supplied with the adhesive kit.**
5. **NOTE:This step is only necessary when installing a new escape hatch.**

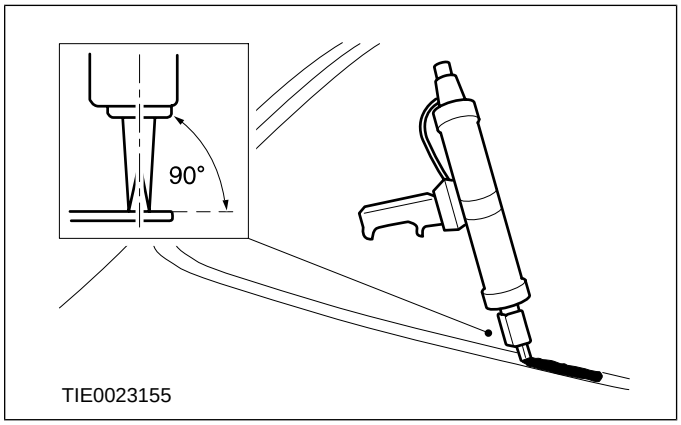
   Install new warning labels in accordance with local regulations, if necessary.



6. **NOTE:Discard the first 100 mm of PU adhesive as this may have a reduced working time.**

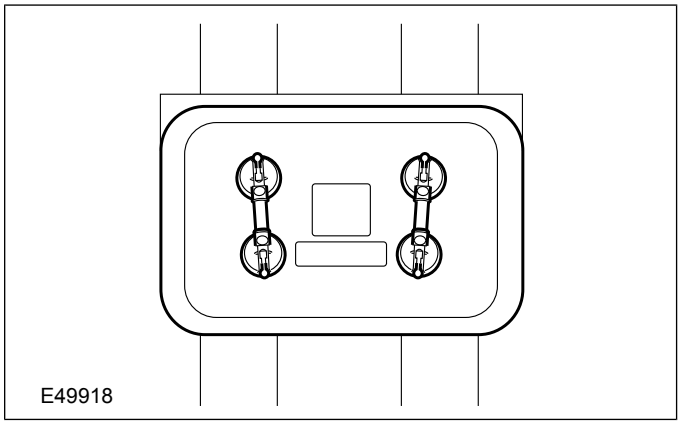
NOTE:To avoid water leaks, any breakage in the continuous bead must be overlapped by 20 mm.

Using the mixing/applicator gun, apply the PU adhesive in a continuous bead of between 8 and 10 mm in height to the escape hatch flange along the bond line.



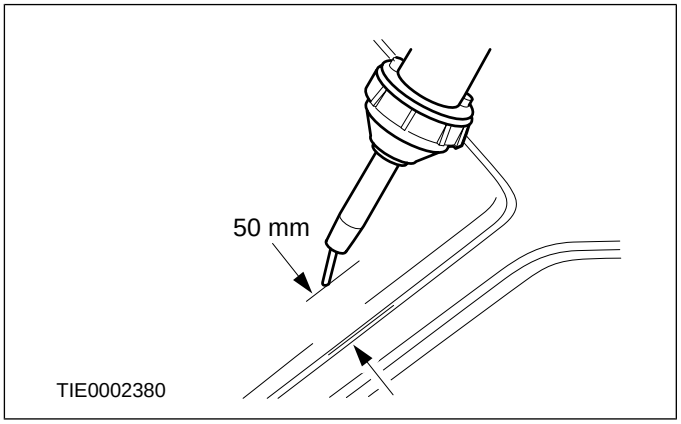
7. **⚠CAUTION:During the curing period of the PU adhesive, the door windows must be left open to prevent a build up of pressure when the doors are closed.**

   Using glazing suction cups, install the escape hatch.
   - Press firmly and evenly into position.



REMOVAL AND INSTALLATION

8. If the ambient temperature falls below 10°C, use a hot air gun and apply warm air (25°C) continuously for 15 minutes (outside the vehicle).



SECTION 501-19 Bumpers

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 501-19-2

REMOVAL AND INSTALLATION

Front Bumper..... 501-19-3
Rear Bumper..... (43 443 0) 501-19-4
Front Bumper Cover..... 501-19-5
Rear Bumper Cover..... 501-19-7

SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Front bumper bolts	47	35	-
Front bumper cover to front bumper bolts	30	22	-
Front bumper cover to fender screws	11	8	-
Front bumper cover to radiator grille opening panel bolts	11	8	-
Rear bumper nuts	20	15	-
Rear bumper bracket bolts	103	76	-
Rear bumper cover bolts	30	22	-

REMOVAL AND INSTALLATION

Front Bumper

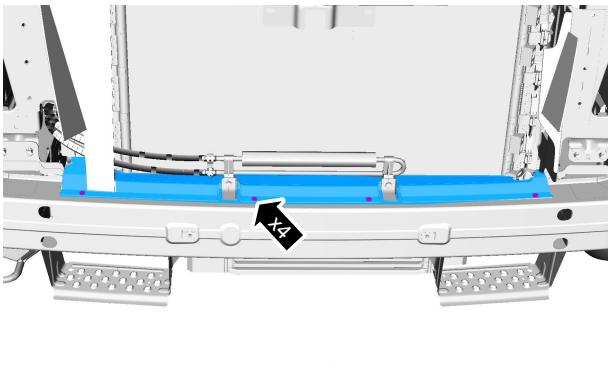
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Remove the bumper cover.

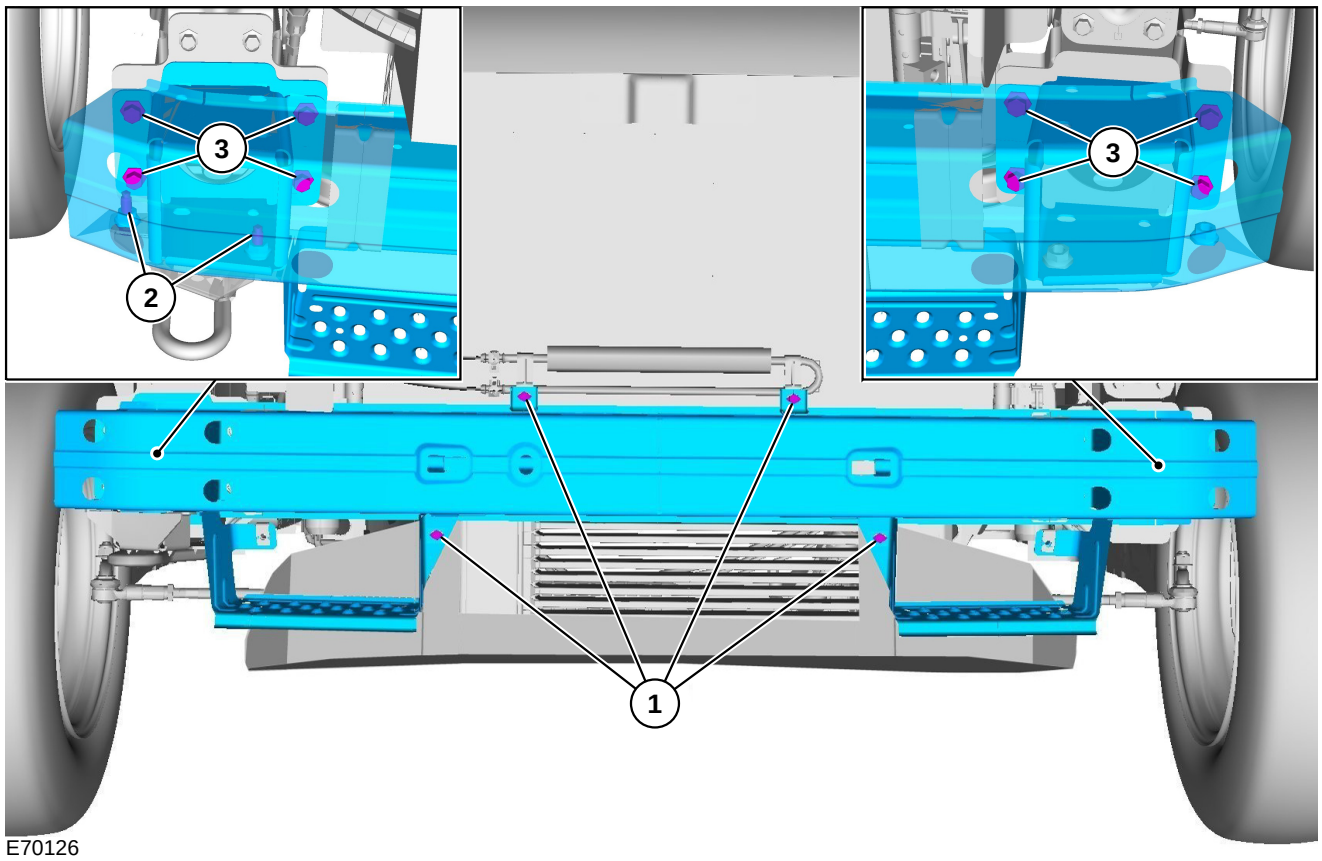
   Refer to: Front Bumper Cover (501-19 Bumpers, Removal and Installation).

2.



E70788

3. 2. Torque: 47 Nm
   3. Torque: 47 Nm



E70126

Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

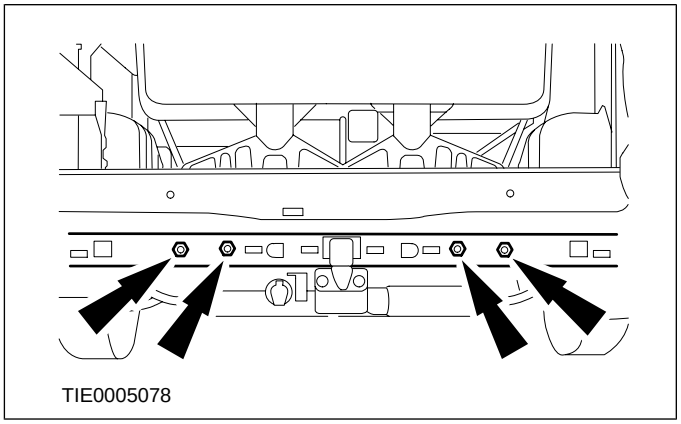
Rear Bumper (43 443 0)

Removal

1. **Remove the bumper cover.**

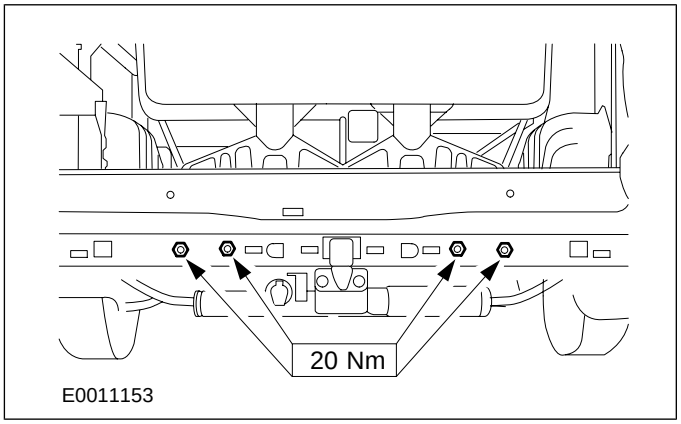
   For additional information, refer to Bumper Cover in this section.

2. **Remove the bumper.**



Installation

1. **To install, reverse the removal procedure.**



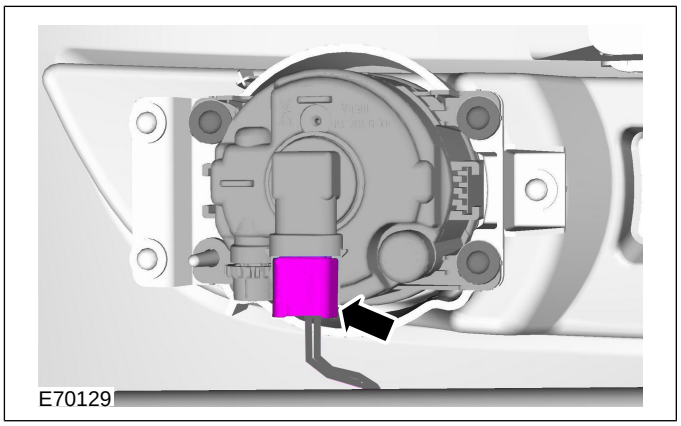
REMOVAL AND INSTALLATION

Front Bumper Cover

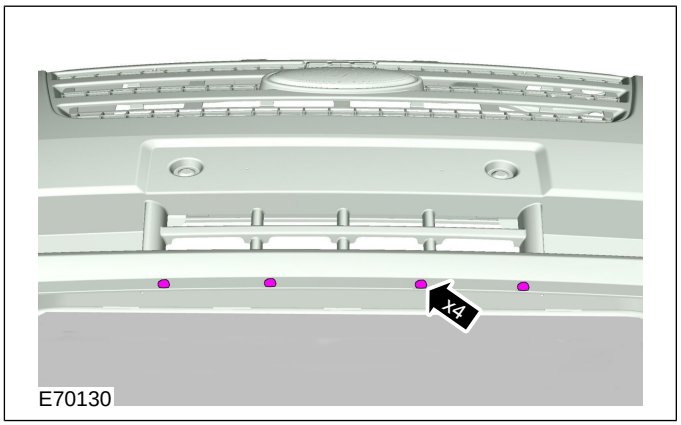
Removal

NOTE: Removal steps in this procedure may contain installation details.

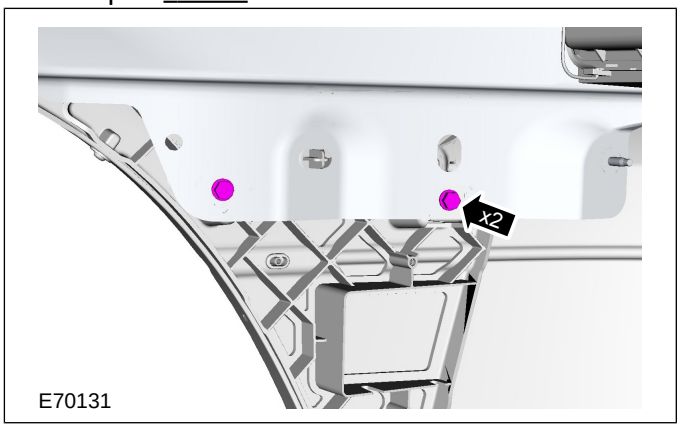
1. On both sides.



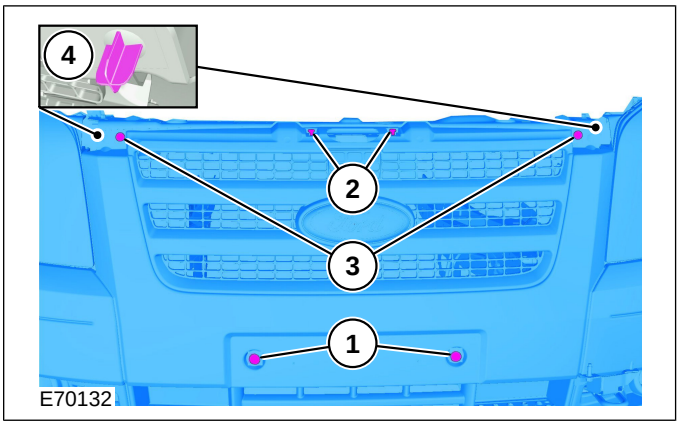
2.



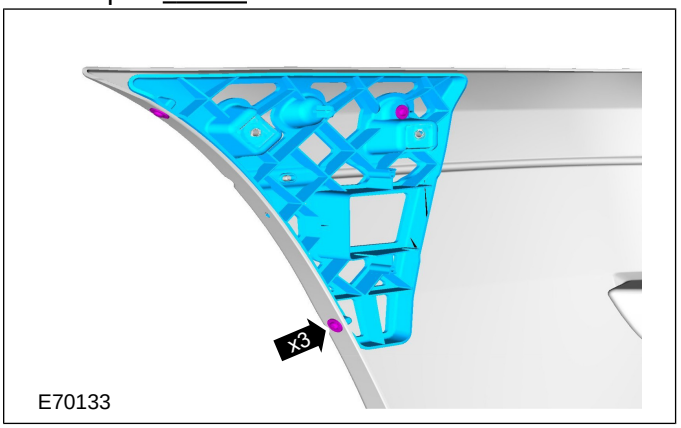
3. On both sides.
Torque: 11 Nm



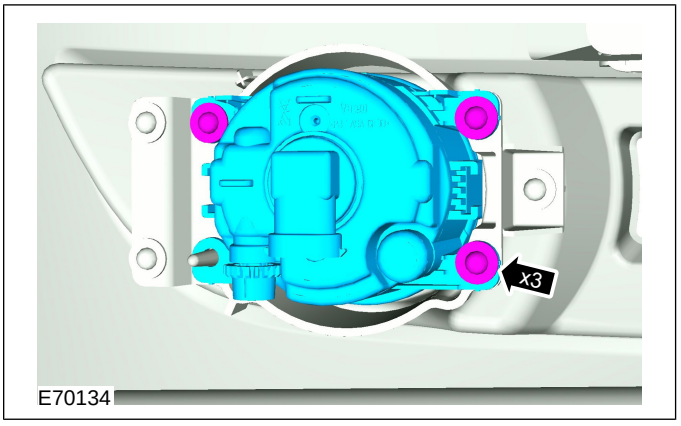
4. 1. Torque: 30 Nm
3. Torque: 11 Nm



5. On both sides.
Torque: 11 Nm

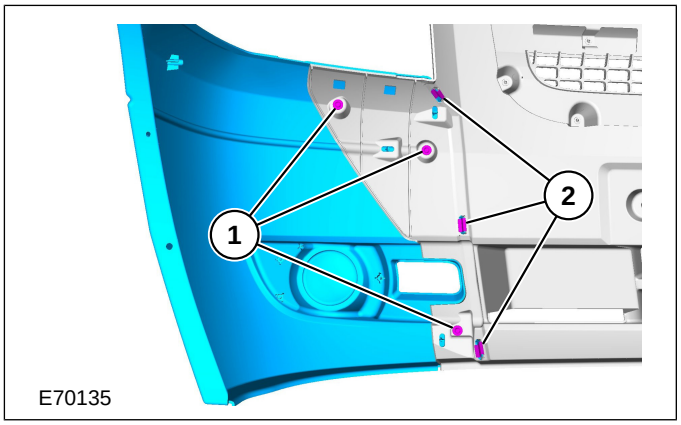


6. On both sides.

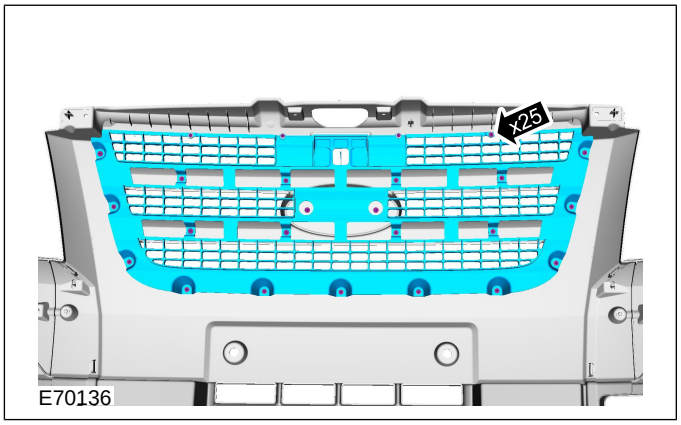


REMOVAL AND INSTALLATION

7. On both sides.



8.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Rear Bumper Cover

General Equipment

Electric drill

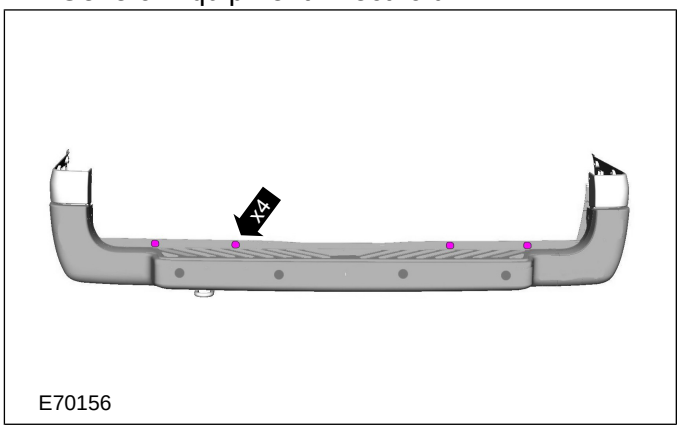
General Equipment

Blind rivet gun

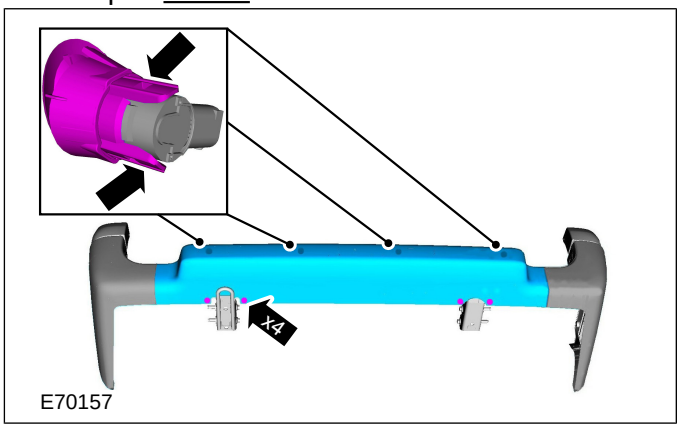
Removal

NOTE: Removal steps in this procedure may contain installation details.

1. General Equipment: Electric drill

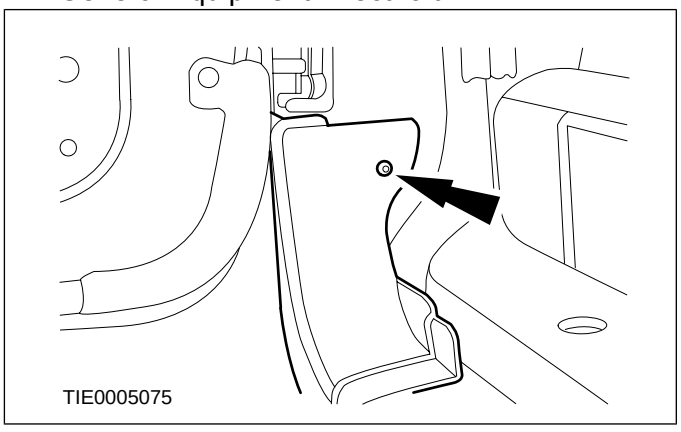


2. Torque: 30 Nm



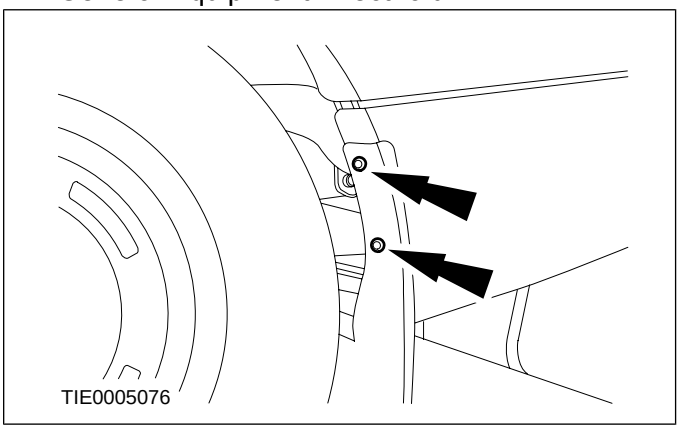
3. On both sides.

General Equipment: Electric drill

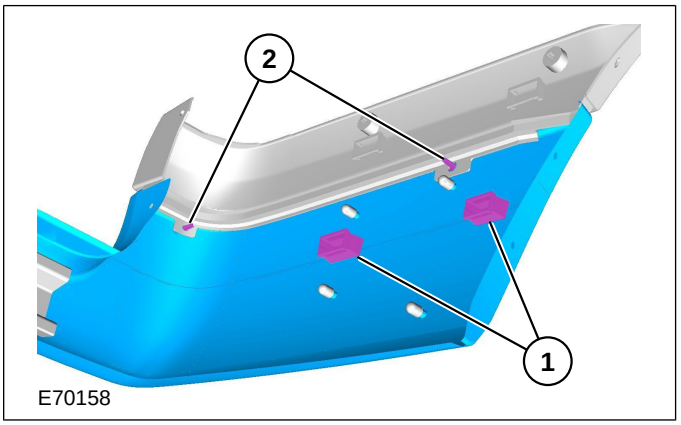


4. On both sides.

General Equipment: Electric drill



5. On both sides.



Installation

1. To install, reverse the removal procedure.

General Equipment: Blind rivet gun

SECTION 501-20A Safety Belt System

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 501-20A-2

DESCRIPTION AND OPERATION

Safety Belt System 501-20A-3

DIAGNOSIS AND TESTING

Safety Belt System — Vehicles With: Central Junction Box (CJB) 501-20A-4
- Principles of Operations 501-20A-4
- Inspection and Verification 501-20A-5
- Symptom Chart 501-20A-5
- Component Test 501-20A-5
- Static Test 501-20A-6

REMOVAL AND INSTALLATION

Front Safety Belt Retractor	(40 222 0)	501-20A-7
Front Safety Belt Retractor — Vehicles With: Double Passenger Seat	(40 222 0)	501-20A-8
Rear Safety Belt Retractor	(40 248 0)	501-20A-9
Rear Safety Belt Retractor — Chassis Double Cab	(40 248 0)	501-20A-11
Safety Belt Shoulder Height Adjuster	(40 225 0)	501-20A-13
Safety Belt Retractor and Pretensioner		501-20A-15

SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Safety belt retractor retaining bolts	40	30	-
Driver safety belt buckle retaining bolts	40	30	-
Front single passenger single seat safety belt buckle retaining bolts	40	30	-
Front double passenger seat inner safety belt buckle retaining bolt	55	41	-
Front double passenger seat outer safety belt buckle retaining bolt	40	30	-
Safety belt lower anchor retaining bolts	40	30	-
Safety belt upper anchor retaining bolts	40	30	-
Safety belt shoulder height adjuster retaining bolts	40	30	-
Seat outer trim panel retaining screws	3	-	27
Seat front trim panel retaining screws	3	-	27

DESCRIPTION AND OPERATION

Safety Belt System

WARNING:All safety belts including retractors, buckles and attaching hardware in use during a collision must be removed and new assemblies installed. All safety belts not in use during a collision must be inspected and new assemblies installed if any damage or incorrect operation is found. Failure to follow these instructions may result in personal injury.



DTV4003021

WARNING:All vehicles fitted with a passenger air bag have a WARNING sticker attached to the instrument panel PROHIBITING the use of rear facing child seats in the front seating positions. Failure to follow this instruction may result in personal injury.

CAUTION:Do not attempt to repair or lubricate the retractor / buckle mechanisms or modify the belts.

Vehicles with passenger air bag module

Both the driver and passenger front seat safety belt retractors incorporate retractor pretensioners. The safety belt retractor pretensioners are connected to the restraints control module (RCM). The RCM monitors the circuits and if a fault is detected will illuminate the air bag warning indicator located in the instrument cluster.

The safety belt retractor pretensioners have a lower deployment threshold than that required by the air bags. Hence it is possible during a minor collision, which exceeds the deployment threshold, that only the safety belt retractor pretensioners will deploy.

Vehicles without passenger air bag module

The driver safety belt retractor incorporates a retractor pretensioner, the passenger safety belt retractor is of a conventional type without pretensioner.

All vehicles

The safety belt system utilizes a combination of two-point lap safety belts and three-point lap and diagonal safety belts depending on the individual vehicle specification. The safety belt retractors in all front inboard passenger seating positions (if equipped) and the rear inboard seating position in Chassis Double Cab vehicles, where two-point lap safety belts are fitted, and all 11 to 15 seater bus rear seat positions incorporate web grabbers as standard. All other safety belt retractors are of the conventional retractor type.

Front outboard three-point safety belt retractors are mounted in the B-pillar. The rear outboard seat positions in Chassis Double Cab vehicles incorporate conventional three-point safety belt retractors mounted in the rear center beam. All other safety belt retractors are seat mounted.

Safety belt shoulder height adjusters, mounted in the B-pillar, are fitted as standard on the drivers side on all variants and the passenger side on all 8 to 15 seater bus variants. Safety belt shoulder height adjusters, mounted in the B-pillar, on the passenger side are available as an option on Van, Kombi and Chassis Cab variants.

The safety belt buckles are either seat or body mounted depending on the vehicle specifications.

DIAGNOSIS AND TESTING

Safety Belt System — Vehicles With: Central Junction Box (CJB)

Principles of Operations

WARNINGS:

All safety belt components including retractors, buckles, child safety seat tether brackets and attaching hardware in use during a collision must be removed and new components installed. New safety belt components should also be installed where safety belts not in use during a collision, are inspected and found to be damaged or operate incorrectly. Failure to follow these instructions may result in personal injury.

All vehicles equipped with a passenger air bag have a WARNING sticker attached to the instrument panel PROHIBITING the use of rear facing child seats in the front seating positions. Failure to follow this instruction may result in personal injury.

CAUTION:Do not attempt to repair or lubricate the retractor / buckle mechanisms or modify the belts.

The safety belt system utilizes a combination of two point lap safety belts and three point lap and diagonal safety belts, depending on the individual vehicle specifications.

The driver front seat safety belt, and passenger front seat safety belt if also equipped with passenger air bag, incorporate retractor pretensioners. The safety belt pretensioners are controlled as part of the supplementary restraint system (SRS). When the ignition is turned on the RUN position the SRS warning indicator will illuminate for three seconds. If the SRS, including the safety belt electrical system, is operating correctly the SRS warning indicator will be extinguished. If a fault is detected the SRS warning indicator will illuminate the air bag warning indicator located in the instrument cluster.

REFER to:Air Bag and Safety Belt Pretensioner Supplemental Restraint System (SRS) (501-20 Supplemental Restraint System, Diagnosis and Testing).

Emergency Locking Retractor (ELR)

The ELR is part of the safety belt system that in normal operation allows free movement of the belted occupant. In an emergency the ELR will lock, preventing webbing payout and hence forward movement of the occupant. Locking may be achieved by one of two mechanisms:

Vehicle Motion Sensor (VMS)

The VMS is operated by sudden deceleration of the vehicle or excessive tilt. Once operated, it causes a locking pawl to be engaged, thus locking the retractor, preventing webbing payout. When the vehicle is stationary the VMS stabilizes causing the pawl to disengage and unlock the retractor allowing webbing payout.

Webbing Motion Sensor (WMS)

The WMS is operated by rapid acceleration of the webbing. Once operated, it causes a locking pawl to be engaged thus locking the retractor. When the vehicle is stationary the VMS stabilizes causing the pawl to disengage and unlock the retractor allowing webbing payout.

ELR Types

The locking method used is dependent on which type of ELR is fitted:

Web Grabber Retractor (KC2.1)

Fitted to all front seating positions without air bags and all 11 to 15 seater bus rear 3-point seat positions. As soon as the VMS or WMS is activated, the clamping mechanism starts locking and the steering disc puts the rotation lever in motion. The clamping wedge is moved up and clamps the webbing against a force guide and clamp ring. Decreased webbing force leads to de-blocking of the clamp mechanism, since the force of the retaining spring pulls back the clamping wedge.

Spindle Locking Retractor (R27W)

Fitted to all Kombi, Double Chassis Cab and 8 or 9 seater bus 3-point seat positions. As soon as the VMS or WMS is activated, a lock dog located in the spindle is steered into the teeth on the retractor frame, preventing the spindle turning and webbing payout. When stationary, the VMS will stabilize, causing the pawl to disengage, unlocking the retractor and allowing payout.

DIAGNOSIS AND TESTING

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical damage.
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

Visual Inspection Chart

Mechanical
– Safety belt retractor – Safety belt buckle and pretensioner – Safety belt buckle

Symptom Chart

Symptom Chart

Symptom	Possible Sources	Action
• Normal mode - occupant restraint system inoperative	• Safety belt retractor.	• CARRY OUT the Safety Belt Component Test in this section.

Component Test

Poor Retraction

If a safety belt does not retract correctly, check that the anchor covers and trim are correctly installed and not rubbing against the safety belt webbing. Where necessary, check that the safety belt webbing is not rubbing at one end of the retractor cover slot and if so, correct by loosening the retaining bolt, aligning the retractor to centralize the safety belt webbing and tightening the bolt.

The safety belt retractors are dual sensitive, which means that they have:

– a vehicle motion sensor, which locks the safety belt webbing under braking, cornering, on steep hills and in adverse camber conditions.
– a webbing motion sensor, which locks when the safety belt webbing is quickly extracted.

Both systems should be fully operational and can be checked by the tests below:

Vehicle Motion Sensor Test

Either of the following two procedures may be used to check correct operation of the vehicle motion sensor. Both methods require two technicians, but note that technicians of larger than normal build should not be asked to conduct these tests. This is to avoid the possibility of a fully unrolled safety belt webbing being mistaken for a correctly locked safety belt retractor.

Test Method 1 (braking)

WARNING:It is important that during this test, the wearers allow the safety belt to provide the restraint and do not attempt to anticipate the sudden deceleration. The steering wheel should not be used as a brace. However, both driver and passenger should prepare themselves for the possibility that the safety belts will not lock. The passenger should hold their hands in front of them, just clear of the instrument panel or front seat backrest, depending on which safety belt is being tested. Failure to follow these instructions may result in personal injury.

This method requires a quiet or private stretch of road.

– Make sure that the road is clear and that full visibility is maintained at all times.
– Both driver and passenger should adopt a normal, comfortable seating position. Both occupants should wear the safety belts and the safety belt webbing must be correctly adjusted, with no slack.
– Proceed at a speed of 10 km/h (6 mph). Do not exceed 10 km/h (6 mph) for this test.
– Apply the foot brake sharply to stop the vehicle. If the vehicle motion sensor lock mechanism is operating correctly, the safety belt webbing will lock and restrain the wearer.

DIAGNOSIS AND TESTING

– Conduct the test twice in each passenger seat position.
– Any safety belt retractor which does not restrain the wearer must not be used. A new safety belt must be installed. REFER to:(501-20 Safety Belt System)

Front Safety Belt Retractor (Removal and Installation),
Front Safety Belt Retractor - Vehicles With: Double Passenger Seat (Removal and Installation),
Rear Safety Belt Retractor (Removal and Installation),
Rear Safety Belt Retractor - Chassis Double Cab (Removal and Installation).

Test Method 2 (turning circle)

This method requires a flat open area of private road, sufficient for the vehicle to be driven in a continuous circle on full steering lock.

– The driver should wear the safety belt provided and the belt webbing must be correctly adjusted, with no slack.
– The passenger should occupy a rear seat with the safety belt correctly adjusted.
– Start the engine and, with the steering on full right-hand lock, drive the vehicle in a continuous circle at 16 km/h (10 mph). Do not exceed 16 km/h (10 mph) for this test.
– When the speed is stable, the passenger should attempt to slowly extract the safety belt webbing from the safety belt retractor. If the vehicle motion sensor lock mechanism is operating correctly, it will not be possible to extract the webbing. This test should be repeated for each passenger seating position.
– Any safety belt retractor from which it is possible to extract the webbing during this test must not be used, a new safety belt must be installed. REFER to:(501-20 Safety Belt System)

Front Safety Belt Retractor (Removal and Installation),
Front Safety Belt Retractor - Vehicles With: Double Passenger Seat (Removal and Installation),
Rear Safety Belt Retractor (Removal and Installation),
Rear Safety Belt Retractor - Chassis Double Cab (Removal and Installation).

Static Test

With the vehicle stationary and on level ground, take firm hold of the safety belt webbing (on the tongue side of the upper safety belt anchor) and pull quickly. The retractor should lock within 0.25 meters (10 inches), preventing further webbing payout. Any safety belt retractor from which it is possible to extract further webbing must not be used. A new safety belt must be installed.

REMOVAL AND INSTALLATION

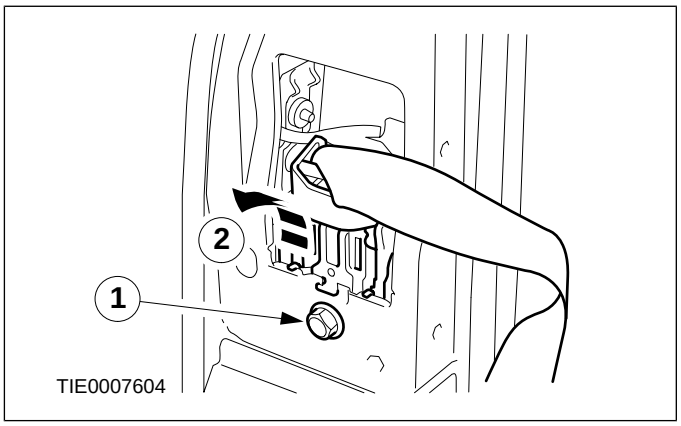
Front Safety Belt Retractor (40 222 0)

Removal

1. **Remove the B-pillar trim panel.**

   For additional information, refer to: B-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

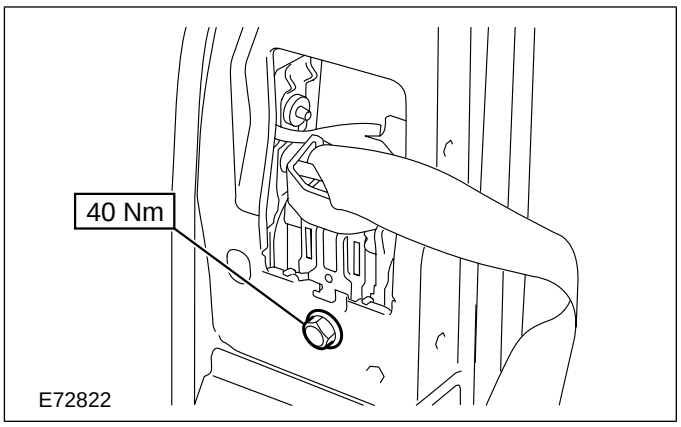
2. **Remove the safety belt retractor.**
   1. Remove the bolt.
   2. Lift the retractor from the locating tang.



Installation

1. **CAUTION:Make sure the safety belt retractor locating tang is correctly located.**

   To install, reverse the removal procedure.



REMOVAL AND INSTALLATION

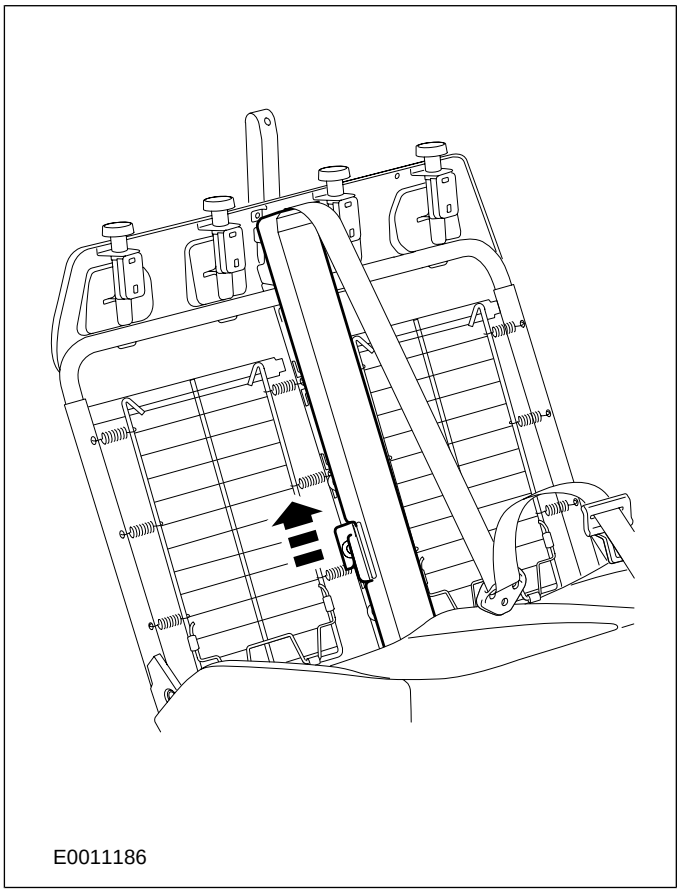
Front Safety Belt Retractor — Vehicles With: Double Passenger Seat (40 222 0)

Removal

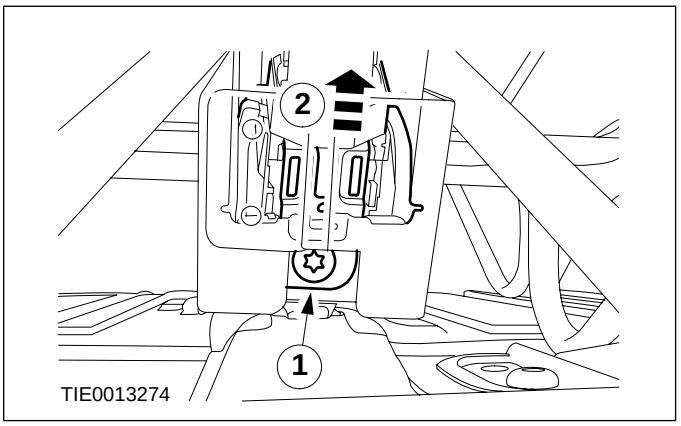
1. **Disassemble the double passenger seat backrest.**

   For additional information, refer to: Double Passenger Seat Backrest (501-10 Seating, Disassembly and Assembly).

2. **Remove the safety belt channel.**



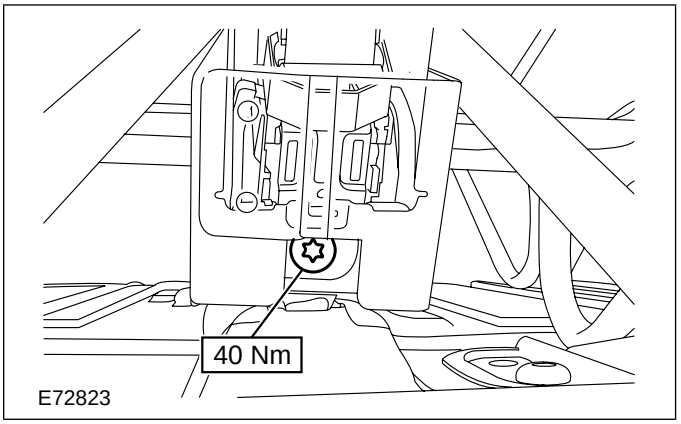
3. **Remove the safety belt retractor.**
   1. Remove the bolt.
   2. Lift the retractor from the locating tang.



Installation

1. **⚠CAUTION:Make sure the safety belt retractor locating tang is correctly located.**

   To install, reverse the removal procedure.



REMOVAL AND INSTALLATION

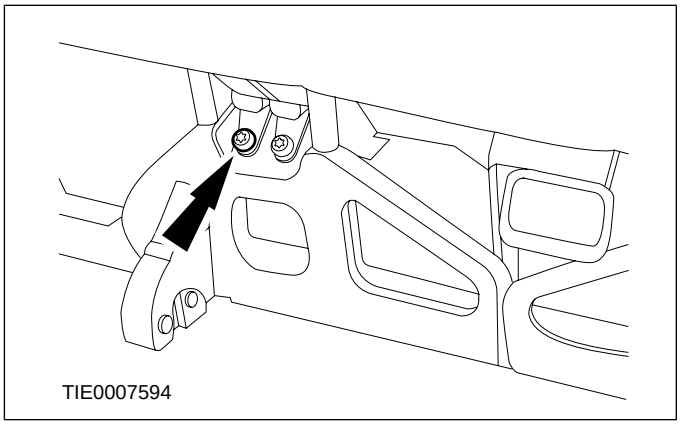
Rear Safety Belt Retractor (40 248 0)

Removal

NOTE: This procedure details the Removal and Installation of a rear safety belt retractor from a dual safety belt retractor mounting. The single safety belt retractor mounting is similar.

1. **⚠ CAUTION: The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt at all times when the safety belt is detached or removed.**

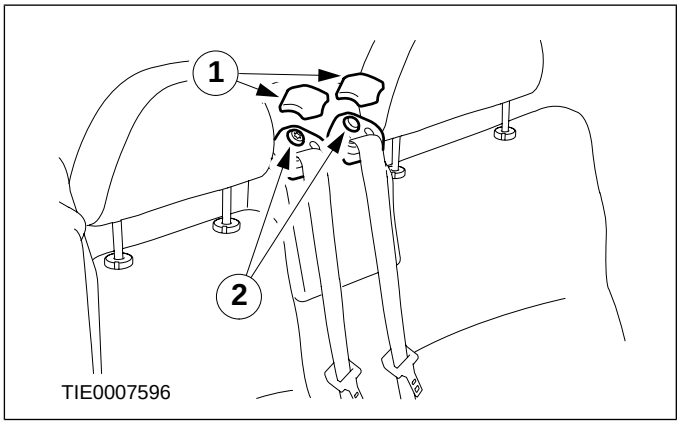
   Detach the safety belt lower anchor from the underside of the seat.



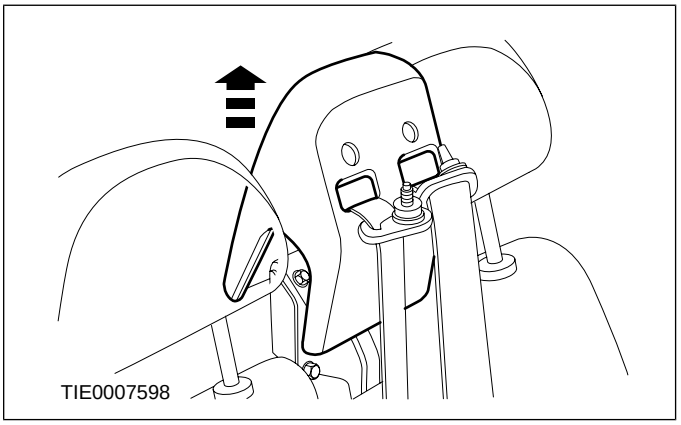
2. **⚠ CAUTION: The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt at all times when the safety belt is detached or removed.**

   Detach the safety belt upper anchors.

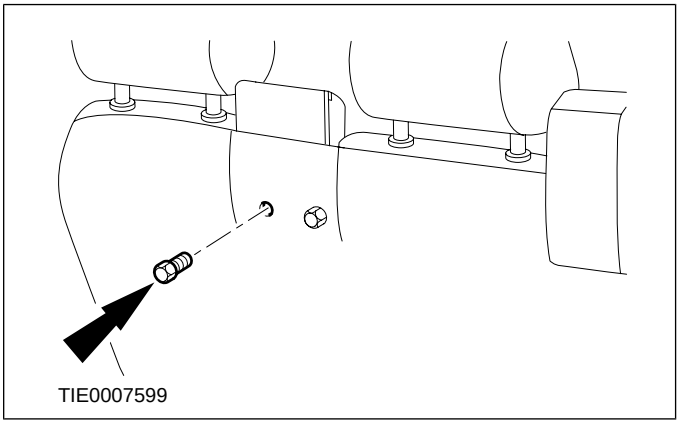
   1. Remove the covers.
   2. Remove the bolts.



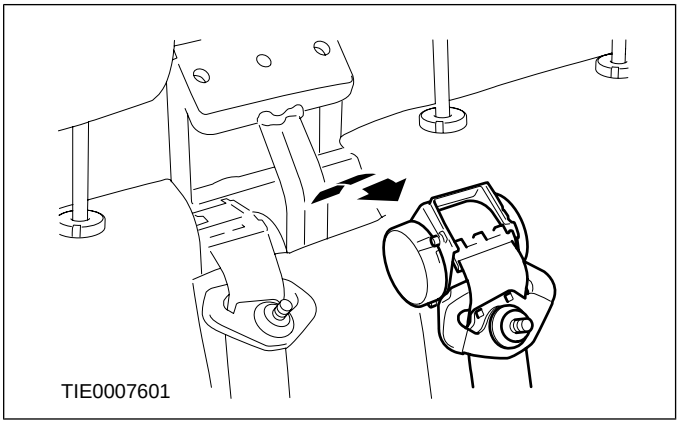
3. **Remove the safety belt retractor covers.**
   - Feed the safety belt webbing through the cover.



4. **Detach the safety belt retractor from the seat backrest.**



5. **Remove the safety belt retractor.**
   - Lift the retractor from the locating tang.

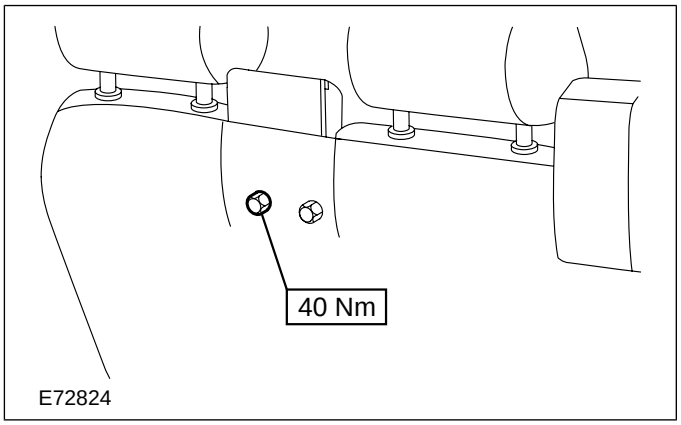


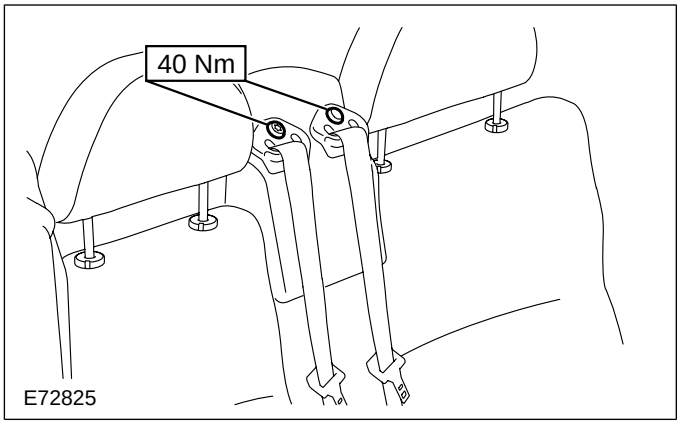
Installation

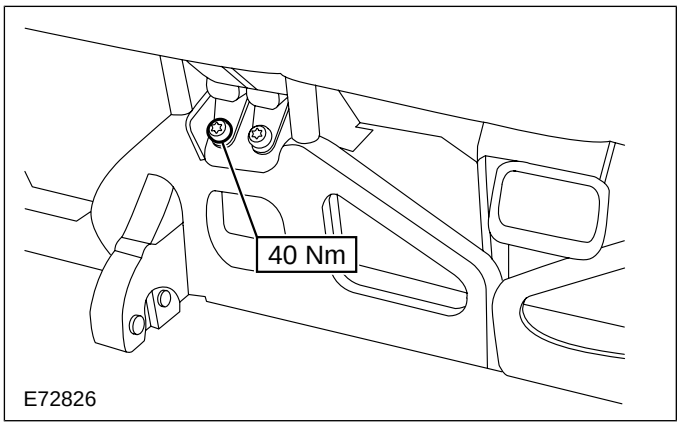
1. **⚠ CAUTION: Make sure the safety belt retractor locating tang is correctly located.**

REMOVAL AND INSTALLATION

To install, reverse the removal procedure.







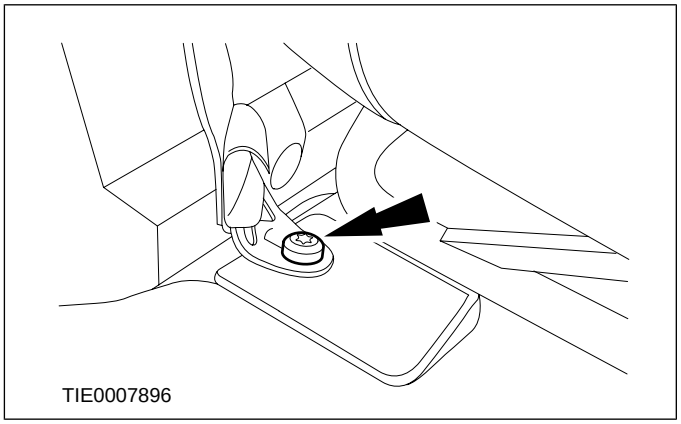
REMOVAL AND INSTALLATION

Rear Safety Belt Retractor — Chassis Double Cab (40 248 0)

Removal

1. **CAUTION:The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt at all times when the safety belt is detached or removed.**

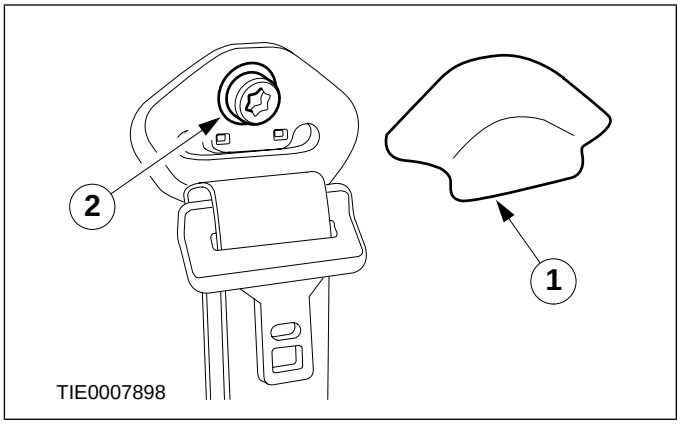
   Detach the safety belt lower anchor from the underside of the seat.


TIE0007896

2. **CAUTION:The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt at all times when the safety belt is detached or removed.**

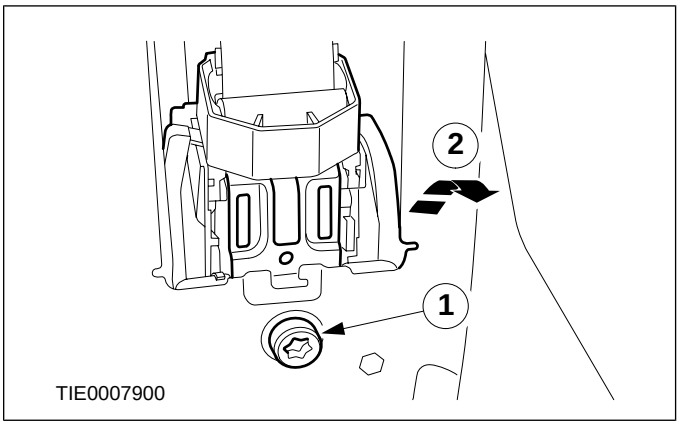
   Detach the safety belt upper anchor from the B-pillar.

   1. Remove the cover.
   2. Remove the bolt.



TIE0007898

3. **Remove the safety belt retractor.**
   1. Remove the bolt.
   2. Lift the retractor from the locating tang.

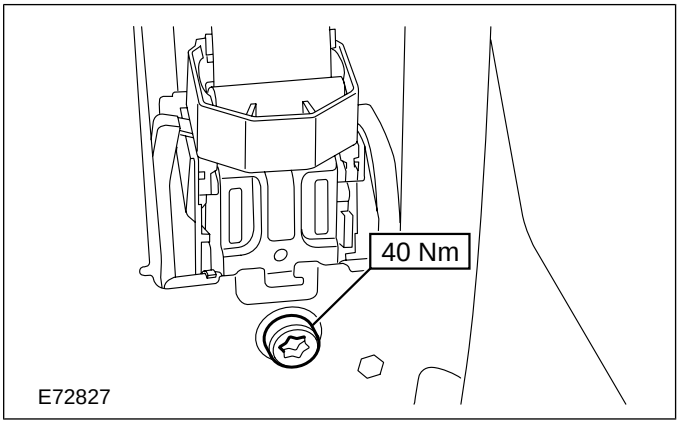


TIE0007900

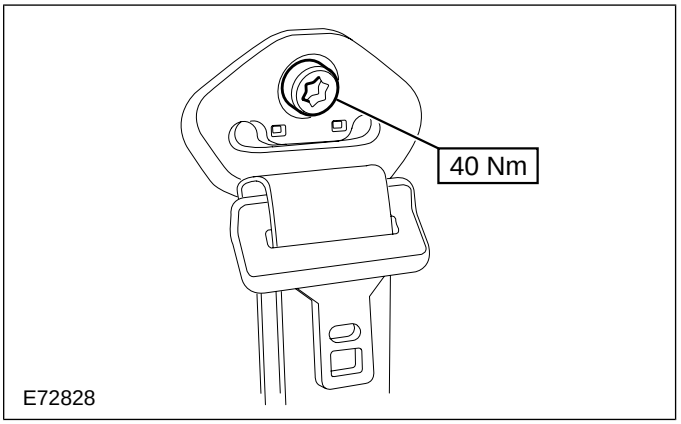
Installation

1. **CAUTION:Make sure the safety belt retractor locating tang is correctly located.**

   To install, reverse the removal procedure.

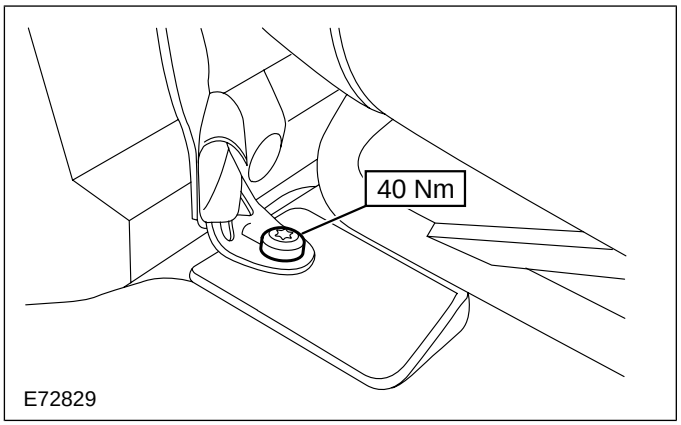


E72827



E72828

REMOVAL AND INSTALLATION

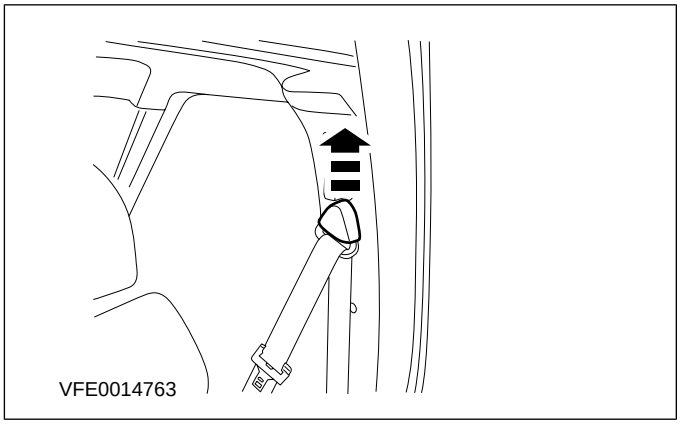


REMOVAL AND INSTALLATION

Safety Belt Shoulder Height Adjuster (40 225 0)

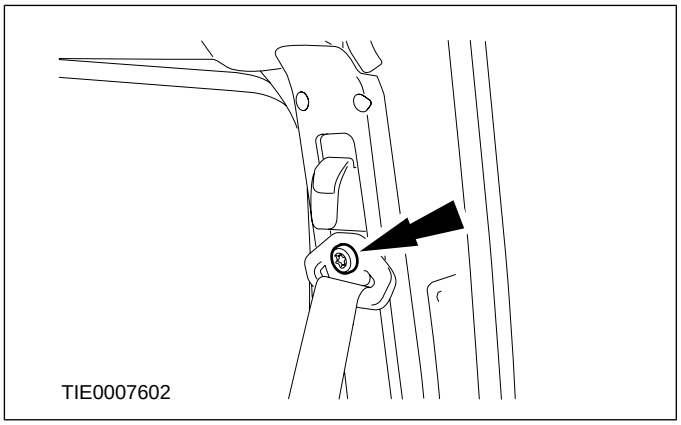
Removal

1. **Remove the safety belt upper anchor cover.**

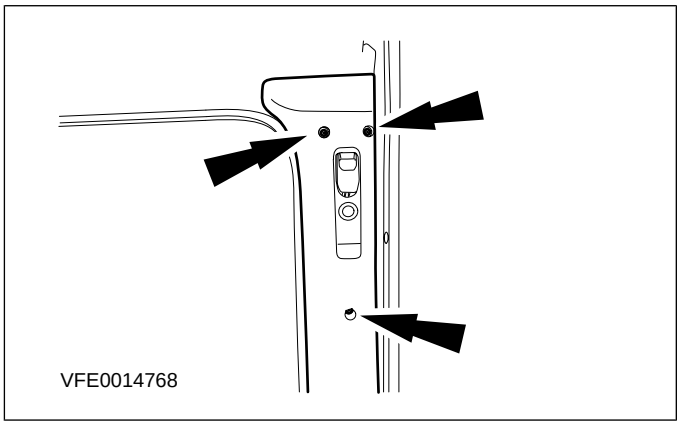


2. **⚠CAUTION:The bolt securing the safety belt anchor is held captive by a paper washer. The bolt, spacer and paper washer must remain on the safety belt at all times when the safety belt is detached or removed.**

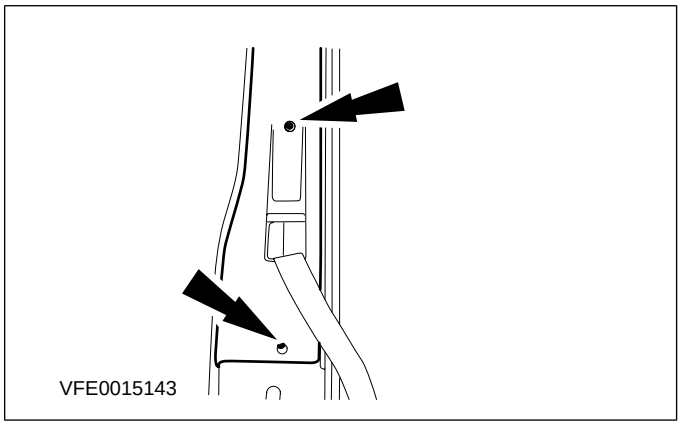
   Detach the safety belt upper anchor.



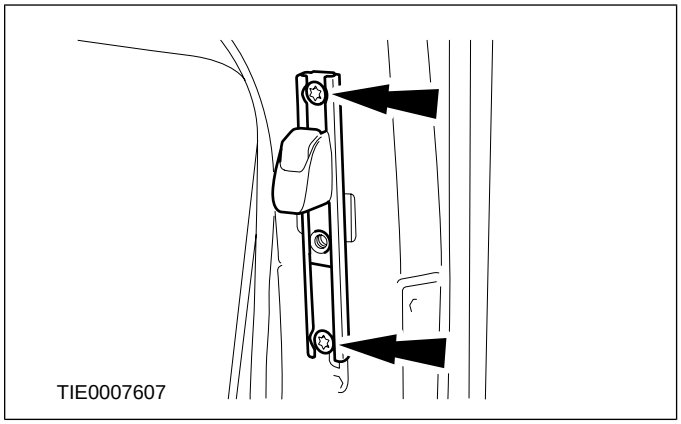
3. **Remove the B-pillar trim panel upper retaining screws.**



4. **Remove the B-pillar trim panel lower retaining screws.**

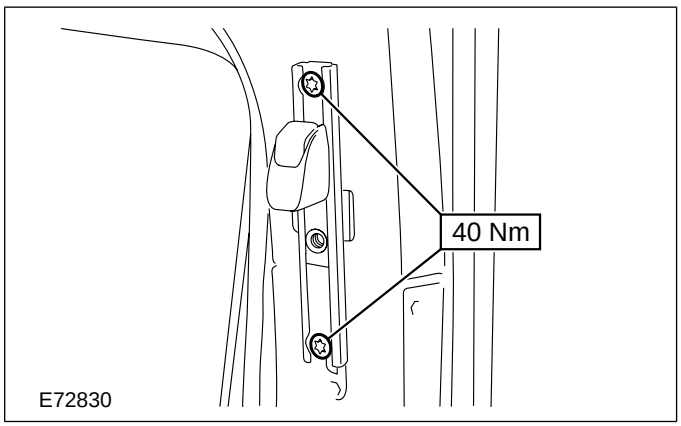


5. **Remove the safety belt shoulder height adjuster.**

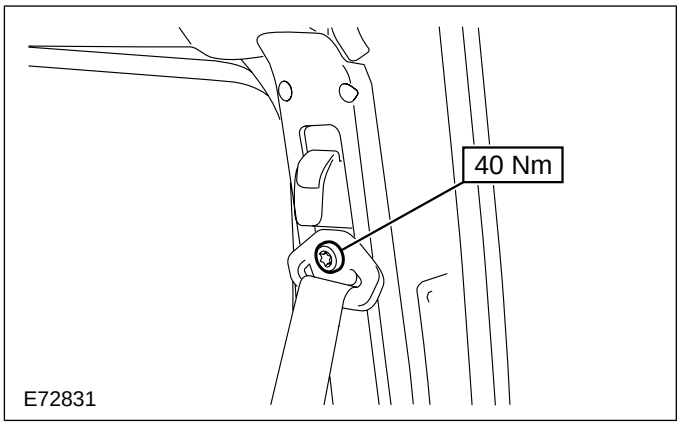


Installation

1. **To install, reverse the removal procedure.**



REMOVAL AND INSTALLATION



REMOVAL AND INSTALLATION

Safety Belt Retractor and Pretensioner

Removal

WARNINGS:

To avoid accidental deployment, the air bag control module backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the supplemental restraint system (SRS), or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.

Always wear safety glasses when working on an air bag equipped vehicle and when handling an air bag module. Failure to follow this instruction may result in personal injury.

To minimize the possibility of premature deployment, do not use radio key code savers when working on the SRS. Failure to follow this instruction may result in personal injury.

Never probe the electrical connectors of air bag modules or any other SRS component. Failure to follow this instruction may result in personal injury.

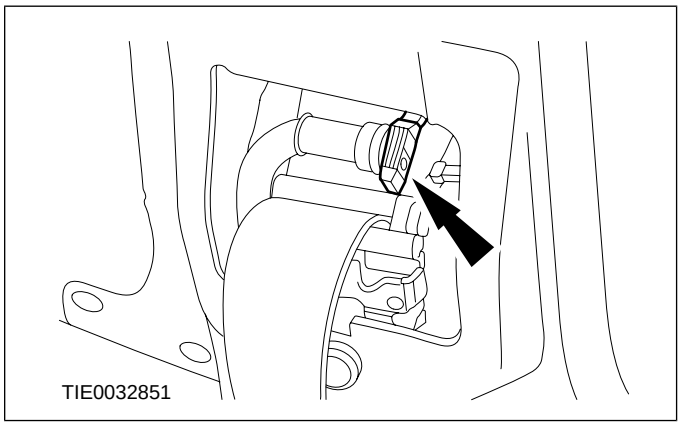
1. **Disconnect the battery ground cable.**

   For additional information, refer to: Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

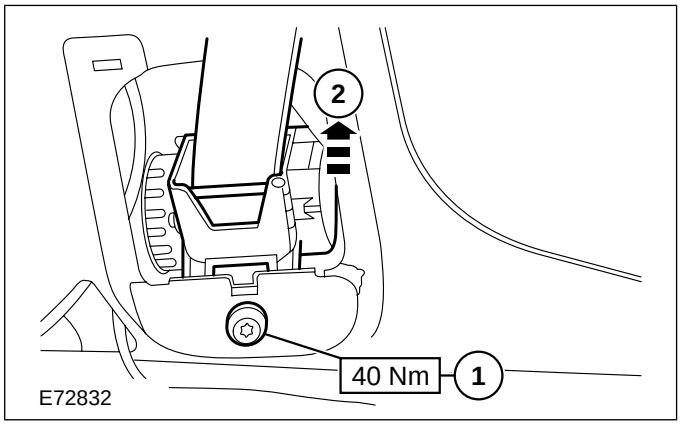
2. **Remove the B-pillar trim panel.**

   For additional information, refer to: B-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

3. **Disconnect the safety belt retractor and pretensioner electrical connector.**



4. **Remove the safety belt retractor and pretensioner.**
   1. Remove the safety belt retractor and pretensioner retaining bolt.
   2. Lift the safety belt retractor and pretensioner to detach the locating tang.



Installation

WARNINGS:

Always wear safety glasses when working on an air bag equipped vehicle and when handling an air bag module. Failure to follow this instruction may result in personal injury.

Never probe the electrical connectors of air bag modules or any other SRS component. Failure to follow this instruction may result in personal injury.

REMOVAL AND INSTALLATION

1. **CAUTION:Make sure that the safety belt retractor and pretensioner locating tang is correctly located.**

NOTE: Make sure that the safety belt shoulder height adjuster locking control is correctly located on the safety belt shoulder height adjuster.

To install, reverse the removal procedure.

SECTION 501-20B Supplemental Restraint System

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 501-20B-2

DESCRIPTION AND OPERATION

Air Bag and Safety Belt Pretensioner Supplemental Restraint System (SRS) 501-20B-3

DIAGNOSIS AND TESTING

Air Bag and Safety Belt Pretensioner Supplemental Restraint System (SRS) 501-20B-7
- Diagnosing Customer Concerns Without Hard DTCs 501-20B-7
- Diagnosing Customer Concerns with Hard DTCs 501-20B-7
- Deactivation 501-20B-8
- Reactivation 501-20B-8
- Glossary 501-20B-9
- Principles of Operation 501-20B-9
- Inspection and Verification 501-20B-10
- Symptom Chart 501-20B-10
- Pinpoint Tests 501-20B-14

GENERAL PROCEDURES

Deployed Air Bag Disposal 501-20B-64
Unserviceable Air Bag Disposal 501-20B-65
Scrapped Vehicle Undeployed Air Bag Disposal 501-20B-66
Scrapped Vehicle Air Bag and Safety Belt Pretensioner Disposal - In-Vehicle Disposal 501-20B-69
- All air bag modules 501-20B-72

REMOVAL AND INSTALLATION

Driver Air Bag Module 501-20B-73
Restraints Control Module (RCM) 501-20B-74
Clockspring 501-20B-75

SPECIFICATIONS

Special Tool Usage

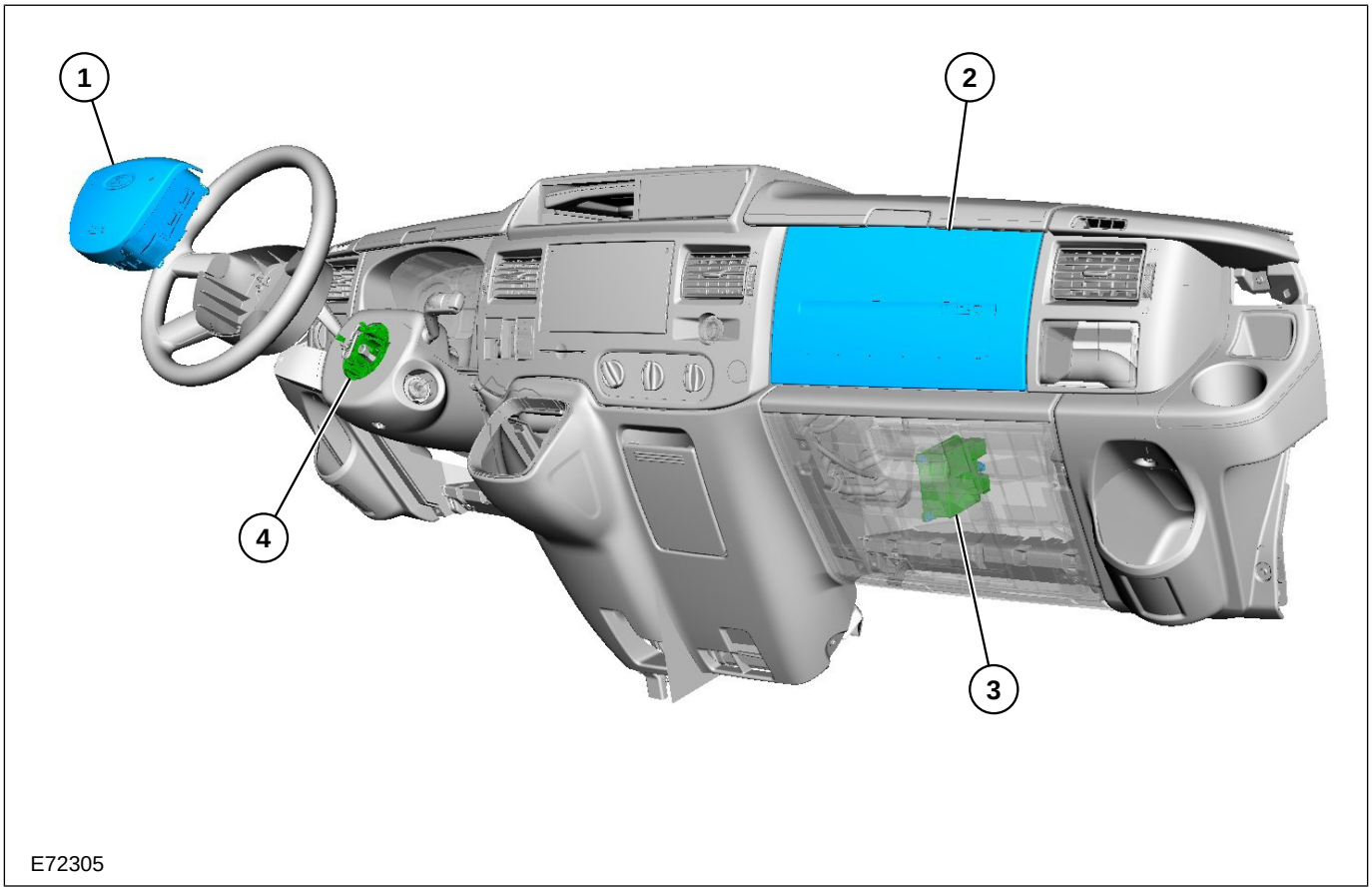
	Driver Air Bag Module	Passenger Air Bag Module	Side Air Bag Module
Air Bag Simulator	418-525	418-525	418-142
Test and Deployment Lead (Part of Test and Deployment Lead, Air Bag/Pyrotechnic Safety Belt 418-S055)	501-073A	501-073A	501-075

Torque Specifications

Description	Nm	lb-ft	lb-in
Passenger air bag module nuts	8	-	71
Restraints control module nuts	9	-	80
Side air bag module nuts	9	-	80
Side impact sensor bolt	9	-	80
Steering wheel retaining bolt	48	35	-

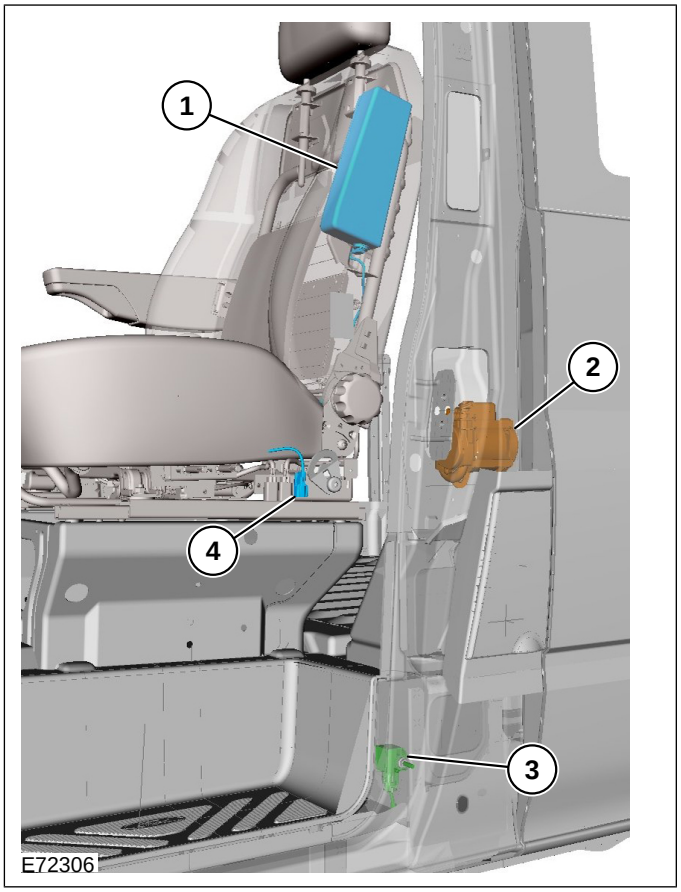
DESCRIPTION AND OPERATION

Air Bag and Safety Belt Pretensioner Supplemental Restraint System (SRS)



Item	Description
1	Drive air bag module
2	Passenger air bag module
3	Restraints control module
4	Clockspring

DESCRIPTION AND OPERATION



Item	Description
1	Side air bag module
2	Safety belt retractor and pretensioner
3	Side impact sensor
4	Side air bag module wiring harness

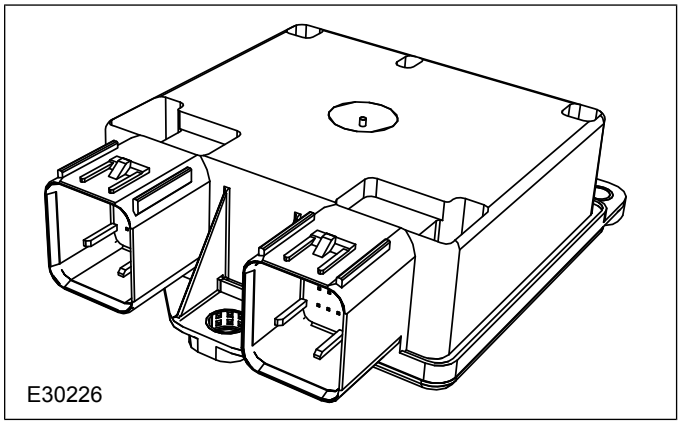
System structure

The following components form part of the supplemental restraint system (SRS):

- restraints control module
- side impact sensor
- driver and passenger air bag modules
- side air bag modules
- front passenger safety belt buckle and pretensioner
- driver safety belt retractor and pretensioner
- clockspring
- air bag warning indicator

Restraints control module

The Restraints control module is located under the instrument panel on the right-hand side of the heater. The installation marks on the air bag control module are to make sure it is aligned correctly.



A micromechanical sensor is incorporated into the restraints control module. This measures the acceleration/deceleration in the event of a collision. The calculated value is evaluated by the restraints control module to determine the severity of the impact.

The restraints control module compares the values it receives from the side impact sensors and the micromechanical sensor. If the deceleration due to a frontal or side impact exceeds a stored value then the air bag control module triggers the air bags and safety belt pretensioners as required.

If the vehicle battery is destroyed in the collision, a voltage hold circuit in the air bag control module will still enable the front air bags to be triggered up to 150 ms after the start of the impact.

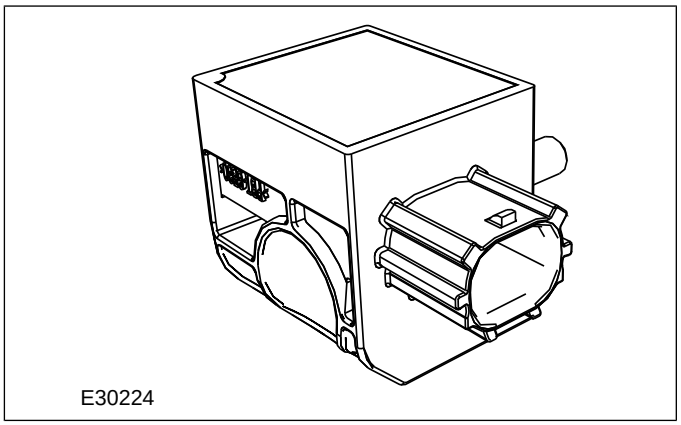
If a system fault is detected by the air bag control module, the air bag warning indicator is illuminated. The fault can be located by carrying out a diagnostic check using the Worldwide Diagnostic System (WDS).

The restraints control module can be used again after a collision for up to 5 times, provided that the restraints control module is not physically damaged and that it passes a self-test.

Side Impact Sensors

The side impact sensors are located at the bottom of the B-pillars and transmit digitally encoded acceleration/deceleration information to the restraints control module.

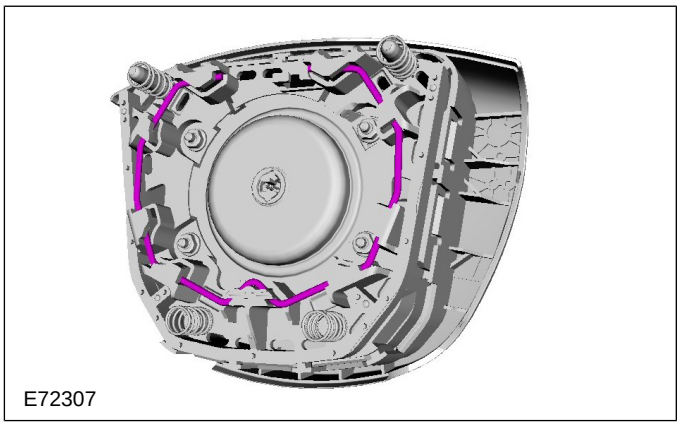
DESCRIPTION AND OPERATION


E30224

The side impact sensor can be used again after a collision, provided that the side impact sensor is not physically damaged and that it passes a self-test.

Driver Air Bag Module

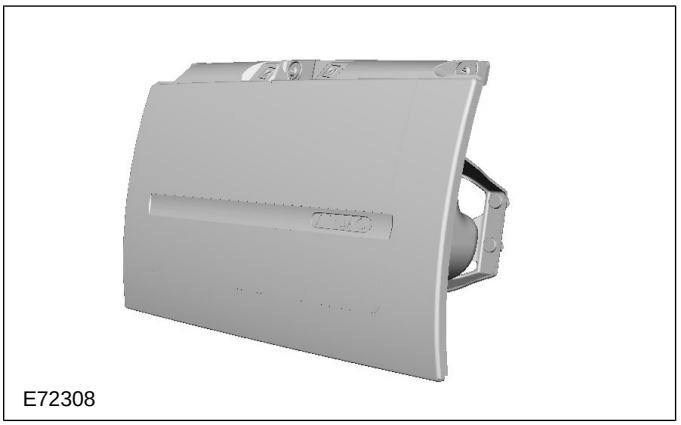
The driver air bag module is fitted to the steering wheel, the cover forming the outer surface of the steering wheel boss. The cover has invisible 'split lines' moulded in its surface allowing the air bag to easily exit through the cover when the system deploys.


E72307

A new driver air bag module and driver air bag module wiring harness must be installed following deployment.

Passenger Air Bag Module

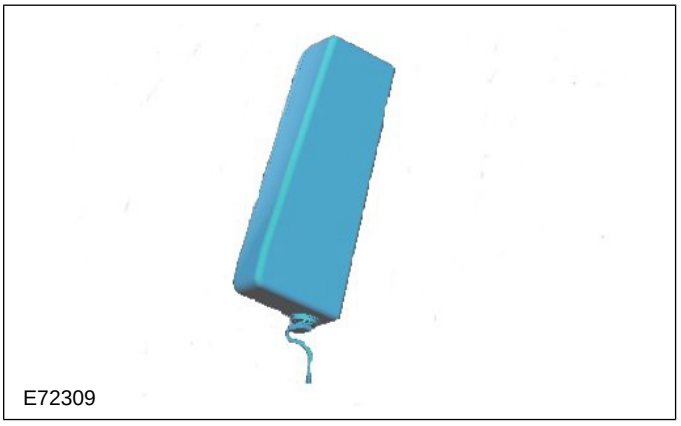
The passenger air bag module is located above the glove compartment and is secured to the in-vehicle crossbeam and the instrument panel. The cover is intergrated into the instrument panel to provide an unobtrusive appearance. The cover has invisible 'split lines' moulded in its surface allowing the air bag to easily exit through the cover when the system deploys.


E72308

A new passenger air bag module and passenger air bag module wiring harness must be installed following deployment.

Side Air Bag Module

The side air bag modules are incorporated in the front seat backrests. A sewn-on label on the respective backrest indicates that the vehicle is equipped with side air bag modules.


E72309

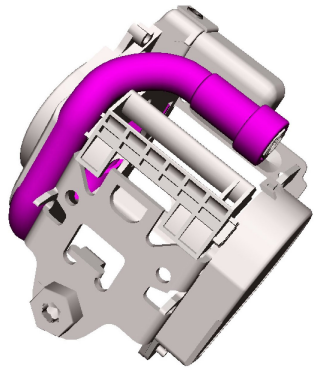
When a side air bag is deployed, the seam of the seat cover tears open enabling the side air bag to inflate unhindered from the front seat backrest.

A new side air bag module must be installed following deployment.

Safety Belt Retractor and Pretensioner

The safety belt pretensioner is integrated in the safety belt retractor.

DESCRIPTION AND OPERATION



E55580

A load limiter is built into the retractor spindle of the driver safety belt retractor. The spindle is designed as a torsion bar and, by turning, limits the belt force on the shoulder to a predetermined limit.

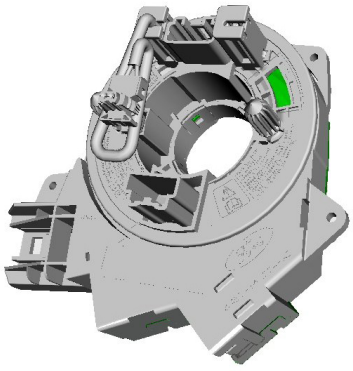
The safety belt pretensioner is designed to remove the slack from the safety belt webbing in the event of a frontal or near frontal collision over the predetermined limit.

The safety belt pretensioner can only be deployed once. A new driver safety belt retractor and pretensioner must be installed if the safety belt pretensioner has been deployed.

The safety belt pretensioner is triggered simultaneously with the front air bags.

Clockspring

The clockspring is designed to carry signals between the air bag control module and the driver air bag module. The clockspring is installed on the steering column and consists of fixed and moving parts connected by a coiled Mylar tape with internal conducting tracks. The Mylar tape is able to 'wind up' and 'unwind' as the steering wheel is rotated, maintaining electrical contact at all times between the air bag control module and the driver air bag module.



E72310

Vehicles equipped with stability assist have a steering wheel rotation sensor incorporated in the clockspring.

A new clockspring must be installed following a driver air bag module deployment.

Air Bag Warning Indicator

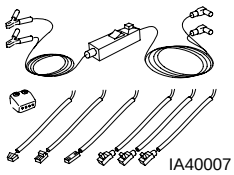
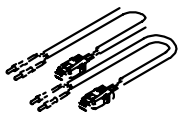
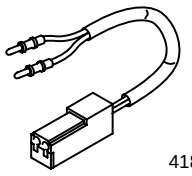
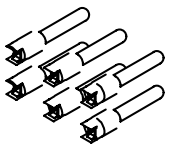
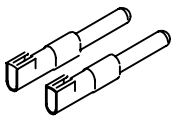
The SRS will communicate concerns during a driving cycle or after initial key ON by means of a warning indicator located in the instrument cluster.

If a concern is detected, the air bag control module will communicate by flashing the warning indicator and a diagnostic trouble code (DTC) is logged by the air bag control module in a non-volatile memory. The DTC can be downloaded using WDS.

DIAGNOSIS AND TESTING

Air Bag and Safety Belt Pretensioner Supplemental Restraint System (SRS)

Special Tool(s)

 IA40007	Test and Deployment Lead, Air Bag/Pyrotechnic Safety Belt 418-S055 (40-007)
 418525	Test and Deployment Lead; Driver and Passenger Air Bag Module 418–525
 418142	Test and Deployment Lead, Side Air Bag Module 418–142
 501073	Simulator, Driver and Passenger Air Bags 501-073A
 501075	Simulator, Side Air Bag 501-075

General Equipment

Worldwide diagnostic system (WDS)

Diagnosing Customer Concerns Without Hard DTCs

WARNING:The back up power supply must be depleted, before any work is carried out on the SRS. Wait at least one minute after disconnecting the battery ground cable. Failure to follow this instruction may result in personal injury.

NOTE: Following the pinpoint tests when a diagnostic trouble code (DTC) is not present, or the air bag warning lamp is not permanently illuminated, will result in needless replacement of air bag system components and repeat repairs.

Speak with the customer to determine if a particular set of conditions must be met in order for a fault to occur. If an illuminated air bag warning lamp is reported by the customer but is not present when the vehicle comes in for repair, pinpoint test diagnostics cannot be used.

Diagnosing Customer Concerns with Hard DTCs

WARNING:Do not use substitute air bag simulators when working on the SRS. Use only the appropriate tool. Failure to follow this instruction may result in personal injury.

Most air bag system diagnostic procedures require the use of system deactivation and system reactivation procedures. These procedures require the air bag module(s) and safety belt buckle pretensioners to be disconnected from the SRS, thereby removing the risk of air bag deployment while diagnostics are carried out.

Air bag simulators are required to carry out diagnosis and testing of the air bag system. The simulator contains a resistor, used to simulate an air bag module connection to the system. It is not acceptable to short-circuit the air bag module connections with a 0 ohm jumper wire. If a 0 ohm jumper wire is used to short-circuit the air bag module connections, an illuminated air bag warning lamp will be displayed and a DTC logged by the restraints control module (RCM).

DIAGNOSIS AND TESTING

Deactivation

WARNING:The back up power supply must be depleted, before any work is carried out on the SRS. Wait at least one minute after disconnecting the battery ground cable. Failure to follow this instruction may result in personal injury.

1. Disconnect the battery ground cable.

   REFER to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).
2. Wait 1 minute for the backup power supply in the RCM to deplete its stored energy.

WARNING:Place the air bag module on a ground wired bench, with the trim cover facing up to avoid accidental deployment. Failure to follow this instruction may result in personal injury.

3. Remove the driver air bag module from the vehicle.

   REFER to:Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).
4. Connect the air bag simulator to the sub-harness in place of the driver air bag module at the top of the steering column.
5. Disconnect the passenger air bag module electrical connector.

   REFER to:Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).
6. Connect the air bag simulator to the wiring harness in place of the passenger air bag module.
7. Disconnect the driver side air bag module electrical connector.
8. Connect the side air bag module simulator to the driver side air bag module electrical connector in place of the side air bag module.
9. Detach the B-pillar trim panel to gain access to the driver safety belt retractor pretensioner electrical connector.

   REFER to:B-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
10. Disconnect the driver safety belt retractor pretensioner electrical connector.
11. Connect the driver safety belt retractor pretensioner simulator to the wiring harness in place of the driver safety belt retractor pretensioner.
12. Disconnect the passenger side air bag module electrical connector.
13. Connect the side air bag module simulator to the passenger side air bag module electrical connector in place of the side air bag module.
14. Detach the B-pillar trim panel to gain access to the passenger safety belt retractor pretensioner electrical connector.

    REFER to:B-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
15. Disconnect the passenger safety belt retractor pretensioner electrical connector.
16. Connect the passenger safety belt retractor pretensioner simulator to the wiring harness in place of the passenger safety belt retractor and pretensioner.
17. Connect the battery ground cable.

    REFER to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

Reactivation

WARNING:The air bag simulators must be removed and the air bag modules reconnected when reactivated to avoid non-deployment in a collision. Failure to follow this instruction may result in personal injury.

1. Disconnect the battery ground cable.

   REFER to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).
2. Wait 1 minute for the backup power supply in the RCM to deplete its stored energy.
3. Remove the driver air bag simulator from the driver air bag module wiring harness at the top of the steering column.
4. Connect and install the driver air bag module.

   REFER to:Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).
5. Remove the passenger air bag simulator from the passenger air bag module harness.
6. Connect and install the passenger air bag module.

   REFER to:Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).

DIAGNOSIS AND TESTING

7. Remove the driver side air bag module simulator from the driver side air bag module electrical connector.
8. Connect the driver side air bag module electrical connector.
9. Remove the driver safety belt retractor pretensioner simulator from the driver safety belt retractor pretensioner wiring harness.
10. Connect the driver safety belt retractor pretensioner electrical connector.
11. Attach the B-pillar trim panel.

    REFER to:B-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
12. Remove the passenger side air bag module simulator from the passenger side air bag module electrical connector.
13. Connect the passenger side air bag module electrical connector.
14. Remove the passenger safety belt retractor pretensioner simulator from the passenger safety belt retractor pretensioner wiring harness.
15. Connect the passenger safety belt retractor pretensioner electrical connector.
16. Attach the B-pillar trim panel.

    REFER to:B-Pillar Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
17. Connect the battery ground cable.

    REFER to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).
18. Prove out the system.

Glossary

Air Bag Simulator

Air bag simulators are used to simulate air bag module connections to the system.

Deactivate the System

Deactivate the system means to carry out the deactivation procedure. REFER to Deactivation in this procedure.

Prove Out the System

The air bag warning indicator will illuminate for 3 seconds.

Reactivate the System

Reactivate the system means to carry out the reactivation procedure. REFER to Reactivation in this procedure.

Principles of Operation

SRS (SRS) Operation

The vehicle is equipped with DC fired single point sensing system. Vehicles equipped with side air bags are equipped with side impact sensors.

In the event of a severe frontal or 3-quarter frontal impact, in excess of a predetermined limit, the driver and passenger (if equipped) front air bag(s) will deploy.

In the event of a severe full side impact, in excess of a predetermined limit, either the driver or passenger side air bags (if equipped) will deploy.

Air bag deployment will only occur, in the event of a severe collision when the ignition key is in the RUN position.

RCM

The RCM retains full control of the whole system. Providing continual system checks and full diagnostic capabilities, the non-volatile memory stores the fault codes, which are down loaded through the diagnostic link connector to WDS. A visual warning indicator which is housed within the instrument cluster, is illuminated when the ignition is switched ON for 3 seconds then goes out. If a fault occurs the warning indicator remains illuminated after a further 5 seconds.

The RCM provides an auxiliary power supply, sufficient to deploy the air bag(s) for a minimum of 150mS, in the event of a failure in the vehicle power supply during or after an accident. The auxiliary power supply is discharged by the RCM within 60 seconds of the battery ground cable being disconnected. Thus making sure the SRS remains operational.

DIAGNOSIS AND TESTING

The RCM contains an electronic acceleration sensor to evaluate and process impact data from the frontal direction and a micromachine sensor that acts as the safing sensor for frontal impacts. Provided both the safing sensor and the electronic acceleration sensor detect an impact in excess of a predetermined limit the RCM initiates the circuit to deploy the frontal air bags.

Side Impact Sensors

The side impact sensors contain an acceleration sensor, filter, amplifier and an application specific integrated circuit for signal transmitting.

The side impact sensor processes the impact data against stored data. In the event of a side impact, in excess of a predetermined limit, the side impact sensor will send a signal to the RCM. The sensor opposite the impact side acts as the safing sensor for lateral impacts. If the electronic acceleration sensor also detects a side impact, in excess of a predetermined limit, a signal is then sent from the RCM to deploy the side air bags (if equipped).

Air Bag Warning Indicator

The air bag warning indicator is incorporated into the instrument cluster, together with the automatic detach detect (ADD) circuit, the air bag warning indicator comes on for 3 seconds at key ON. If the system self tests OK the air bag warning indicator extinguishes, if a fault is detected the air bag warning indicator will illuminate continually from key ON or not illuminate at all, depending on the nature of the fault.

The RCM retaining bolts are part of the ground circuit. The ADD circuit is designed to illuminate the air bag warning indicator continuously, if the RCM circuit is broken, either by:

- Loss of the RCM power supply.
- Loss of the RCM ground circuit.
- Disconnection of the RCM electrical connector.

Diagnostic evaluation of the SRS can be made through the data link connector (DLC) and WDS to establish the nature of the concern.

Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

Visual Inspection Chart

Electrical
– Fuse(s) – Electrical connector(s) – Circuit(s) – Air bag module(s)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the cause is not visually evident, connect WDS to the DLC and select the vehicle to be tested from the WDS menu.
5. Retrieve the DTCs and refer to the Symptom Chart.

Symptom Chart

Symptom Chart

NOTE: It is only allowed to repair circuits between connectors. If damage has occurred within a connector a connector replacement kit, if available, must be installed. If a connector replacement kit is not available a new wiring harness must be installed. Connectors must not be disassembled.

Symptom	Possible Sources	Action
• No communication with the module	• DLC. • RCM. • Circuit(s).	• GO to Pinpoint Test A.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• DTC B1231: Longitudinal acceleration threshold exceeded	• Crash data memory full.	**NOTE:** The crash data memory can be cleared a maximum of five times. • Clear down the crash data memory using WDS. REPEAT the self-test, CLEAR the DTCs.
• DTC B1317: Battery voltage high	• Charging system.	• CHECK the charging system. REFER to: Charging System (414-00 Charging System - General Information, Diagnosis and Testing). REPEAT the self-test, CLEAR the DTCs.
• DTC B1318: Battery voltage low	• Battery. • Charging system. • Circuit(s).	• GO to Pinpoint Test B.
• DTC B1342: RCM is defective	• RCM.	• INSTALL a new RCM. REFER to: Restraints Control Module (RCM) (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs.
• DTC B1868: Air bag warning indicator open circuit or short to ground	• Instrument cluster.	• CHECK the instrument cluster. REFER to: Instrument Cluster (413-01 Instrument Cluster, Diagnosis and Testing).
• DTC B1877: Driver side safety belt pretensioner open circuit	• Driver side safety belt pretensioner. • Circuit(s).	• GO to Pinpoint Test C.
• DTC B1878: Passenger side safety belt pretensioner open circuit	• Passenger side safety belt pretensioner. • Circuit(s).	• GO to Pinpoint Test D.
• DTC B1879: Driver side safety belt pretensioner short to ground	• Driver side safety belt pretensioner. • Circuit(s).	• GO to Pinpoint Test E.
• DTC B1881: Passenger side safety belt pretensioner open circuit	• Passenger side safety belt pretensioner. • Circuit(s).	• GO to Pinpoint Test F.
• DTC B1882: Passenger side safety belt pretensioner short to battery	• Passenger side safety belt pretensioner. • Circuit(s).	• GO to Pinpoint Test G.
• DTC B1883: Passenger side safety belt pretensioner short to ground	• Passenger side safety belt pretensioner. • Circuit(s).	• GO to Pinpoint Test H.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• DTC B1885: Driver side safety belt pretensioner low resistance	• Driver side safety belt pretensioner. • Circuit(s).	• GO to Pinpoint Test I.
• DTC B1886: Passenger side safety belt pretensioner low resistance	• Passenger side safety belt pretensioner. • Circuit(s).	• GO to Pinpoint Test J.
• DTC B1916: Driver air bag short to battery	• Driver air bag module. • Clockspring. • Circuit(s).	• GO to Pinpoint Test K.
• DTC B1925: Passenger air bag short to battery	• Circuit(s).	• GO to Pinpoint Test L.
• DTC B1932: Driver air bag open circuit or high resistance	• Driver air bag module. • Clockspring. • Circuit(s).	• GO to Pinpoint Test M.
• DTC B1933: Passenger air bag open circuit or high resistance	• Passenger air bag module. • Circuit(s).	• GO to Pinpoint Test N.
• DTC B1934: Driver air bag circuit low resistance	• Driver air bag module. • Clockspring. • Circuit(s).	• GO to Pinpoint Test O.
• DTC B1935: Passenger air bag circuit low resistance	• Passenger air bag module. • Circuit(s).	• GO to Pinpoint Test P.
• DTC B1936: Driver air bag circuit short to ground	• Driver air bag module. • Clockspring. • Circuit(s).	• GO to Pinpoint Test Q.
• DTC B1938: Passenger air bag circuit short to ground	• Passenger air bag module. • Circuit(s).	• GO to Pinpoint Test R.
• DTC B1992: Driver side air bag circuit short to battery	• Circuit(s).	• GO to Pinpoint Test S.
• DTC B1993: Driver side air bag circuit short to ground	• Driver side air bag module. • Circuit(s).	• GO to Pinpoint Test T.
• DTC B1994: Driver side air bag circuit open circuit	• Driver side air bag module. • Circuit(s).	• GO to Pinpoint Test U.
• DTC B1995: Driver side air bag circuit low resistance on squib	• Driver side air bag module. • Circuit(s).	• GO to Pinpoint Test V.
• DTC B1996: Passenger side air bag circuit short to battery	• Passenger side air bag module. • Circuit(s).	• GO to Pinpoint Test W.
• DTC B1997: Passenger side air bag circuit short to ground	• Passenger side air bag module. • Circuit(s).	• GO to Pinpoint Test X.
• DTC B1998: Passenger side air bag circuit open circuit	• Passenger side air bag module. • Circuit(s).	• GO to Pinpoint Test Y.
• DTC B1999: Passenger side air bag circuit low resistance on squib	• Passenger side air bag module. • Circuit(s).	• GO to Pinpoint Test Z.

DIAGNOSIS AND TESTING

Symptom	Possible Sources	Action
• DTC B2444: Driver side impact sensor internal fault	• Driver side impact sensor.	• INSTALL a new driver side impact sensor. REFER to:Side Impact Sensor (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs.
• DTC B2445: Passenger side impact sensor internal fault	• Passenger side impact sensor.	• INSTALL a new passenger side impact sensor. REFER to:Side Impact Sensor (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs.
• DTC B2477: RCM configuration failure	• RCM.	• CONFIGURE the RCM. REFER to WDS. REPEAT the self-test, CLEAR the DTCs.
• DTC B2792: Cross link between firing circuits	• Circuit(s).	• GO to Pinpoint Test AA.
• DTC P1796: CAN controller circuit (BUS off)	• Circuit(s).	• GO to Pinpoint Test AB.
• DTC U0155: Lost communication with instrument cluster control module	• Instrument cluster.	• CHECK the instrument cluster. REFER to:Instrument Cluster (413-01 Instrument Cluster, Diagnosis and Testing). REPEAT the self-test, CLEAR the DTCs.
	• Circuit(s).	• CHECK the CAN bus. REFER to:Communications Network (418-00 Module Communications Network, Diagnosis and Testing). REPEAT the self-test, CLEAR the DTCs.
• DTC U2017: Driver side impact sensor communications fault	• Driver side impact sensor.	• CHECK the driver side impact sensor calibration. REFER to WDS. REPEAT the self-test, CLEAR the DTCs.
	• Circuit(s).	• GO to Pinpoint Test AC. REPEAT the self-test, CLEAR the DTCs.
• DTC U2018: Passenger side impact sensor communications fault	• Passenger side impact sensor.	• CHECK the passenger side impact sensor calibration. REFER to WDS. REPEAT the self-test, CLEAR the DTCs.

DIAGNOSIS AND TESTING

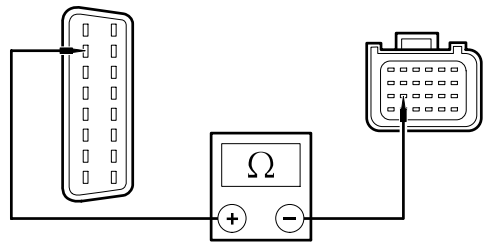
Symptom	Possible Sources	Action
	• Circuit(s).	• GO to Pinpoint Test AD. REPEAT the self-test, CLEAR the DTCs.
• RCM disconnected or inoperative	• RCM • Circuit(s).	• GO to Pinpoint Test AE.

Pinpoint Tests

PINPOINT TEST A : NO COMMUNICATION WITH THE MODULE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
A1: CHECK THAT WDS IS COMMUNICATING THROUGH THE DLC	
	1 Select an alternative system to check the DLC. • Is WDS able to communicate with the selected system? → **Yes** GO to A2. → **No** CHECK the DLC. For additional information, refer to the Wiring Diagrams. REPEAT the self-test, CLEAR the DTCs.
A2: CHECK THE AIR BAG WARNING INDICATOR	
	1 Ignition switch in position II.
	2 The air bag warning indicator should illuminate when the ignition is in the ON position for three seconds and then go out. If a fault is present, the air bag warning light will then will illuminate continually. • Is the warning indicator operating? → **Yes** GO to A3. → **No** CHECK the instrument cluster. REFER to:Instrument Cluster (413-01 Instrument Cluster, Diagnosis and Testing).
A3: CHECK THE DLC CIRCUIT	
⚠ **WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.**	
	1 Ignition switch in position 0.

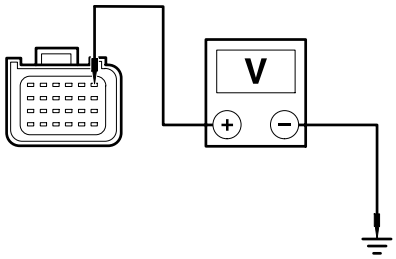
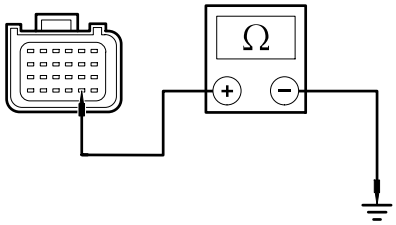
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Deactivate the SRS.
	3 Disconnect RCM CR114A.
 TIE0030225	4 Measure the resistance between the DLC CDB04 pin 7, circuit VDB10A (GY) and the RCM CR114A pin 17, circuit VDB10D (GY), harness side. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new RCM. REFER to:Restraints Control Module (RCM) (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit VDB10A (GY) or circuit VDB10D (GY). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST B : DTC B1318: BATTERY VOLTAGE LOW

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
NOTE: Use a digital multimeter for all electrical measurements.	
B1: CHECK THE BATTERY VOLTAGE	
	1 Ignition switch in position II.
	2 Check the battery voltage with the ignition in the ON position. • Is the battery voltage greater than 9 volts? → **Yes** GO to B2. → **No** CHECK the battery and charging system. REFER to: Battery (414-01 Battery, Mounting and Cables, Diagnosis and Testing), Charging System (414-00 Charging System - General Information, Diagnosis and Testing). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B2: CHECK THE RCM SUPPLY CIRCUIT	
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
	1 Ignition switch in position 0.
	2 Deactivate the SRS.
	3 Disconnect RCM CR114A.
	4 Ignition switch in position II.
 TIE0030178	5 Measure the voltage between the: Chassis Cab • RCM CR114A pin 1, circuit SBP68A (RD/GN), harness side and ground. Van, Bus, Kombi • RCM CR114A pin 1, circuit SBP68A (GN/RD), harness side and ground. • Is the voltage between 9 and 16 volts? → **Yes** GO to B3. → **No** REPAIR circuit SBP68A (RD/GN) or circuit SBP68A (GN/RD). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
B3: CHECK THE RCM GROUND CIRCUIT	
	1 Ignition switch in position 0.
 TIE0030179	2 Measure the resistance between the RCM CR114A pin 20, circuit GD112A (BK/GN), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new RCM. REFER to:Restraints Control Module (RCM) (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit GD112A (BK/GN). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

PINPOINT TEST C : DTC B1877: SIDE SAFETY BELT PRETENSIONER OPEN CIRCUIT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
C1: CHECK THE DRIVER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to C2. → **No** GO to C3.
C2: PROVE OUT THE DRIVER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Driver Side Safety Belt Retractor Pretensioner Simulator.
	3 Connect Driver Side Safety Belt Retractor Pretensioner Electrical Connector CR120.
	4 Ignition switch in position II.
	5 Carry out the self-test. • Does the system prove out correctly? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver side safety belt retractor and pretensioner. REFER to:Safety Belt Retractor and Pretensioner (501-20 Safety Belt System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
C3: CHECK THE DRIVER SIDE SAFETY BELT PRETENSIONER FOR OPEN CIRCUIT OR HIGH RESISTANCE	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect RCM CR114B.
	3 Disconnect Driver Side Safety Belt Pretensioner Simulator.
	4 Measure the resistance between the: Chassis Cab • RCM CR114B pin 4, circuit RR201B (BU/OG), harness side and the driver side safety belt retractor pretensioner electrical connector CR120 pin 1, circuit RR201E (BU/OG), harness side. • RCM CR114B pin 5, circuit RR120B (GN/RD), harness side and the driver side safety belt retractor pretensioner electrical connector CR120 pin 2, circuit RR120E (GN/RD), harness side. Van, Bus Kombi • RCM CR114B pin 4, circuit RR201B (BU/OG), harness side and the driver side safety belt retractor pretensioner electrical connector CR120 pin 1, circuit RR201D (BU/OG), harness side. • RCM CR114B pin 5, circuit RR120B (BN/GN), harness side and the driver side safety belt retractor pretensioner electrical connector CR120 pin 2, circuit RR120D (BN/GN), harness side. • Are the resistances less than 5 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit RR120B (GN/RD), or circuit RR120B (BN/GN), or circuit RR120D (BN/GN), or circuit RR120E (GN/RD), or circuit RR201B (BU/OG), or circuit RR201E (BU/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

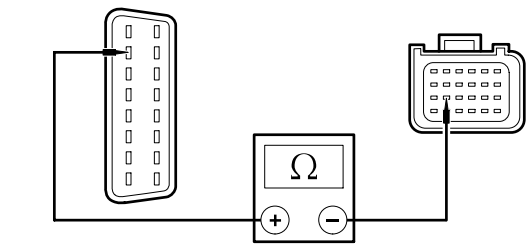
PINPOINT TEST D : DTC B1878: DRIVER SIDE SAFETY BELT PRETENSIONER SHORT TO BATTERY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
D1: CHECK THE DRIVER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to D2. → **No** GO to D3.
D2: PROVE OUT THE DRIVER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Driver Side Safety Belt Retractor Pretensioner Simulator.
	3 Connect Driver Side Safety Belt Retractor Pretensioner CR120.
	4 Ignition switch in position II.
	5 Carry out the self-test. • Does the system prove out correctly? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver safety belt retractor and pretensioner. REFER to:Safety Belt Retractor and Pretensioner (501-20 Safety Belt System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
D3: CHECK THE DRIVER SIDE SAFETY BELT PRETENSIONER FOR A SHORT TO BATTERY	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114B.
	3 Disconnect Driver Safety Belt Pretensioner Simulator.
	4 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030225	5 Measure the voltage between the: Chassis Cab • RCM CR114B pin 4, circuit CR201B (BU/OG), harness side and ground. • RCM CR114B pin 5, circuit RR120B (GN/RD), harness side and ground. Van, Bus, Kombi • RCM CR114B pin 4, circuit CR201B (BU/OG), harness side and ground. • RCM CR114B pin 5, circuit RR120B (BN/GN), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit RR120B (GN/RD), or circuit RR120B (BN/GN), or circuit CR201B (BU/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

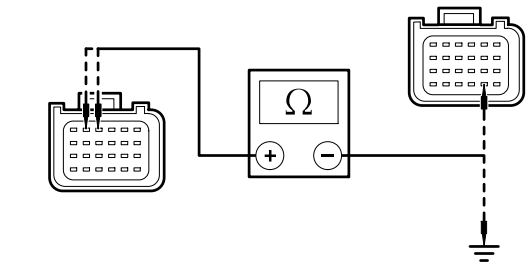
PINPOINT TEST E : DTC B1879: DRIVER SIDE SAFETY BELT PRETENSIONER SHORT TO GROUND

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
E1: CHECK THE DRIVER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to E2. → **No** GO to E3.
E2: PROVE OUT THE DRIVER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Driver Side Safety Belt Retractor Pretensioner Simulator.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Connect Driver Side Safety Belt Retractor Pretensioner CR120.
	4 Ignition switch in position II.
	5 Carry out the self-test. • Does the system prove out correctly? → **Yes** REPEAT the self-test, CLEAR the DTCs. → **No** INSTALL a new driver safety belt retractor and pretensioner. REFER to:Safety Belt Retractor and Pretensioner (501-20 Safety Belt System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
E3: CHECK THE DRIVER SIDE SAFETY BELT PRETENSIONER FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114A.
	3 Disconnect RCM CR114B.
	4 Disconnect Driver Side Safety Belt Retractor Pretensioner Simulator.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030186	5 Measure the resistance between the: Chassis Cab • RCM CR114B pin 4, circuit CR201B (BU/OG), harness side and ground. • RCM CR114B pin 5, circuit RR120B (GN/RD), harness side and ground. • RCM CR114A pin 20, circuit GD112A (BK/GN), harness side and the RCM CR114B pin 4, circuit CR201B (BU/OG) harness side. • RCM CR114A pin 20, circuit GD112A (BK/GN), harness side and the RCM CR114B pin 5, circuit RR120B (GN/RD), harness side. Van, Bus, Kombi • RCM CR114B pin 4, circuit CR201B (BU/OG), harness side and ground. • RCM CR114B pin 5, circuit RR120B (BN/GN), harness side and ground. • RCM CR114A pin 20, circuit GD112A (BK/GN), harness side and the RCM CR114B pin 4, circuit CR201B (BU/OG) harness side. • RCM CR114A pin 20, circuit GD112A (BK/GN), harness side and the RCM CR114B pin 5, circuit RR120B (BN/GN), harness side. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit RR120B (GN/RD), or circuit RR120B (BN/GN), or circuit GD112A (BK/GN), or circuit CR201B (BU/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

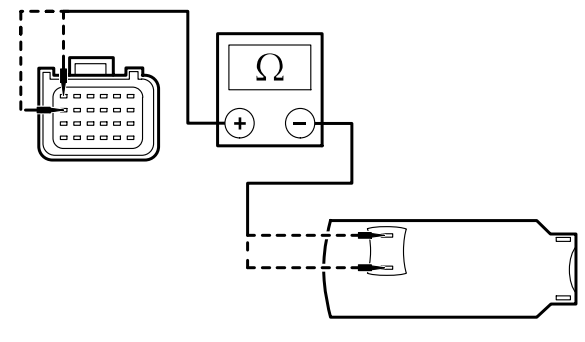
PINPOINT TEST F : DTC B1881: PASSENGER SIDE SAFETY BELT PRETENSIONER OPEN CIRCUIT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
F1: CHECK THE PASSENGER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to F2. → **No** GO to F3.
F2: PROVE OUT THE PASSENGER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Passenger Side Safety Belt Retractor Pretensioner Simulator.
	3 Connect Passenger Side Safety Belt Retractor Pretensioner CR122.
	4 Ignition switch in position II.
	5 Carry out the self-test. • Does the system prove out correctly? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new passenger safety belt retractor and pretensioner. REFER to:Safety Belt Retractor and Pretensioner (501-20 Safety Belt System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
F3: CHECK THE PASSENGER SIDE SAFETY BELT PRETENSIONER FOR OPEN CIRCUIT OR HIGH RESISTANCE	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114B.
	3 Disconnect Passenger Side Safety Belt Retractor Pretensioner Simulator.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E71679	4 Measure the resistance between the: Chassis Cab • RCM CR114B pin 6, circuit RR122B (BU/RD), harness side and the passenger side safety belt retractor pretensioner CR122 pin 2, circuit RR122E (BU/RD), harness side. • RCM CR114B pin 12, circuit CR203B (GY/VT), harness side and the passenger side safety belt retractor pretensioner CR122 pin 1, circuit CR203E (GY/VT), harness side. Van, Bus, Kombi • RCM CR114B pin 6, circuit RR122A (BN), harness side and the passenger side safety belt retractor pretensioner CR122 pin 2, circuit RR122D (BN), harness side. • RCM CR114B pin 12, circuit CR203A (GY/VT), harness side and the passenger side safety belt retractor pretensioner CR122 pin 1, circuit CR203D (GY/VT), harness side. • Are the resistances less than 5 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit RR122A (BN), or circuit RR122B (BU/RD), or circuit RR122E (BU/RD), or circuit CR203B (GY/VT), or circuit CR203E (GY/VT). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

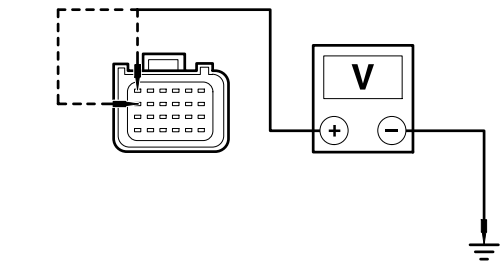
PINPOINT TEST G : DTC B1882: PASSENGER SIDE SAFETY BELT PRETENSIONER SHORT TO BATTERY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
G1: CHECK THE PASSENGER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to G2. → **No** GO to G3.
G2: PROVE OUT THE PASSENGER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Passenger Side Safety Belt Retractor Pretensioner Simulator.
	3 Connect Passenger Side Safety Belt Retractor Pretensioner CR122.
	4 Ignition switch in position II.
	5 Carry out the self-test. • Does the system prove out correctly? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new RCM. REFER to:Restraints Control Module (RCM) (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
G3: CHECK THE PASSENGER SIDE SAFETY BELT PRETENSIONER FOR A SHORT TO BATTERY	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114B.
	3 Disconnect Passenger Side Safety Belt Retractor Pretensioner Simulator.
	4 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030188	5 Measure the voltage between the: Chassis Cab • RCM CR114B pin 6, circuit RR122B (BU/RD), harness side and ground. • RCM CR114B pin 12, circuit CR203B (GY/VT), harness side and ground. Van, Bus, Kombi • RCM CR114B pin 6, circuit RR122A (BN), harness side and ground. • RCM CR114B pin 12, circuit CR203A (GY/VT), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit RR122A (BN), or circuit RR122B (BU/RD), or circuit CR203A (GY/VT), or circuit CR203B (GY/VT). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

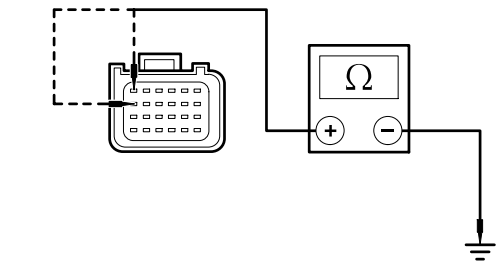
PINPOINT TEST H : DTC B1883: PASSENGER SIDE SAFETY BELT PRETENSIONER SHORT TO GROUND

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
H1: CHECK THE PASSENGER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to H2. → **No** GO to H3.
H2: PROVE OUT THE PASSENGER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Passenger Side Safety Belt Retractor Pretensioner Simulator.
	3 Connect Passenger Side Safety Belt Retractor Pretensioner CR122.
	4 Ignition switch in position II.
	5 Carry out the self-test. • Does the system prove out correctly? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new passenger side safety belt retractor and pretensioner. REFER to:Safety Belt Retractor and Pretensioner (501-20 Safety Belt System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
H3: CHECK THE PASSENGER SIDE SAFETY BELT PRETENSIONER CIRCUIT FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114B.
	3 Disconnect Passenger Side Safety Belt Retractor Pretensioner Simulator.

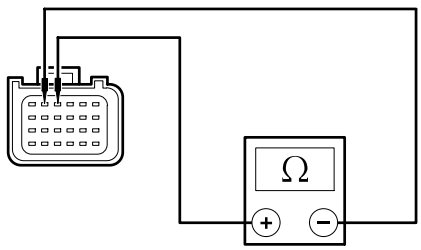
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030187	4 Measure the resistance between the: Chassis Cab • RCM CR114B pin 6, circuit RR122B (BU/RD), harness side and ground. • RCM CR114B pin 12, CR203B (GY/VT), harness side and ground. Van, Bus, Kombi • RCM CR114B pin 6, circuit RR122A (BN), harness side and ground. • RCM CR114B pin 12, circuit CR203A (GY/VT), harness side and ground. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. No → **No** REPAIR circuit RR122A (BN), or circuit RR122B (BU/RD), or circuit CR203A (GY/VT), or circuit CR203B (GY/VT). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST I : DTC B1885: DRIVER SIDE SAFETY BELT PRETENSIONER LOW RESISTANCE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
I1: CHECK THE DRIVER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to I2. → **No** GO to I3.
I2: PROVE OUT THE DRIVER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Ignition switch in position 0.

DIAGNOSIS AND TESTING

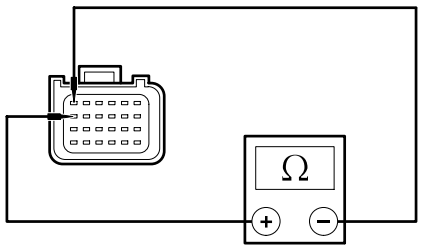
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Driver Side Safety Belt Retractor Pretensioner Simulator.
	3 Connect Driver Side Safety Belt Retractor Pretensioner CR120.
	4 Ignition switch in position II.
	5 Carry out the self-test. • Does the system prove out correctly? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver side safety belt retractor and pretensioner. REFER to:Safety Belt Retractor and Pretensioner (501-20 Safety Belt System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
I3: CHECK THE DRIVER SIDE SAFETY BELT PRETENSIONER FOR LOW RESISTANCE	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114B.
	3 Disconnect Driver Side Safety Belt Retractor Pretensioner Simulator.
 TIE0030189	4 Measure the resistance between the: Chassis Cab • RCM CR114B pin 4, circuit CR201B (BU/OG), harness side and the RCM CR114B pin 5, circuit RR120B (GN/RD), harness side. Van, Bus, Kombi • RCM CR114B pin 4, circuit CR201B (BU/OG), harness side and the RCM CR114B pin 5, circuit RR120B (BN/GN), harness side. • Is the resistance greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit RR120B (GN/RD) or circuit RR120B (BN/GN) and circuit CR201B (BU/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

PINPOINT TEST J : DTC B1886: PASSENGER SIDE SAFETY BELT PRETENSIONER LOW RESISTANCE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
J1: CHECK THE PASSENGER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to J2. → **No** GO to J3.
J2: PROVE OUT THE PASSENGER SIDE SAFETY BELT PRETENSIONER CIRCUIT	
	1 Ignition switch in position 0.
	2 Disconnect Passenger Side Safety Belt Retractor Pretensioner Simulator.
	3 Connect Passenger Side Safety Belt Retractor Pretensioner CR122.
	4 Ignition switch in position II.
	5 Carry out the self-test. • Does the system prove out correctly? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** the system. INSTALL a new passenger side safety belt retractor and pretensioner. REFER to:Safety Belt Retractor and Pretensioner (501-20 Safety Belt System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. No
J3: CHECK THE PASSENGER SIDE SAFETY BELT PRETENSIONER FOR LOW RESISTANCE	
	1 Ignition switch in position 0.

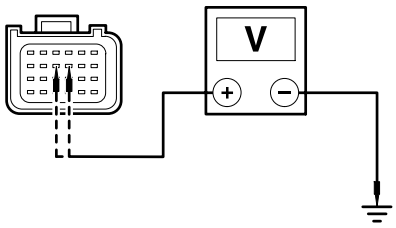
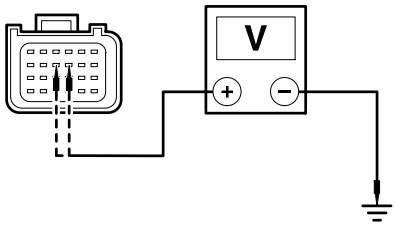
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect RCM CR114B.
	3 Disconnect Passenger Side Safety Belt Retractor Pretensioner Simulator.
 TIE0030190	4 Measure the resistance between the: Chassis Cab • RCM CR114B pin 6, circuit RR122B (BU/RD), harness side and the RCM CR114B pin 12, circuit CR203B (GY/VT), harness side. Van, Bus, Kombi • RCM CR114B pin 6, circuit RR122A (BN), harness side and the RCM CR114B pin 12, circuit CR203A (GY/VT), harness side. • Is the resistance greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR203B (GY/VT) or circuit RR122B (BU/RD). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST K : DTC B1916: DRIVER AIR BAG SHORT TO BATTERY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
K1: CHECK THE DRIVER AIR BAG WIRING HARNESS FOR A SHORT TO BATTERY OR IGNITION	
	1 Deactivate the SRS.
	2 Disconnect Driver Air Bag Module Simulator.
	3 Disconnect RCM CR114A.
	4 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030191	5 Measure the voltage between: • RCM CR114A pin 9, circuit A_CR101A (VT/BN), harness side and ground. • RCM CR114A pin 10, circuit A_RR101A (YE/GN), harness side and ground. • Is any voltage present? → **Yes** GO to K2. → **No** CONNECT the driver air bag module simulator and the RCM CR114A. REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
K2: CHECK THE CLOCKSPRING FOR A SHORT TO BATTERY OR IGNITION	
	1 Ignition switch in position 0.
	2 Disconnect Clockspring CR115.
	3 Ignition switch in position II.
 TIE0030191	4 Measure the voltage between the: • RCM CR114A pin 9, circuit A_CR101A (VT/BN), harness side and ground. • RCM CR114A pin 10, circuit A_RR101A (YE/GN), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit A_RR101A (YE/GN) or circuit A_CR101A (VT/BN). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new clockspring. REFER to:Clockspring (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

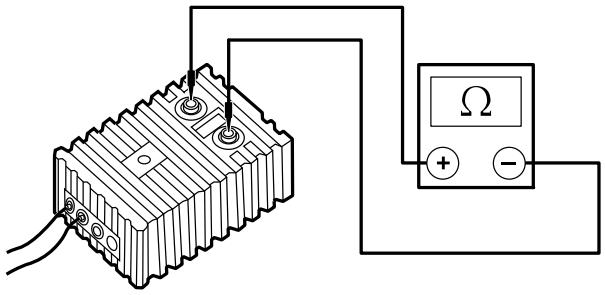
PINPOINT TEST L : DTC B1925: PASSENGER AIR BAG SHORT TO BATTERY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
L1: CHECK THE PASSENGER AIR BAG WIRING HARNESS FOR A SHORT TO BATTERY OR IGNITION	
	1 Deactivate the SRS.
	2 Disconnect Passenger Air Bag Module Simulator.
	3 Disconnect RCM CR114A.
	4 Ignition switch in position II.
	5 Measure the voltage between the: • RCM CR114A pin 7, circuit RR103A (VT/GN), harness side and ground. • RCM CR114A pin 8, circuit CR103A (GY/BU), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit RR103A (VT/GN) or circuit CR103A (GY/BU). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** CONNECT the passenger air bag module simulator and the RCM CR114A. REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

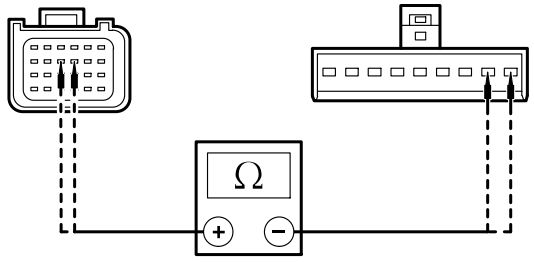
PINPOINT TEST M : DTC B1932: DRIVER AIR BAG OPEN CIRCUIT OR HIGH RESISTANCE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
M1: CHECK THE DRIVER AIR BAG CIRCUIT RESISTANCE	
	1 Deactivate the SRS.
	2 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to M2. → **No** GO to M3.
M2: CHECK THE DRIVER AIR BAG MODULE SQUIB RESISTANCE	
⚠ **WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.**	
	1 Connect the Test and Deployment Lead to the driver air bag module.
	2 Select DMM specific on WDS.
	3 Connect the Test and Deployment Lead to WDS.
 TIE39388	4 Measure the resistance of the air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver air bag module. REFER to:Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
M3: CHECK THE CLOCKSPRING FOR OPEN CIRCUIT OR HIGH RESISTANCE	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114A.
	3 Disconnect Clockspring CR115.

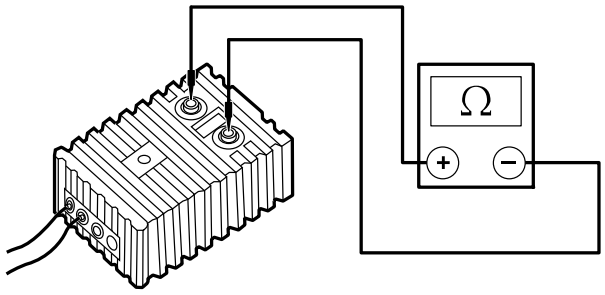
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E65047	4 Measure the resistance between the: • RCM CR114A pin 9, circuit A_CR101A (VT/BN), harness side and the Clockspring CR115A pin 2, circuit A_CR101B (VT/BN), harness side. • RCM CR114A pin 10, circuit A_RR101A (YE/GN), harness side and the Clockspring CR115A pin 1, circuit A_RR101B (YE/GN), harness side. • Are the resistances less than 5 ohms? → **Yes** INSTALL a new clockspring. REFER to:Clockspring (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit A_CR101A (VT/BN), or circuit A_CR101B (VT/BN), or circuit A_RR101A (YE/GN), or circuit A_RR101B (YE/GN). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

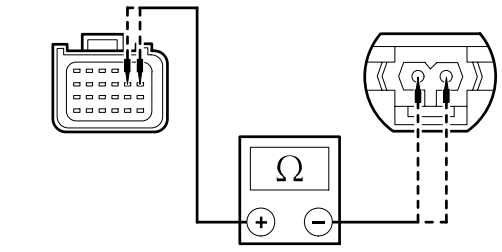
PINPOINT TEST N : DTC B1933: PASSENGER AIR BAG OPEN CIRCUIT OR HIGH RESISTANCE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
N1: CHECK THE PASSENGER AIR BAG CIRCUIT RESISTANCE	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to N2. → **No** GO to N3.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
N2: CHECK THE PASSENGER AIR BAG MODULE SQUIB RESISTANCE	
WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the driver air bag module.
	2 Select DMM specific on WDS.
	3 Connect the Test and Deployment Lead to WDS.
 TIE39388	4 Measure the resistance of the passenger air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new passenger air bag module. REFER to:Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
N3: CHECK THE PASSENGER AIR BAG WIRING HARNESS FOR OPEN CIRCUIT OR HIGH RESISTANCE	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114A.
	3 Disconnect Passenger Air Bag Module Simulator.

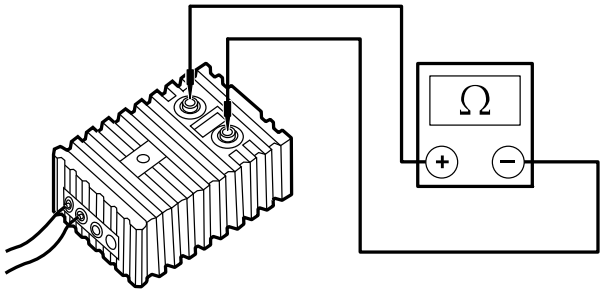
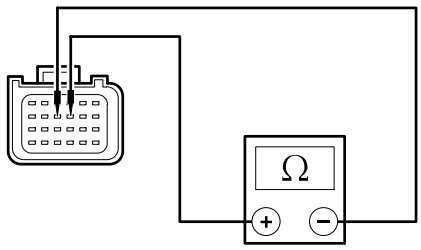
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030194	4 Measure the resistance between the: • RCM CR114A pin 7, circuit RR103A (VT/GN), harness side and the passenger air bag module CR103 pin 1, circuit RR103B (VT/GN), harness side. • RCM CR114A pin 8, circuit CR103A (GY/BU), harness side and the passenger air bag module CR103 pin 2, circuit CR103B (GY/BU), harness side. • Are the resistances less than 5 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR103A (GY/BU), or circuit RR103B (VT/GN), or circuit RR103A (VT/GN), or circuit CR103B (GY/BU). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST O : DTC B1934: DRIVER AIR BAG CIRCUIT LOW RESISTANCE

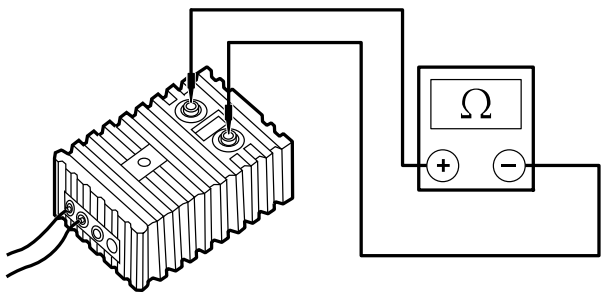
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
O1: CHECK THE DRIVER AIR BAG CIRCUIT RESISTANCE	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to O2. → **No** GO to O3.
O2: CHECK THE DRIVER AIR BAG MODULE SQUIB RESISTANCE	
WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the driver air bag module.

DIAGNOSIS AND TESTING

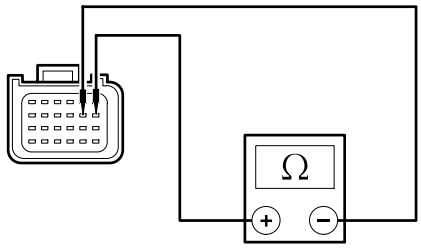
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Select DMM specific on WDS.
	3 Connect the Test and Deployment Lead to WDS.
 TIE39388	4 Measure the resistance of the driver air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver air bag module. REFER to:Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
O3: CHECK THE CLOCKSPRING FOR LOW RESISTANCE	
	1 Ignition switch in position 0.
	2 Disconnect Clockspring CR115.
	3 Disconnect RCM CR114A.
 TIE0030195	4 Measure the resistance between the RCM CR114A pin 9, circuit A_CR101A (VT/BN), harness side and the RCM CR114A pin 10, circuit A_RR101A (YE/GN), harness side. • Is the resistance greater than 10,000 ohms? → **Yes** INSTALL a new clockspring. REFER to:Clockspring (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit A_RR101A (YE/GN) and circuit A_CR101A (VT/BN). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

PINPOINT TEST P : DTC B1935: PASSENGER AIR BAG CIRCUIT LOW RESISTANCE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
P1: CHECK THE PASSENGER AIR BAG CIRCUIT RESISTANCE	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to P2. → **No** GO to P3.
P2: CHECK THE PASSENGER AIR BAG MODULE SQUIB RESISTANCE	
WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the passenger air bag module.
	2 Select DMM specific on WDS.
	3 Connect the Test and Deployment Lead to WDS.
 TIE39388	4 Measure the resistance of the air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new passenger air bag module. REFER to:Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
P3: CHECK THE PASSENGER AIR BAG WIRING HARNESS FOR LOW RESISTANCE	
	1 Ignition switch in position 0.

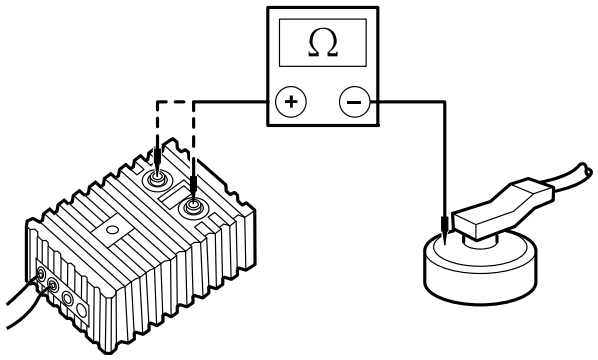
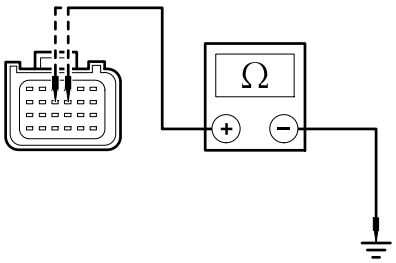
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect Passenger Air Bag Simulator..
	3 Disconnect RCM CR114A.
 TIE0030196	4 RCM CR114A pin 7, circuit RR103A (VT/GN), harness side and the RCM CR114A pin 8, circuit CR103A (GY/BU), harness side. • Is the resistance greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit RR103A (VT/GN) and circuit CR103A (GY/BU). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

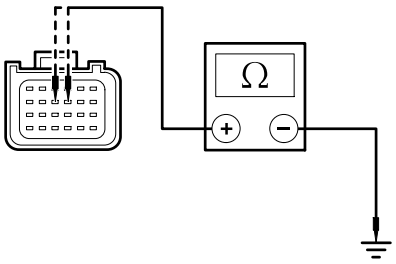
PINPOINT TEST Q : DTC B1936: DRIVER AIR BAG CIRCUIT SHORT TO GROUND

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
Q1: CHECK THE DRIVER AIR BAG CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to Q2. → **No** GO to Q3.
Q2: CHECK THE DRIVER AIR BAG MODULE	
WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the driver air bag module.
	2 Select DMM specific on WDS.
	3 Connect the Test and Deployment Lead to WDS.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E39389	4 Measure the resistance between each of the terminals and the driver air bag module casing. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver air bag module. REFER to:Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
Q3: CHECK THE DRIVER AIR BAG WIRING HARNESS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114A.
	3 Disconnect Driver Air Bag Module Simulator.
 TIE0030197	4 Measure the resistance, while turning the steering wheel from lock to lock, between the: • RCM CR114A pin 9, circuit A_CR101A (VT/BN), harness side and ground. • RCM CR114A pin 10, circuit A_RR101A (YE/GN), harness side and ground. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** GO to Q4.
Q4: CHECK THE CLOCKSPRING FOR A SHORT TO GROUND	
	1 Disconnect Clockspring CR115.

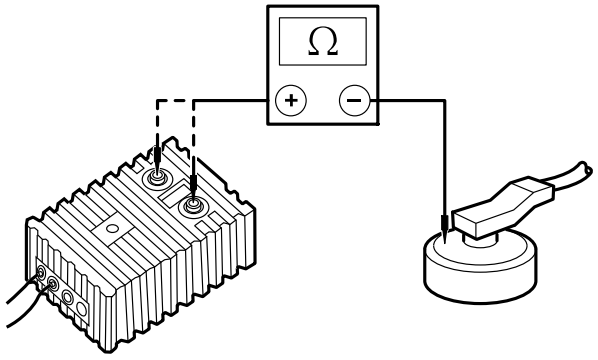
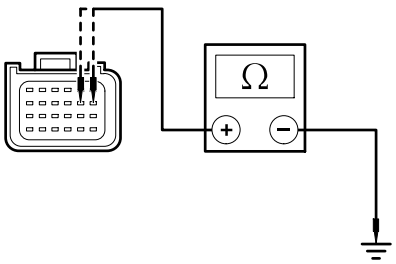
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030197	2 Measure the resistance, while turning the steering wheel from lock to lock, between the: • RCM CR114A pin 9, circuit A_CR101A (VT/BN), harness side and ground. • RCM CR114A pin 10, circuit A_RR101A (YE/GN), harness side and ground. • Are the resistances greater than 10,000 ohms? → **Yes** INSTALL a new clockspring. REFER to:Clockspring (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit A_RR101A (YE/GN) or circuit A_CR101A (VT/BN). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST R : DTC B1938: PASSENGER AIR BAG CIRCUIT SHORT TO GROUND

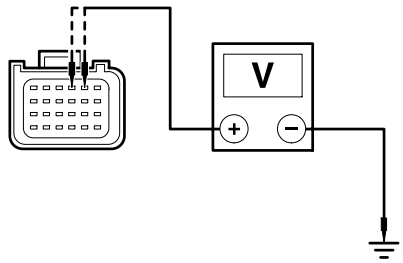
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
R1: THE PASSENGER AIR BAG CIRCUIT RESISTANCE	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to R2. → **No** GO to R3.
R2: CHECK THE PASSENGER AIR BAG MODULE	
WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the passenger air bag module.
	2 Select DMM specific on WDS.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Connect the Test and Deployment Lead to WDS.
 E39389	4 Measure the resistance between each of the terminals and the passenger air bag module casing. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new passenger air bag module. REFER to:Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
R3: CHECK THE PASSENGER AIR BAG WIRING HARNESS FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114A.
	3 Disconnect Passenger Air Bag Module Simulator..
 TIE0030198	4 Measure the resistance between: • RCM CR114A pin 7, circuit RR103A (VT/GN), harness side and ground. • RCM CR114A pin 8, circuit CR103A (GY/BU), harness side and ground. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR103A (GY/BU) or circuit RR103A (VT/GN). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

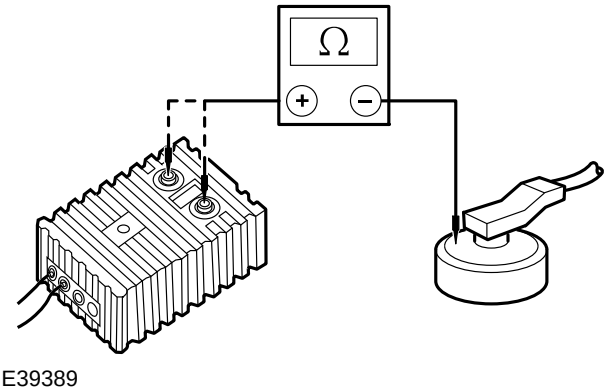
DIAGNOSIS AND TESTING

PINPOINT TEST S : DTC B1992: DRIVER SIDE AIR BAG CIRCUIT SHORT TO BATTERY

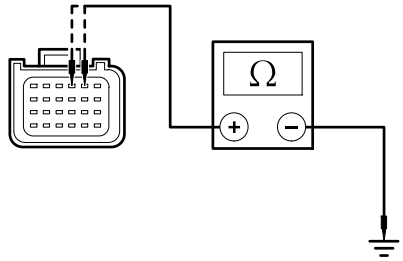
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
S1: CHECK THE DRIVER SIDE AIR BAG CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** GO to S2.
S2: CHECK THE DRIVER SIDE AIR BAG CIRCUIT FOR A SHORT TO BATTERY	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114B.
	3 Ignition switch in position II.
 TIE0030199	4 Measure the voltage between the: • RCM CR114B pin 2, circuit CR105A (GN/BU), harness side and ground. • RCM CR114B pin 3, circuit RR105A (GN/YE), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit CR105A (GN/BU) or circuit RR105A (GN/YE). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

PINPOINT TEST T : DTC B1993: DRIVER SIDE AIR BAG CIRCUIT SHORT TO GROUND

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
T1: CHECK THE DRIVER SIDE AIR BAG CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to T2. → **No** GO to T3.
T2: CHECK THE DRIVER SIDE AIR BAG MODULE	
WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the driver side air bag module.
	2 Select DMM specific on WDS.
	3 Connect the Test and Deployment Lead to WDS.
 E39389	4 Measure the resistance between each of the terminals and the driver side air bag module casing. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver side air bag module. REFER to:Side Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
T3: CHECK THE DRIVER SIDE AIR BAG CIRCUIT FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.

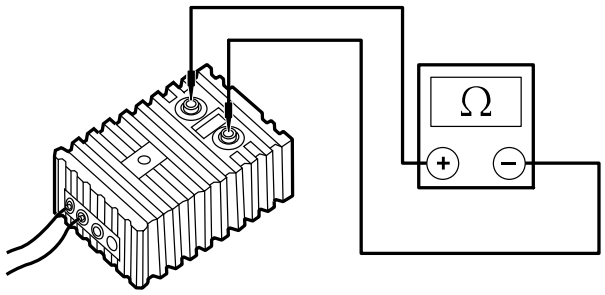
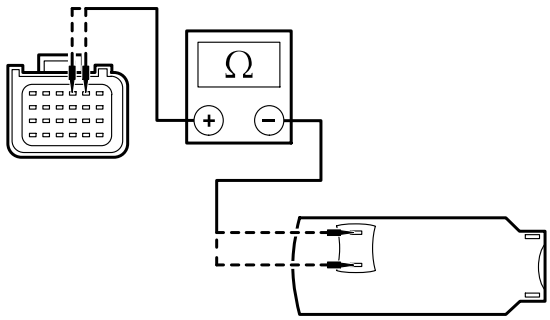
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect RCM CR114B.
	3 Disconnect Driver Side Air Bag Module Simulator.
 TIE0030200	4 Measure the resistance between the: • RCM CR114B pin 2, circuit CR105A (GN/BU), harness side and ground. • RCM CR114B pin 3, circuit RR105A (GN/YE), harness side and ground. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit RR105A (GN/YE) or circuit CR105A (GN/BU). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST U : DTC B1994: DRIVER SIDE AIR BAG CIRCUIT OPEN CIRCUIT

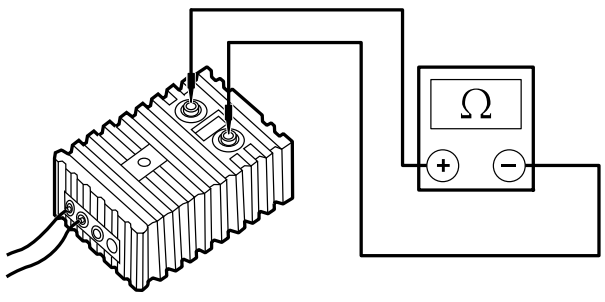
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
U1: CHECK THE DRIVER SIDE AIR BAG CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to U2. → **No** GO to U3.
U2: CHECK THE DRIVER SIDE AIR BAG MODULE SQUIB RESISTANCE	
WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the driver side air bag module.
	2 Select DMM specific on WDS.

DIAGNOSIS AND TESTING

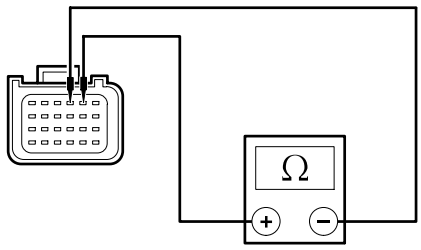
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Connect the Test and Deployment Lead to WDS.
 TIE39388	4 Measure the resistance of the driver side air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver side air bag module. REFER to:Side Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
U3: CHECK THE DRIVER SIDE AIR BAG WIRING HARNESS FOR OPEN CIRCUIT OR HIGH RESISTANCE	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114B.
	3 Disconnect Driver Side Air Bag Module Simulator.
 E71680	4 Measure the resistance between the: • RCM CR114B pin 2, circuit CR105A (GN/BU), harness side and the driver side air bag CR109 pin 2, circuit CR105B (GN/BU), harness side. • RCM CR114B pin 3, circuit RR105A (GN/YE), harness side and the driver side air bag CR109 pin 1, circuit RR105B (GN/YE), harness side. • Are the resistances less than 5 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR105A (GN/BU), or circuit CR105B (GN/BU), or circuit RR105A (GN/YE), or circuit RR105B (GN/YE). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

PINPOINT TEST V : DTC B1995: DRIVER SIDE AIR BAG CIRCUIT LOW RESISTANCE ON SQUIB

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
V1: CHECK THE DRIVER SIDE AIR BAG CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to V2. → **No** GO to V3.
V2: CHECK THE DRIVER SIDE AIR BAG MODULE SQUIB RESISTANCE	
WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the driver side air bag module.
	2 Select DMM specific on WDS.
	3 Connect the Test and Deployment Lead to WDS.
 TIE39388	4 Measure the resistance of the driver side air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new driver side air bag module. REFER to:Side Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
V3: CHECK THE DRIVER SIDE AIR BAG CIRCUIT FOR LOW RESISTANCE	
	1 Ignition switch in position 0.

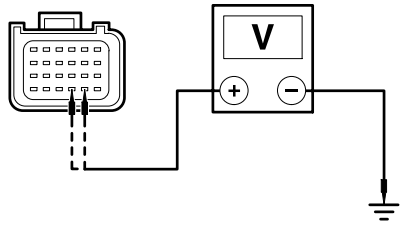
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Disconnect RCM CR114B.
	3 Disconnect Driver Side Air Bag Module Simulator.
 TIE0030202	4 Measure the resistance between the RCM CR114B pin 2, circuit CR105A (GN/BU), harness side and the RCM CR114B pin 3, circuit RR105A (GN/YE), harness side. • Is the resistance greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR105A (GN/BU) and circuit RR105A (GN/YE). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST W : DTC B1996: PASSENGER SIDE AIR BAG CIRCUIT SHORT TO BATTERY

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
W1: CHECK THE PASSENGER SIDE AIR BAG CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** GO to W2.
W2: CHECK THE PASSENGER SIDE AIR BAG CIRCUIT FOR A SHORT TO BATTERY	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114B.
	3 Ignition switch in position II.

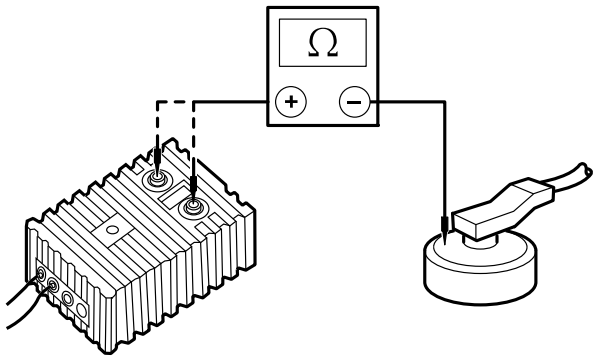
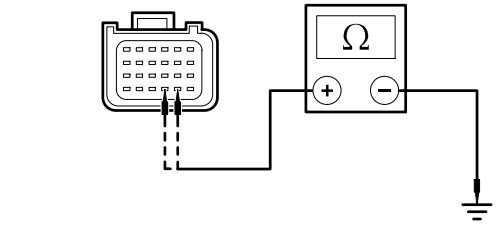
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030203	4 Measure the voltage between the: • RCM CR114B pin 20, circuit CR106A (VT/GY), harness side and ground. • RCM CR114B pin 21, circuit RR106A (YE/OG), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit CR106A (VT/GY) or circuit RR106A (YE/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST X : DTC B1997: PASSENGER SIDE AIR BAG CIRCUIT SHORT TO GROUND

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
X1: CHECK THE PASSENGER SIDE AIR BAG CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to X2. → **No** GO to X3.
X2: CHECK THE PASSENGER SIDE AIR BAG MODULE	
WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the passenger side air bag module.
	2 Select DMM specific on WDS.
	3 Connect the Test and Deployment Lead to WDS.

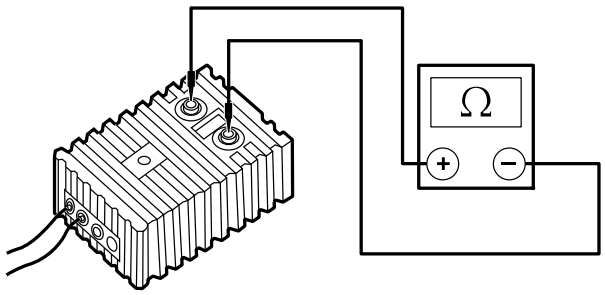
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E39389	4 Measure the resistance between each of the terminals and the passenger side air bag module casing. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new passenger side air bag module. REFER to:Side Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
X3: CHECK THE PASSENGER SIDE AIR BAG CIRCUIT FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114B.
	3 Disconnect Passenger Side Air Bag Module Simulator.
 TIE0030204	4 Measure the resistance between the: • RCM CR114B pin 20, circuit CR106A (VT/GY), harness side and ground. • RCM CR114B pin 21, circuit RR106A (YE/OG), harness side and ground. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR106A (VT/GY) or circuit RR106A (YE/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

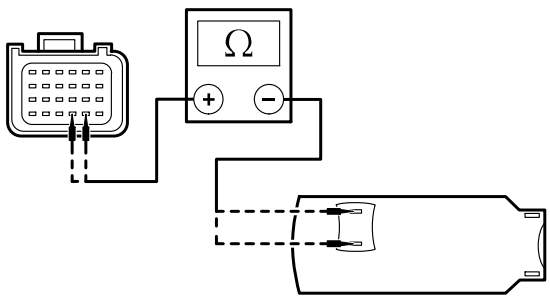
PINPOINT TEST Y : DTC B1998: PASSENGER SIDE AIR BAG CIRCUIT OPEN CIRCUIT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
Y1: CHECK THE PASSENGER SIDE AIR BAG CIRCUIT	
	1 Deactivate the SRS.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to Y2. → **No** GO to Y3.
Y2: CHECK THE PASSENGER SIDE AIR BAG MODULE SQUIB RESISTANCE	
WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the passenger side air bag module.
	2 Select DMM specific on WDS.
	3 Connect the Test and Deployment Lead to WDS.
 TIE39388	4 Measure the resistance of the passenger side air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new passenger side air bag module. REFER to:Side Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
Y3: CHECK THE PASSENGER SIDE AIR BAG WIRING HARNESS FOR OPEN CIRCUIT OR HIGH RESISTANCE	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114B.
	3 Disconnect Passenger Side Air Bag Module Simulator.

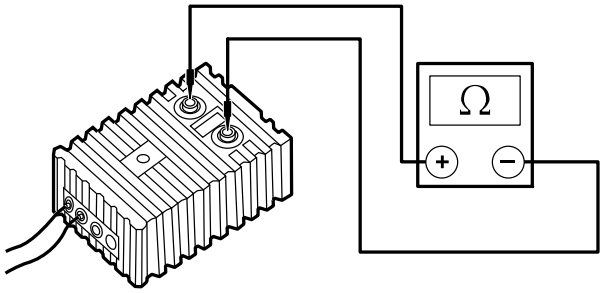
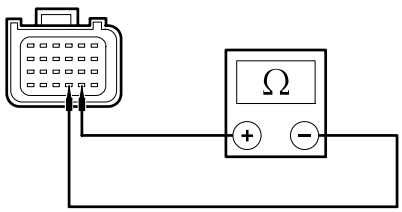
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E71681	4 Measure the resistance between the: • RCM CR114B pin 20, circuit CR106A (VT/GY), harness side and the passenger side air bag module CR111 pin 2, circuit CR106B (VT/GY), harness side. • RCM CR114B pin 21, circuit RR106A (YE/OG), harness side and the passenger side air bag module CR111 pin 1, circuit RR106B (YE/OG), harness side. • Are the resistances less than 5 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR106A (VT/GY), or circuit CR106B (VT/GY), or circuit RR106A (YE/OG), or circuit CR106B (VT/GY). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST Z : DTC B1999: PASSENGER SIDE AIR BAG CIRCUIT LOW RESISTANCE ON SQUIB

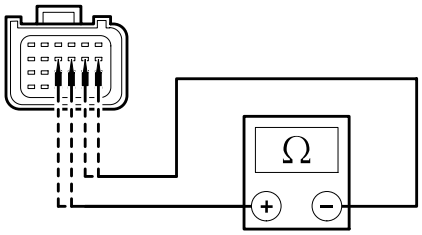
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
Z1: CHECK THE PASSENGER SIDE AIR BAG CIRCUIT	
	1 Deactivate the SRS.
	2 Ignition switch in position II.
	3 Carry out the self-test with the simulators installed. • Does the system prove out correctly? → **Yes** GO to Z2. → **No** GO to Z3.
Z2: CHECK THE PASSENGER SIDE AIR BAG MODULE SQUIB RESISTANCE	
WARNING:Do not proceed with this test unless using WDS. Failure to follow this instruction may result in personal injury.	
	1 Connect the Test and Deployment Lead to the passenger side air bag module.

DIAGNOSIS AND TESTING

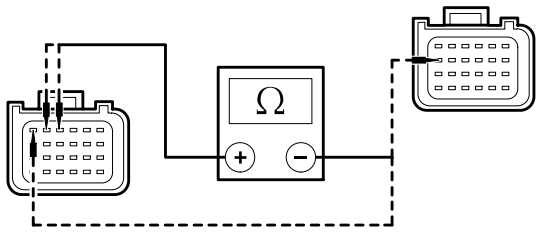
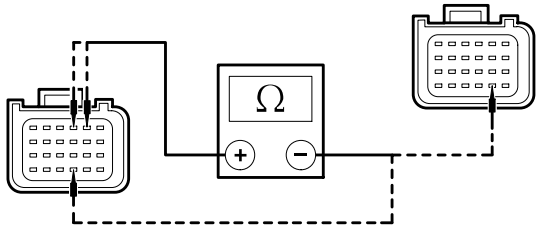
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	2 Select DMM specific on WDS.
	3 Connect the Test and Deployment Lead to WDS.
 TIE39388	4 Measure the resistance of the passenger side air bag module squib. • Is the resistance between 2 and 3 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** INSTALL a new passenger side air bag module. REFER to:Side Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
Z3: CHECK THE PASSENGER SIDE AIR BAG CIRCUIT FOR LOW RESISTANCE	
	1 Ignition switch in position 0.
	2 Disconnect RCM CR114B.
	3 Disconnect Passenger Side Air Bag Module Simulator.
 TIE0030206	4 Measure the resistance between the RCM CR114B pin 20, circuit CR106A (VT/GY), harness side and the RCM CR114B pin 21, circuit RR106A (YE/OG), harness side. • Is the resistance greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit CR106A (VT/GY) and circuit RR106A (YE/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

PINPOINT TEST AA : DTC B2792: CROSS LINK BETWEEN FIRING CIRCUITS

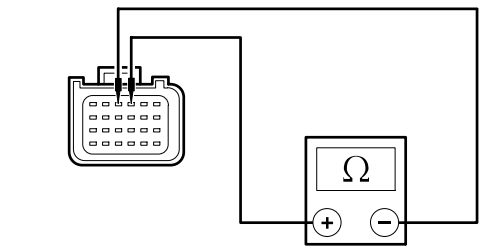
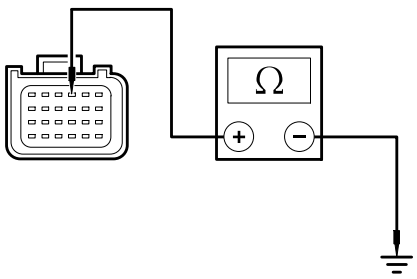
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
NOTE:CHECK for signs of damage or signs of foreign material in the RCM connector.	
AA1: CHECK THE DRIVER AIR BAG CIRCUIT FOR A CROSS LINK TO THE PASSENGER AIR BAG CIRCUIT	
	1 Deactivate the SRS.
	2 Disconnect RCM CR114A.
	3 Disconnect Driver Air Bag Simulator.
	4 Disconnect Passenger Air Bag Simulator.
	5 Measure the resistance between the: • RCM CR114A pin 7, circuit RR103A (VT/GN), harness side and the RCM CR114A pin 10, circuit A_RR101A (YE/GN), harness side. • RCM CR114A pin 8, circuit CR103A (GY/BU), harness side and the RCM CR114A pin 9, circuit A_CR101A (VT/BN), harness side. • Are the resistances greater than 10,000 ohms? → **Yes** GO to AA2. → **No** REPAIR circuit A_RR101A (YE/GN) and circuit RR103A (VT/GN) or circuit A_CR101A (VT/BN) and circuit CR103A (GY/BU). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
AA2: CHECK THE DRIVER SAFETY BELT PRETENSIONER CIRCUIT FOR A CROSS LINK TO THE PASSENGER SAFETY BELT PRETENSIONER CIRCUIT	
	1 Disconnect RCM CR114B.
	2 Disconnect Driver Side Safety Belt Retractor Pretensioner Simulator.
	3 Disconnect Passenger Side Safety Belt Retractor Pretensioner Simulator.

DIAGNOSIS AND TESTING

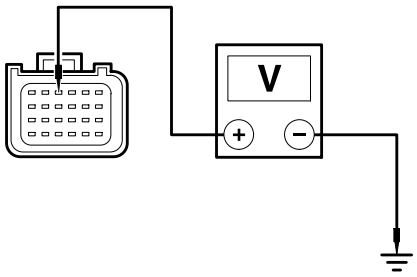
TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E65422	4 Measure the resistance between the: Chassis Cab • RCM CR114B pin 5, circuit RR120B (GN/RD), harness side and the RCM CR114B pin 6, circuit RR122B (BU/RD), harness side. • RCM CR114B pin 12, circuit CR203B (GY/VT), harness side and the RCM CR114B pin 4, circuit CR201B (BU/OG), harness side. Van, Bus, Kombi • RCM CR114B pin 5, circuit RR120B (BN/GN), harness side and the RCM CR114B pin 6, circuit RR122A (BN), harness side. • RCM CR114B pin 12, circuit CR203A (GY/VT), harness side and the RCM CR114B pin 4, circuit CR201B (BU/OG), harness side. • Are the resistances greater than 10,000 ohms? → **Yes** GO to AA3. → **No** REPAIR circuit RR122A (BN) or circuit RR120B (GN/RD) and circuit RR122B (BU/RD) or circuit CR201B (BU/OG) and circuit CR203B (GY/VT). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
AA3: CHECK THE DRIVER SIDE AIR BAG CIRCUIT FOR A CROSS LINK TO THE PASSENGER SIDE AIR BAG CIRCUIT	
 E65423	1 Measure the resistance between the: • RCM CR114B pin 20, circuit CR106A (VT/GY), harness side and the RCM CR114B pin 2, circuit CR105A (GN/BU), harness side. • RCM CR114B pin 3, circuit RR105A (GN/YE), harness side and the RCM CR114B pin 21, circuit RR106A (YE/OG), harness side. • Are the resistances greater than 10,000 ohms? → **Yes** VERIFY the customer concern. REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit RR105A (GN/YE) and circuit RR106A (YE/OG) or circuit CR105A (GN/BU) and circuit CR106A (VT/GY). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

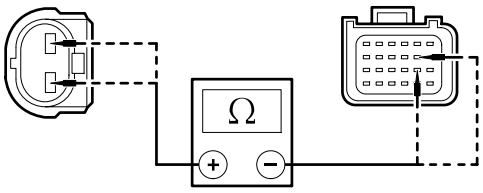
PINPOINT TEST AB : DTC P1796: CAN CONTROLLER CIRCUIT (BUS OFF)

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
AB1: CHECK THE CAN CONTROLLER CIRCUIT FOR LOW RESISTANCE	
	1 Deactivate the SRS.
	2 Disconnect RCM CR114A.
 TIE0020915	3 Measure the resistance between the RCM CR114A pin 3, circuit VBD06C (GY/OG), harness side and the RCM CR114A pin 4, circuit VBD07C (VT/OG), harness side. • Is the resistance less than 5 ohms? → **Yes** REPAIR circuit VBD06C (GY/OG) and circuit VBD07C (VT/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** GO to AB2.
AB2: CHECK THE CAN CONTROLLER CIRCUIT FOR A SHORT TO GROUND	
	1 Measure the resistance between the RCM CR114A pin 3, circuit VBD06C (GY/OG), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** REPAIR circuit VBD06C (GY/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** GO to AB3.
AB3: CHECK THE CAN CONTROLLER CIRCUIT FOR A SHORT TO BATTERY	
	1 Ignition switch in position II.

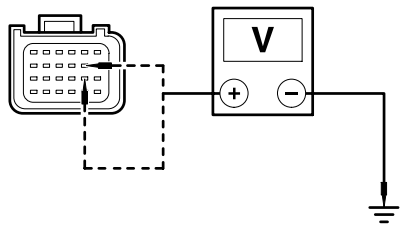
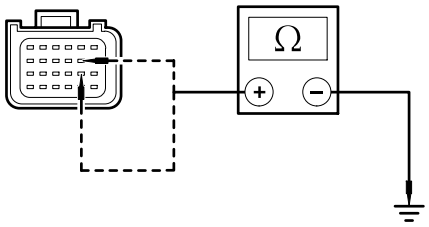
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 E65427	2 Measure the voltage between the RCM CR114A pin 4, circuit VBD07C (VT/OG), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit VBD07C (VT/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** VERIFY the customer concern. REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

PINPOINT TEST AC : DTC U2017: DRIVER SIDE IMPACT SENSOR COMMUNICATIONS FAULT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
AC1: CHECK THE DRIVER SIDE IMPACT SENSOR CIRCUIT	
	1 Deactivate the SRS.
	2 Disconnect RCM CR114B.
	3 Disconnect Driver Side Impact Sensor CR217.
 TIE0030220	4 Measure the resistance between the: • RCM CR114B pin 8, circuit RR131A (VT/GY), harness side and the driver side impact sensor CR217 pin 2, circuit RR131B (VT/GY), harness side. • RCM CR114B pin 14, circuit VR217A (GY/YE), harness side and the driver side impact sensor CR217 pin 1, circuit VR217B (GY/YE), harness side. • Are the resistances less than 5 ohms? → **Yes** GO to AC2. → **No** REPAIR circuit RR131A (VT/GY), or circuit RR131B (VT/GY), or circuit VR217A (GY/YE), or circuit VR217B (GY/YE). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

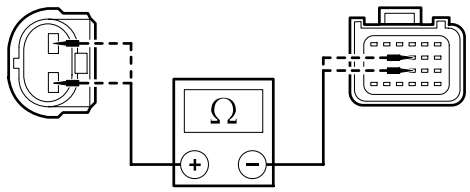
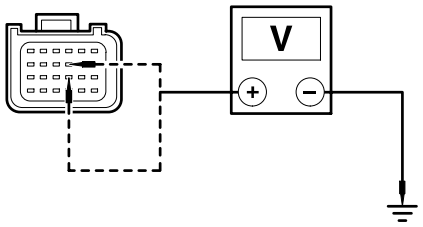
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
AC2: CHECK THE DRIVER SIDE IMPACT SENSOR FOR A SHORT CIRCUIT TO BATTERY	
	1 Ignition switch in position II.
 TIE0030389	2 Measure the voltage between the: • RCM CR114B pin 8, circuit RR131A (VT/GY), harness side and ground. • RCM CR114B pin 14, circuit VR217A (GY/YE), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit RR131A (VT/GY) or circuit VR217A (GY/YE). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** GO to AC3.
AC3: CHECK THE DRIVER SIDE IMPACT SENSOR FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.
 TIE0030221	2 Measure the resistance between the: • RCM CR114B pin 8, circuit RR131A (VT/GY), harness side and ground. • RCM CR114B pin 14, circuit VR217A (GY/YE), harness side and ground. • Are the resistance greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit RR131A (VT/GY) or circuit VR217A (GY/YE). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

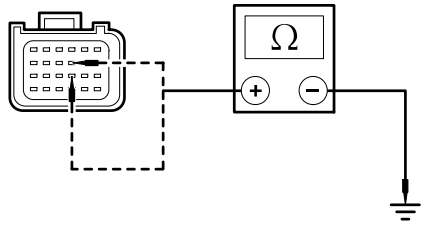
PINPOINT TEST AD : DTC U2018: PASSENGER SIDE IMPACT SENSOR COMMUNICATIONS FAULT

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
AD1: CHECK THE PASSENGER SIDE IMPACT SENSOR CIRCUIT	
	1 Deactivate the SRS.
	2 Disconnect RCM CR114B.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
	3 Disconnect Passenger Side Impact Sensor CR218.
 TIE0030222	4 Measure the resistance between the: • RCM CR114B pin 9, circuit RR132A (BU/WH), harness side and the passenger side impact sensor CR218 pin 2, circuit RR132B (BU/WH), harness side. • RCM CR114B pin 15, circuit VR218A (YE/OG), harness side and the passenger side impact sensor CR218 pin 1, circuit VR218B (YE/OG), harness side. • Are the resistances less than 5 ohms? → **Yes** GO to AD2. → **No** REPAIR circuit RR132A (BU/WH), or circuit RR132B (BU/WH), or circuit VR218A (YE/OG), or circuit VR218B (YE/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
AD2: CHECK THE PASSENGER SIDE IMPACT SENSOR FOR A SHORT CIRCUIT TO BATTERY	
	1 Ignition switch in position II.
 TIE0030223	2 Measure the voltage between the: • RCM CR114B pin 9, circuit RR132A (BU/WH), harness side and ground. • RCM CR114B pin 15, circuit VR218A (YE/OG), harness side and ground. • Is any voltage present? → **Yes** REPAIR circuit RR132A (BU/WH) or circuit VR218A (YE/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** GO to AD3.
AD3: CHECK THE PASSENGER SIDE IMPACT SENSOR FOR A SHORT TO GROUND	
	1 Ignition switch in position 0.

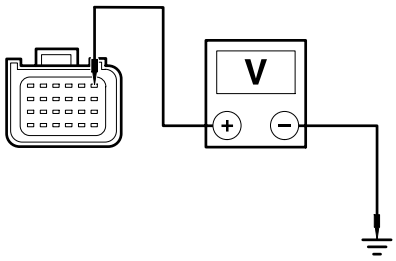
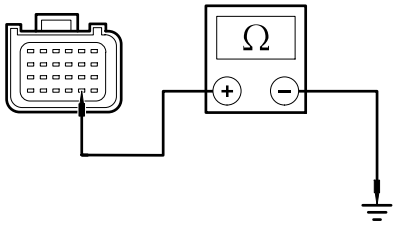
DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030224	2 Measure the resistance between the: • RCM CR114B pin 9, circuit RR132A (BU/WH), harness side and ground. • RCM CR114B pin 15, circuit VR218A (YE/OG), harness side and ground. • Are the resistances greater than 10,000 ohms? → **Yes** REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit RR132A (BU/WH) or circuit VR218A (YE/OG). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

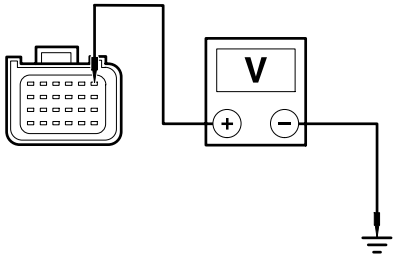
PINPOINT TEST AE : RCM DISCONNECTED OR INOPERATIVE

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
WARNING:Wait at least one minute after disconnecting the battery ground cable before disconnecting any SRS electrical connector. Failure to follow this instruction may result in personal injury.	
NOTE: Use a digital multimeter for all electrical measurements.	
AE1: CHECK THE RCM ELECTRICAL CONNECTORS	
	1 Deactivate the SRS.
	2 Check the RCM electrical connectors. • Are the RCM electrical connectors fully engaged? → **Yes** GO to AE2. → **No** CONNECT the RCM electrical connectors. REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.
AE2: CHECK THE IGNITION SUPPLY CIRCUIT FOR AN OPEN CIRCUIT	
	1 Disconnect RCM CR114A.
	2 Ignition switch in position II.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
 TIE0030178	3 Measure the voltage between the: Chassis Cab • RCM CR114A pin 1, circuit SBP68A (RD/GN), harness side and ground. Van, Bus, Kombi • RCM CR114A pin 1, circuit SBP68B (GN/RD), harness side and ground. • Is the voltage between 9 and 16 volts? → **Yes** GO to AE3. → **No** GO to AE4.
AE3: CHECK THE RCM GROUND CIRCUIT	
	1 Ignition switch in position 0.
 TIE0030179	2 Measure the resistance between the RCM CR114A pin 20, circuit GD112A (BK/GN), harness side and ground. • Is the resistance less than 5 ohms? → **Yes** INSTALL a new RCM. REFER to:Restraints Control Module (RCM) (501-20 Supplemental Restraint System, Removal and Installation). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. No → **No** REPAIR circuit GD112A (BK/GN). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

DIAGNOSIS AND TESTING

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
AE4: CHECK THE IGNITION SUPPLY CIRCUIT	
 TIE0030178	1 Measure the voltage between the: Chassis Cab • RCM CR114A pin 1, circuit SBP68A (RD/GN), harness side and ground. Van, Bus, Kombi • RCM CR114A pin 1, circuit SBP68B (GN/RD), harness side and ground. • Is any voltage present? → **Yes** CHECK the charging circuit. REFER to:Charging System (414-00 Charging System - General Information, Diagnosis and Testing). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system. → **No** REPAIR circuit SBP68A (RD/GN) or circuit SBP68B (GN/RD). REPEAT the self-test, CLEAR the DTCs. REACTIVATE the system.

GENERAL PROCEDURES

Deployed Air Bag Disposal

WARNING:After deployment, the air bag module surface may contain deposits of sodium hydroxide, a product of the gas generate combustion, that is irritating to the skin. Use protective gloves when handling any deployed air bag module. Failure to follow this instruction may result in personal injury.

1. **Remove the deployed air bag module(s). For additional information, refer to the relevant procedure in this section.**
2. **Seal the deployed air bag module(s) in the packaging from the new air bag module(s) or a suitable polythene bag, and then dispose of in accordance with local contaminated waste regulations.**

GENERAL PROCEDURES

Unserviceable Air Bag Disposal

1. **WARNINGS:**

   To minimize the possibility of injury in the event of premature deployment, always carry a live air bag module with the bag and trim cover pointed away from the body. Failure to follow this instruction may result in personal injury.

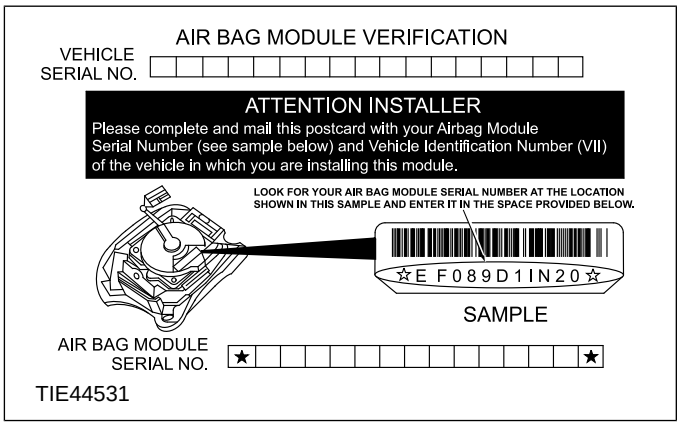
   To prevent premature deployment, live air bag modules must only be placed on work benches which have been ground bonded. Failure to follow this instruction may result in personal injury.

   NOTE: All unserviceable air bag modules have been placed on the Mandatory Return List. All discolored or damaged air bag modules should be treated the same as any unserviceable live air bag module being returned.

   Remove the unserviceable air bag module. For additional information, refer to the relevant procedure in this section.

   NOTE:A prepaid, return postcard is provided with the new air bag module. The new air bag module serial number and the vehicle identification number (VIN) must be recorded on the air bag module verification card.

2. **Before installing the air bag module, record the necessary information. Return the air bag module verification card to Ford Motor Company (driver air bag module verification card shown).**



3. **WARNING:Under no circumstances is an unserviceable air bag module(s) to be returned through the local mailing system. Failure to follow this instruction may result in personal injury.**

   Seal the unserviceable air bag module(s) in the packaging from the new air bag module(s) and address to the appropriate manufacturer. The package should then be forwarded to the Exchange Plan Center (as appointed through the national sales company) who will arrange forwarding to the manufacturer.

4. **NOTE:Autoliv air bag modules and seat belt pretensioners.**

   Autoliv Gmbh, Theodor Heuss Strasse 2, 85221, Dachau, Germany.

5. **NOTE:TRW air bag modules.**

   TRW Occupant Restraint Systems, FAO Rene Getto, Industriestr 20, 73551, Aldorf, Germany.

6. **NOTE:TRW seat belt pretensioners.**

   TRW Occupant Restraint Systems, FAO Helmut Goss, Industriestr 20, 73551, Aldorf, Germany.

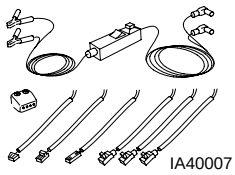
7. **NOTE:Takata Petri air bag modules.**

   Takata Petri AG, Grossostheimer Strasse 223, D-63741 Aschaffenburg, (Supplier Code P790M) Germany.

GENERAL PROCEDURES

Scrapped Vehicle Undeployed Air Bag Disposal

Special Tool(s)

 IA40007	Test and Deployment Lead, Air Bag/Pyrotechnic Safety Belt 418-S055 (40-007A)

General Equipment

12 volt battery

All vehicles

WARNINGS:

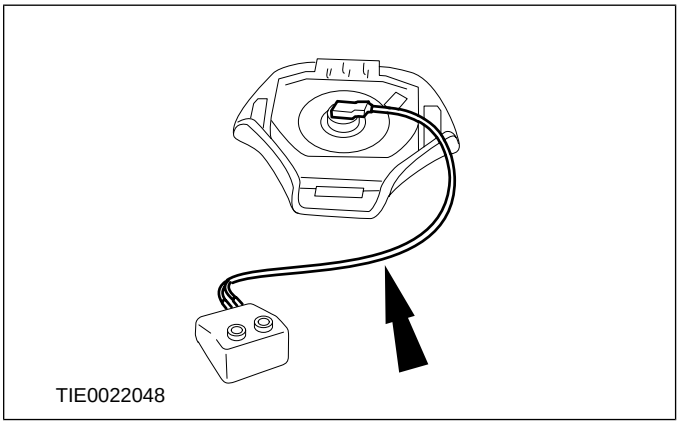
To minimize the possibility of injury in the event of premature deployment, always carry a live air bag module with the bag and trim cover pointed away from the body. Failure to follow this instruction may result in personal injury.

To minimize the possibility of premature deployment, live air bag modules must only be placed on work benches which have been ground bonded. Failure to follow this instruction may result in personal injury.

1. **Disconnect the battery ground cable. For additional information, refer to Section 414-01 [Battery, Mounting and Cables].**
2. **Remove the air bag module(s) to be deployed. For additional information, refer to the relevant procedure(s) in this section.**

Single stage air bag modules

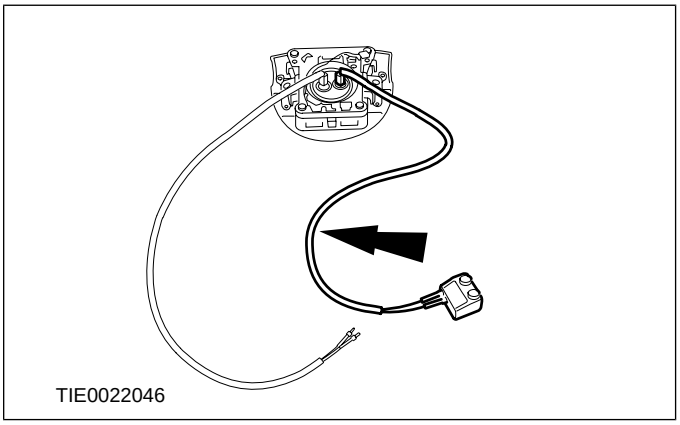
3. **Connect the test lead to the air bag module and the adapter (driver air bag module shown).**



Two stage air bag modules

4. **CAUTION:Do not connect both test leads to the adapter. Both air bag module inflators must be deployed separately.**

   Connect two test leads to the air bag module and the other end of one of the test leads to the adapter (driver air bag module shown).

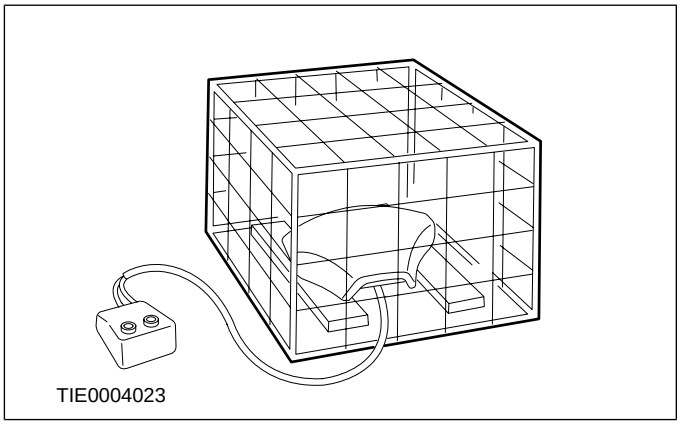


All air bag modules

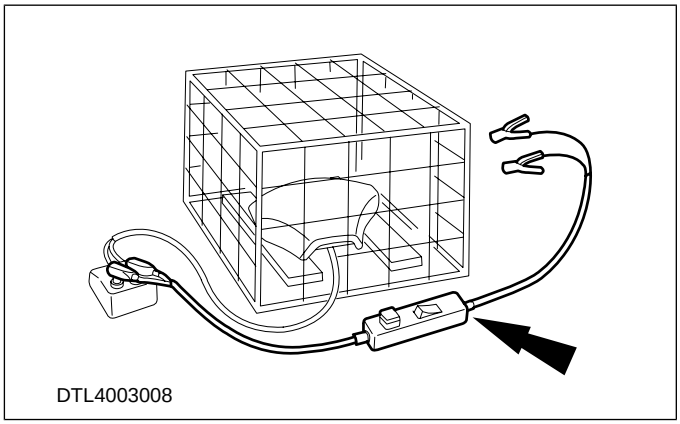
5. **CAUTION:To protect the test lead electrical connector(s) from damage during deployment, raise the air bag module off the ground on two wooden blocks.**

GENERAL PROCEDURES

Place the air bag module inside a suitable rigid wire cage with the air bag module cover uppermost.

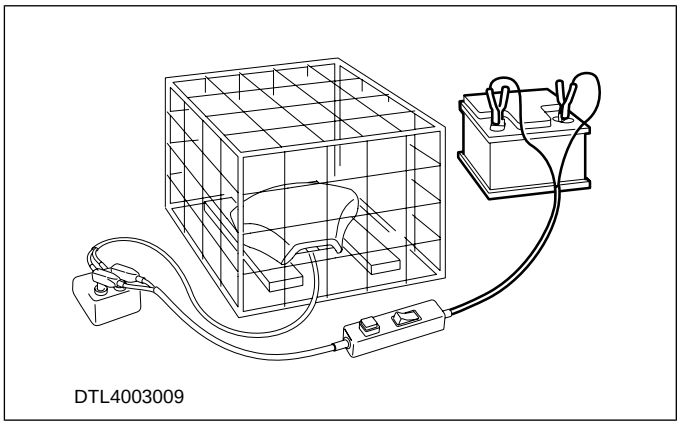

TIE0004023

6. Connect the deployment lead to the adapter.


DTL4003008

7. **WARNING:** Before proceeding make sure that all personnel in the vicinity are aware that a loud noise (bang) is about to occur. Do not let anybody approach closer than six meters. Failure to follow this instruction may result in personal injury.

   Move as far away as possible from the air bag module and connect the deployment lead to the battery.

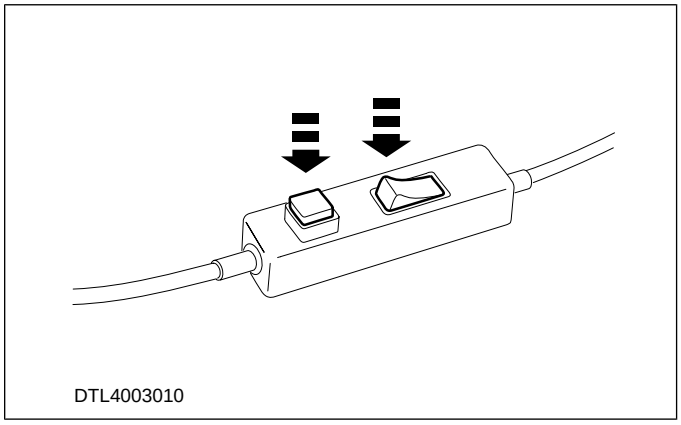

DTL4003009

8. CAUTIONS:

   The air bag module should not be handled immediately following deployment as the air bag module will be very hot.

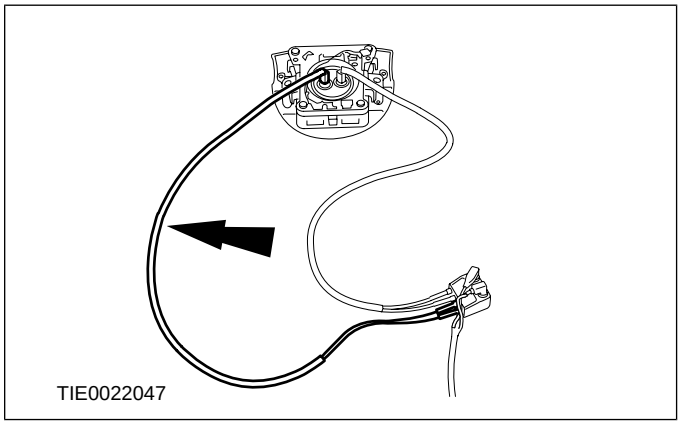
   After deployment, the air bag module surface may contain deposits of sodium hydroxide, a product of the gas generate combustion, that is irritating to the skin. Use protective gloves when handling any deployed air bag module.

   Depress both switches to deploy the air bag.


DTL4003010

Two stage air bag modules

9. Connect the second test lead to the adapter.


TIE0022047

10. **WARNING:** Before proceeding make sure that all personnel in the vicinity are aware that a loud noise (bang) is about to occur. Do not let anybody approach closer than six meters. Failure to follow this instruction may result in personal injury.

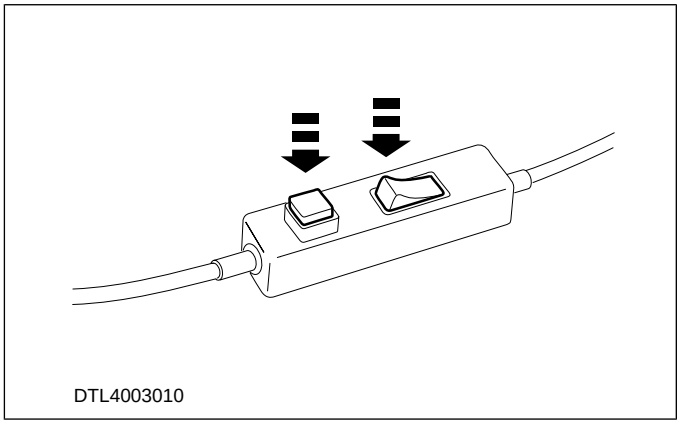
CAUTIONS:

The air bag module should not be handled immediately following deployment as the air bag module will be very hot.

GENERAL PROCEDURES

After deployment, the air bag module surface may contain deposits of sodium hydroxide, a product of the gas generate combustion, that is irritating to the skin. Use protective gloves when handling any deployed air bag module.

Depress both switches to deploy the air bag.



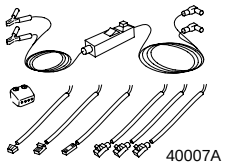
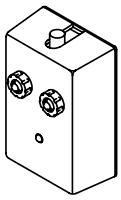
All air bag modules

11. **Deployed air bag module(s) should be sealed in a suitable bag and then disposed of in accordance with local contaminated waste regulations.**

GENERAL PROCEDURES

Scrapped Vehicle Air Bag and Safety Belt Pretensioner Disposal - In-Vehicle Disposal

Special Tool(s)

 40007A	Test and Deployment Lead, Air Bag/Pyrotechnic Safety Belt 418-S055
 418143	Adapter Box (AC) 418-143 (40-007-10)

General Equipment

12 volt battery

1. This procedure must only be carried out by authorised scrap vehicle dismantlers.

WARNINGS:

To avoid accidental deployment, the restraints control module (RCM) backup power supply must be depleted. Wait at least one minute after disconnecting the battery ground cable(s) before commencing any repair or adjustment to the supplemental restraint system (SRS), or any component(s) adjacent to the SRS sensors. Failure to follow these instructions may result in personal injury.

To minimize the possibility of premature deployment, do not use radio key code savers when working on the SRS. Failure to follow this instruction may result in personal injury.

Before deploying the air bag module or safety belt pretensioner pyrotechnic make sure that all personnel in the vicinity are aware that a loud noise (bang) is about to occur. Do not let anybody approach closer than 6 meters. Failure to follow this instruction may result in personal injury.

The air bag module or the safety belt pretensioner should not be handled immediately following deployment as the air bag module will be very hot. Failure to follow this instruction may result in personal injury.

After deployment, the inflator(s) becomes inert, direct contact to the skin or eyes of any free pyrotechnic residues should be avoided. Failure to follow this instruction may result in personal injury.

Always wear gloves and safety glasses when handling deployed air bag modules and safety belt pretensioners. Failure to follow this instruction may result in personal injury.

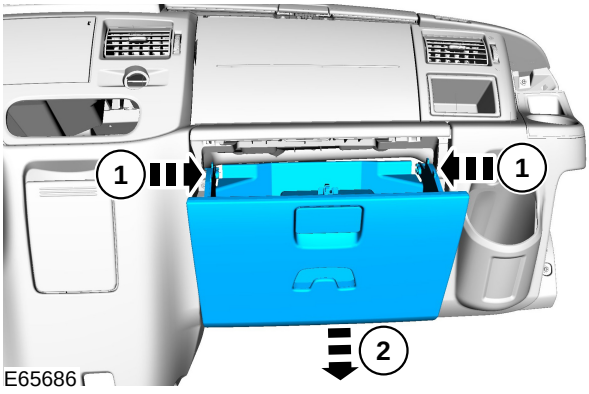
If the air bag module or safety belt pretensioner pyrotechnic residue should contact the eyes, wash the eyes with clean water and seek medical assistance. Failure to follow this instruction may result in personal injury.

If a large amount of air bag or safety belt pretensioner pyrotechnic residue is inhaled, seek medical assistance. Failure to follow this instruction may result in personal injury.

2. Disconnect the battery ground cable.

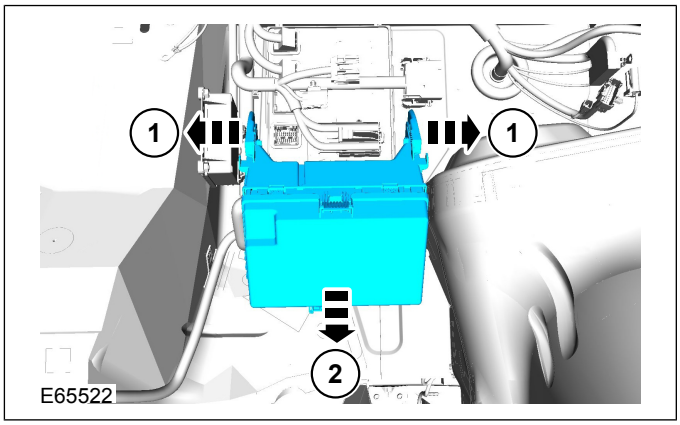
For additional information, refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

3.

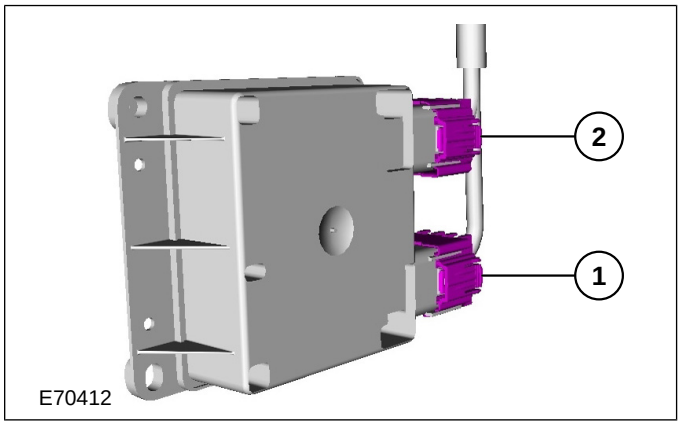


GENERAL PROCEDURES

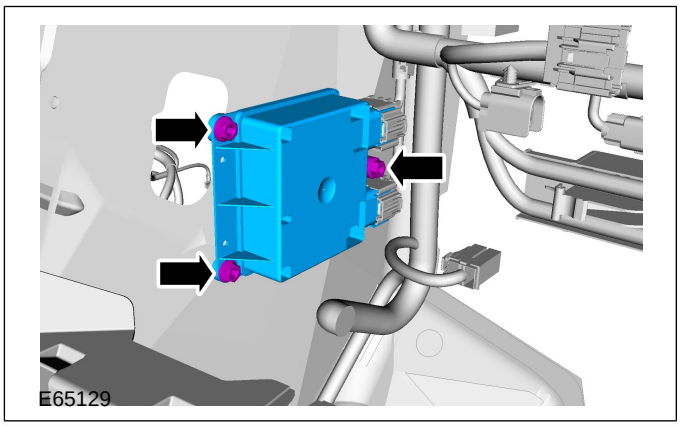
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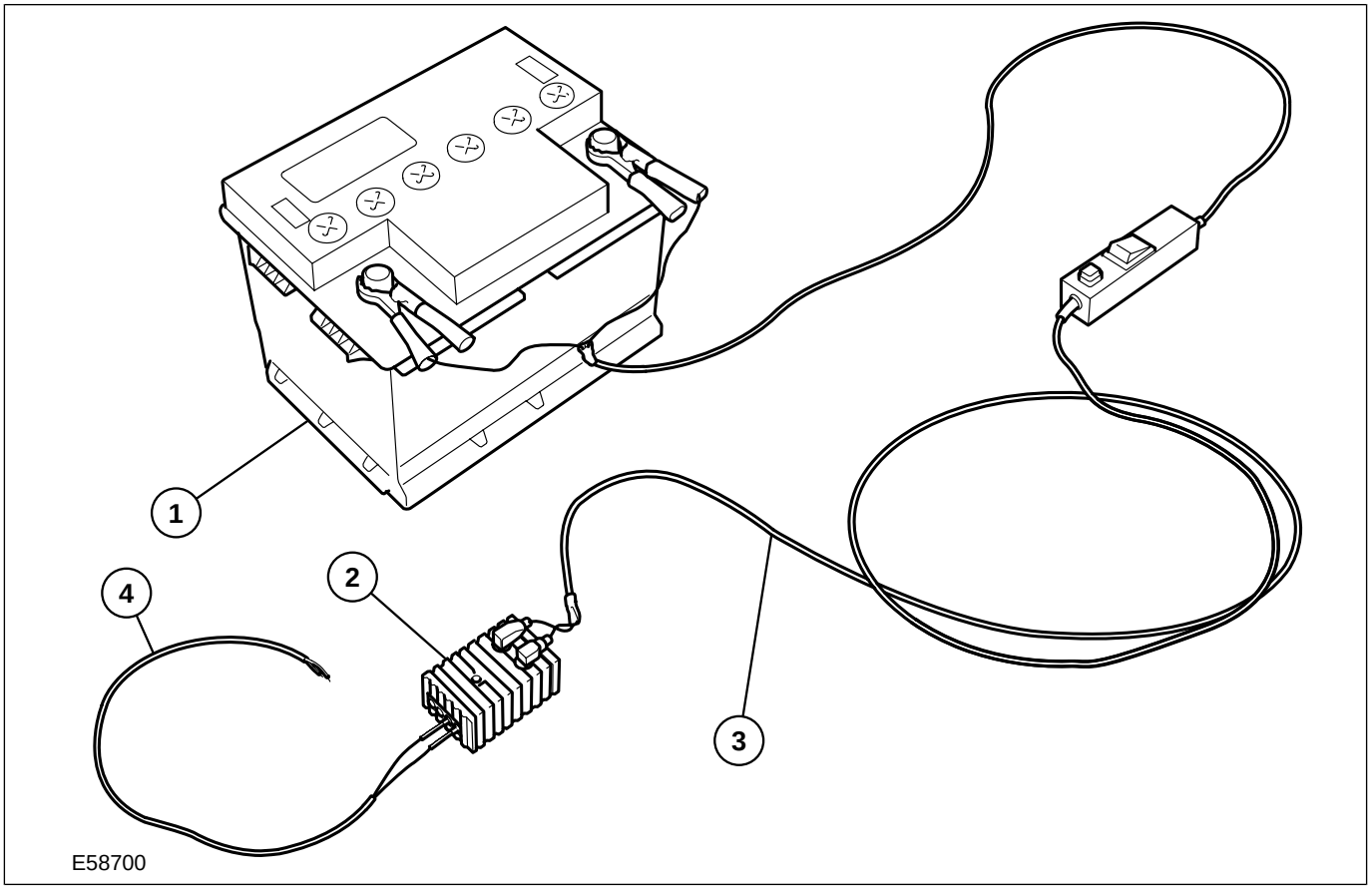
6.



5.

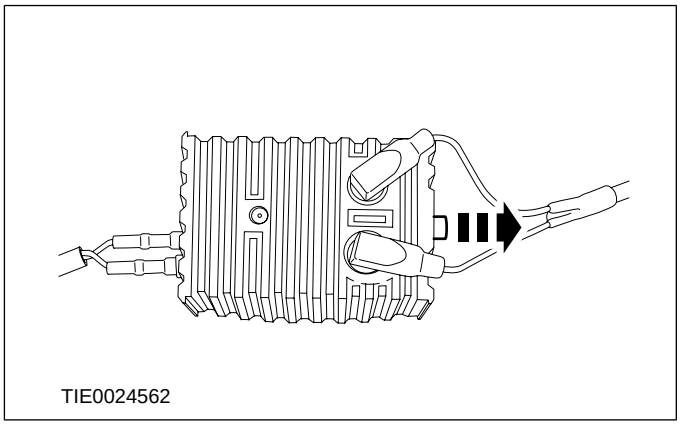


7. **Connect the special tools and general equipment as shown.**
   1. 12 volt battery.
   2. Adapter box (AC).
   3. Deployment lead (part of Test and Deployment Lead, Air Bag/Pyrotechnic Safety Belt).
   4. Deployment lead (part of Test and Deployment Lead, Air Bag/Pyrotechnic Safety Belt) refer to the special tool usage table below.

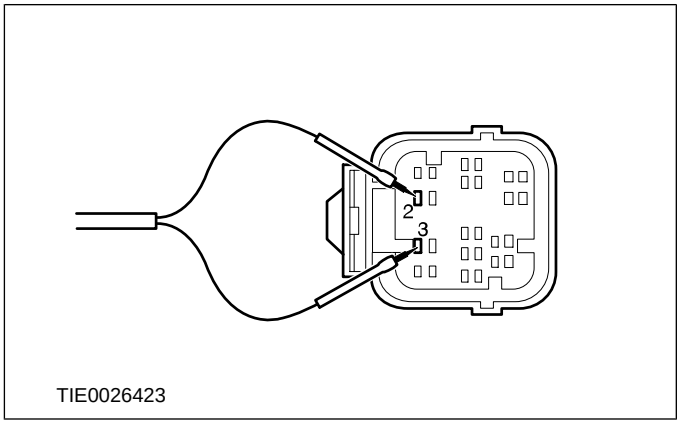


GENERAL PROCEDURES

8. **Release the adapter box AC button.**

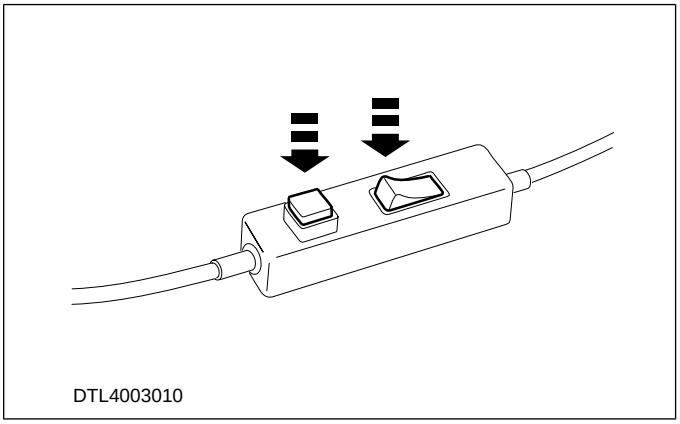

TIE0024562

9. **To deploy an air bag module or safety belt pretensioner, connect the deployment leads to the RCM electrical connector.**
   - For the pin numbers, refer to the special tool usage table below.



TIE0026423

10. **Move as far away as possible from the vehicle and depress both switches to deploy the air bag module or safety belt pretensioner.**


DTL4003010

11. **To deploy the remaining air bag modules and safety belt pretensioners, refer to the special tool usage table below for the RCM electrical connector pin numbers.**
    - Repeat steps nine and ten.

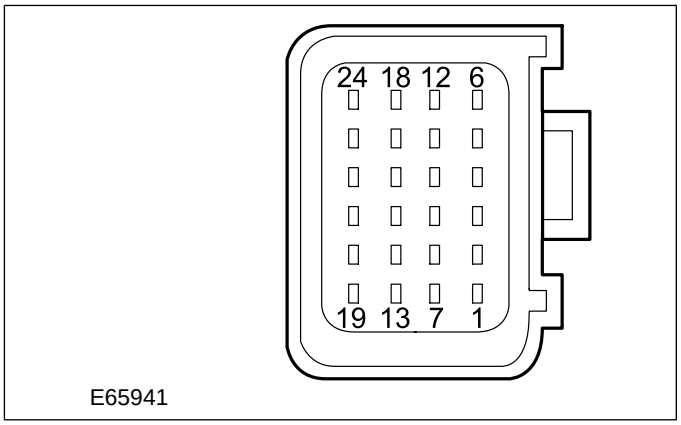
Special Tool Usage

Description	Test and Deployment Lead (Part of Test and Deployment Lead, Air Bag/Pyrotechnic Safety Belt [418-S055)	Electrical connector	Red Deployment Lead	Black Deployment Lead
Driver air bag module	40-007-15	2	Pin 10	Pin 9
Passenger air bag module	40-007-15	2	Pin 7	Pin 8
Side air bag module - driver side	40-007-15	1	Pin 3	Pin 2
Side air bag module - passenger side	40-007-15	1	Pin 21	Pin 20
Safety belt pretensioner - driver side	40-007-15	1	Pin 5	Pin 4

GENERAL PROCEDURES

Description	Test and Deployment Lead (Part of Test and Deployment Lead, Air Bag/Pyrotechnic Safety Belt [418-S055)	Electrical connector	Red Deployment Lead	Black Deployment Lead
Safety belt pretensioner - passenger side	40-007-15	1	Pin 6	Pin 12

12.



All air bag modules

1. **Deployed air bag module(s) and safety belt pretensioners should be sealed in suitable bags and then disposed of in accordance with local contaminated waste regulations.**
2. **If an air bag module or safety belt pretensioner fails to deploy, remove the component. For additional information, refer to:**

   Safety Belt Retractor and Pretensioner (501-20 Safety Belt System, Removal and Installation),
   Driver Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation),
   Passenger Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation),
   Side Air Bag Module (501-20 Supplemental Restraint System, Removal and Installation).
3. **All unserviceable air bag modules have been placed on the Mandatory Return List. All discolored or damaged air bag modules should be treated the same as any unserviceable live air bag module being returned.**

- Seal the unserviceable air bag module or safety belt pretensioner in suitable packaging and return to the Exchange Plan Center, as appointed through the local National Sales Company.

REMOVAL AND INSTALLATION

Driver Air Bag Module

Removal

WARNING:

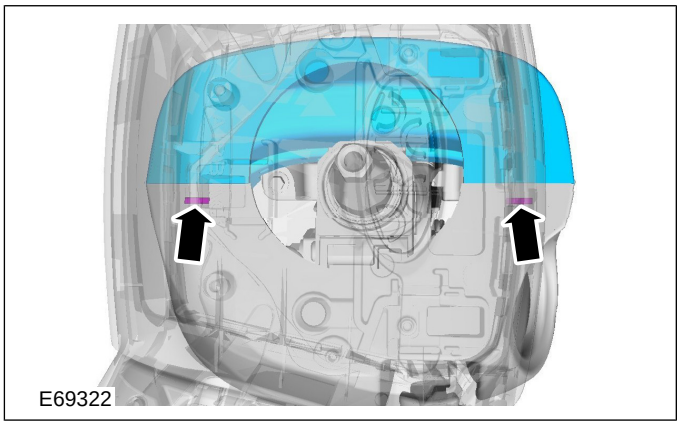
Refer to:Supplemental Restraint System (SRS) Health and Safety Precautions (100-00 General Information, Description and Operation).

NOTE: Removal steps in this procedure may contain installation details.

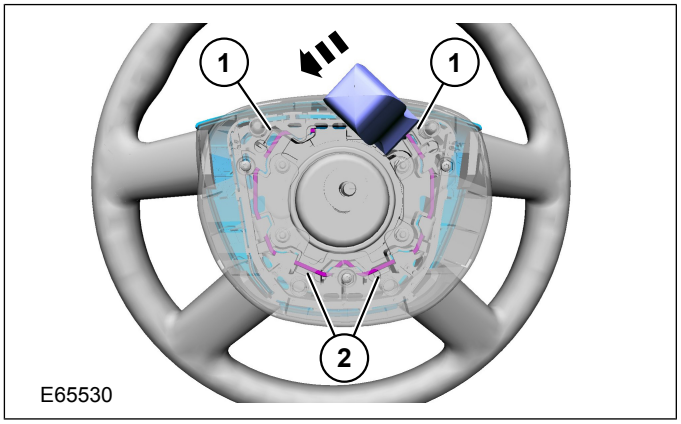
1. Disconnect the battery ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

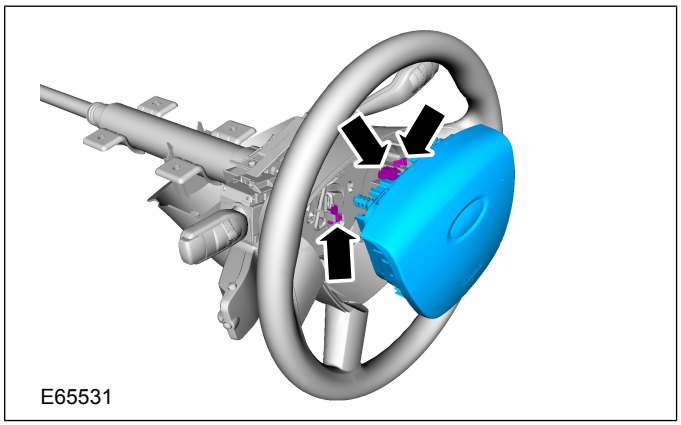
2.



3.



4.



Installation

1. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Restraints Control Module (RCM)

Removal

WARNING:

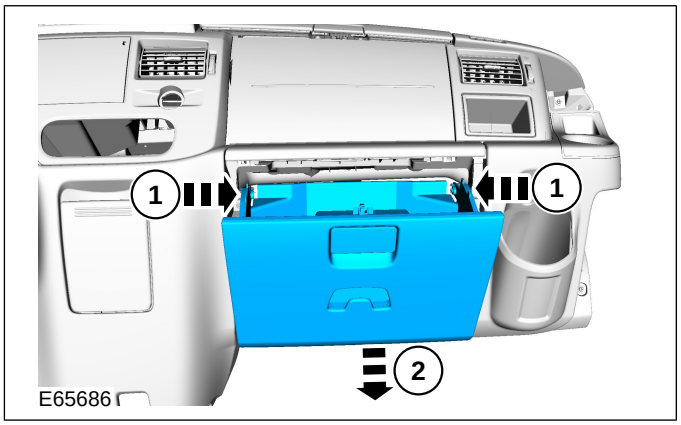
Refer to:Supplemental Restraint System (SRS) Health and Safety Precautions (100-00 General Information, Description and Operation).

NOTE: Removal steps in this procedure may contain installation details.

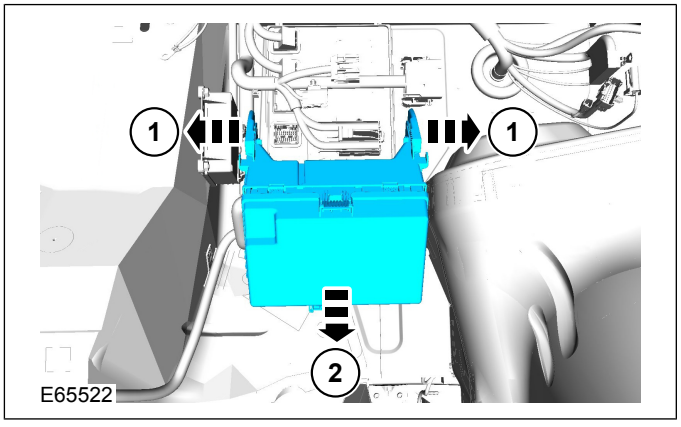
1. Disconnect the battery ground cable.

   Refer to:Battery Disconnect (414-01 Battery, Mounting and Cables, General Procedures).

2.

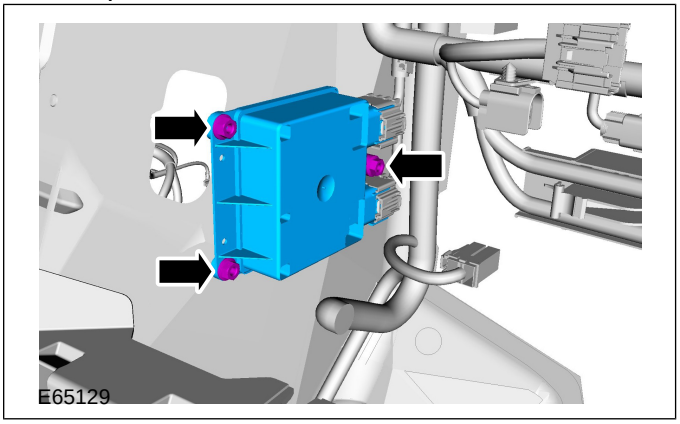


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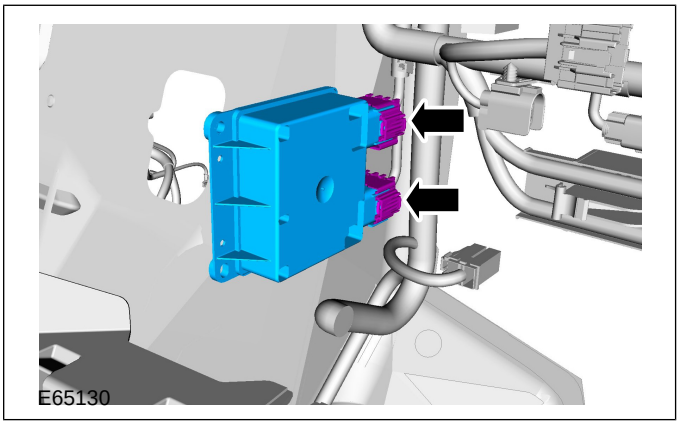


4. **CAUTION:Make sure that the component is correctly located.**

   Torque: 9 Nm



5.



Installation

1. To install, reverse the removal procedure.
2. **WARNING:New restraint control modules must be configured following installation.**

   Configure the restraint control module.

   Refer to:Module Configuration (418-01 Module Configuration, General Procedures).

REMOVAL AND INSTALLATION

Clockspring

General Equipment

Worldwide Diagnostic System (WDS)

Removal

All vehicles

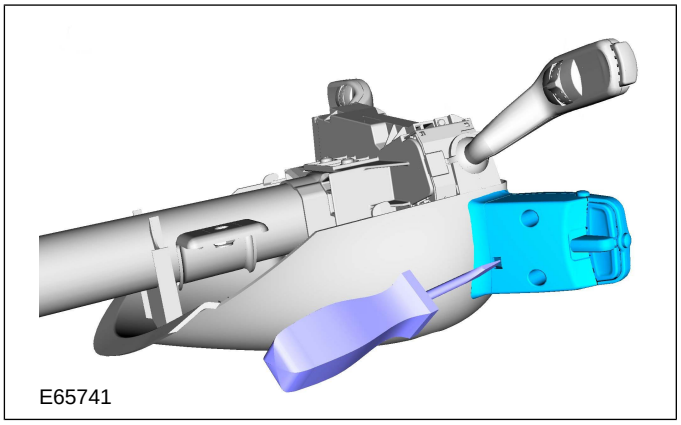
WARNING:

Refer to:Supplemental Restraint System (SRS) Health and Safety Precautions (100-00 General Information, Description and Operation).

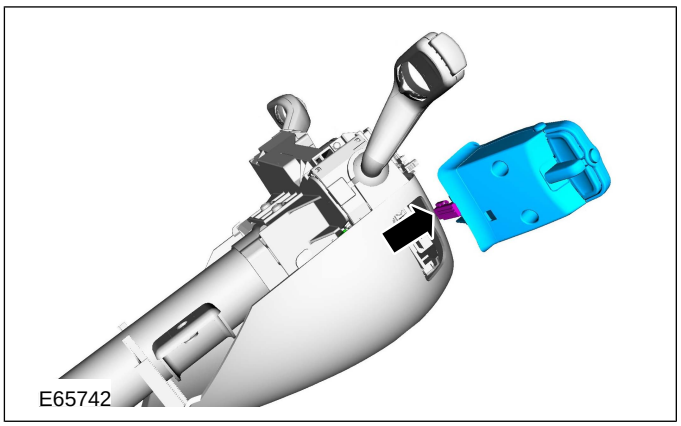
1. Remove the steering wheel.

   Refer to:Steering Wheel (211-04 Steering Column, Removal and Installation).

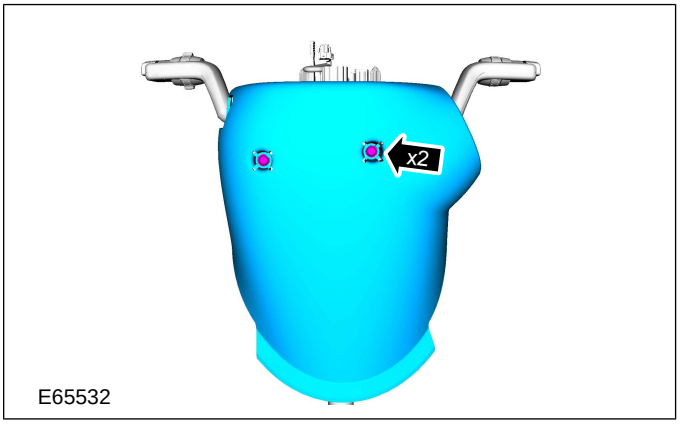
2.



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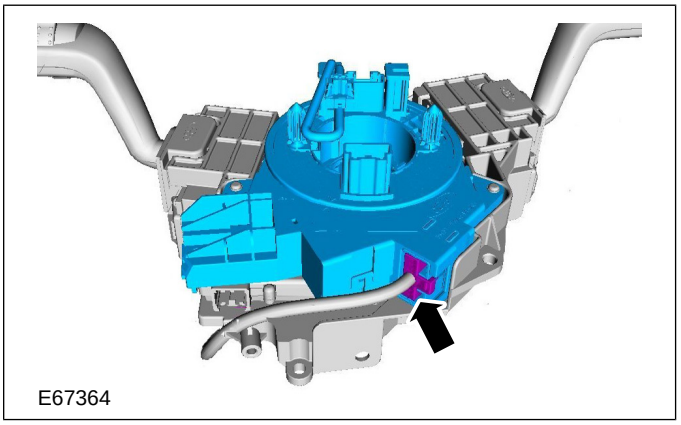


4.



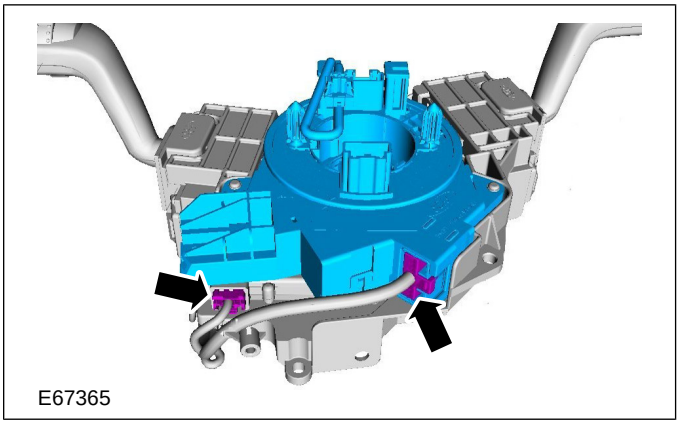
Vehicles without stability assist

5.



Vehicles with stability assist

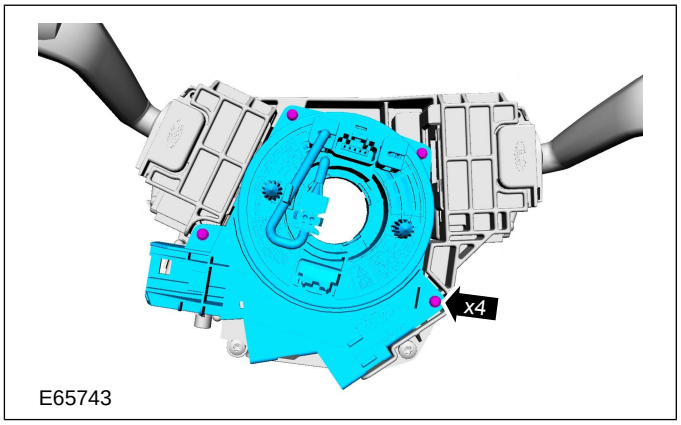
6.



REMOVAL AND INSTALLATION

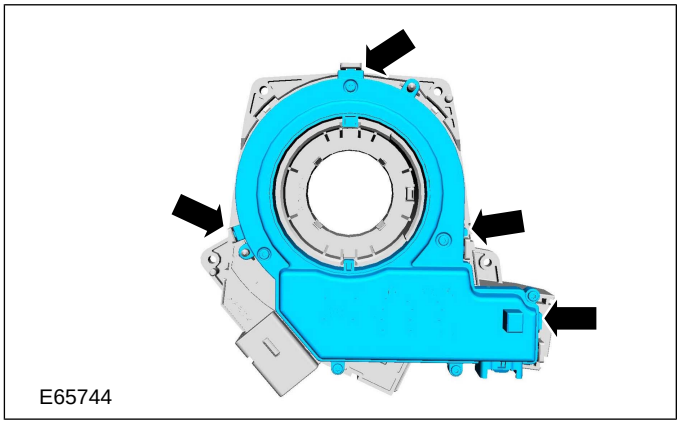
All vehicles

7.



Vehicles with stability assist

8. **CAUTION:Take extra care not to damage the clips.**



Installation

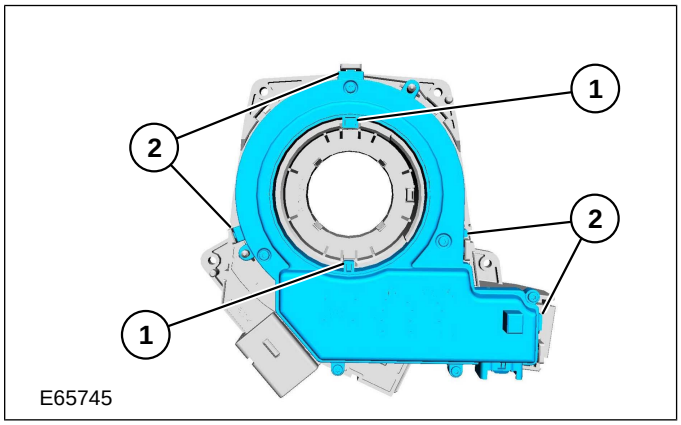
WARNING:

Refer to:Supplemental Restraint System (SRS) Health and Safety Precautions (100-00 General Information, Description and Operation).

Vehicles with stability assist

1. **CAUTION:Take extra care not to damage the clips.**

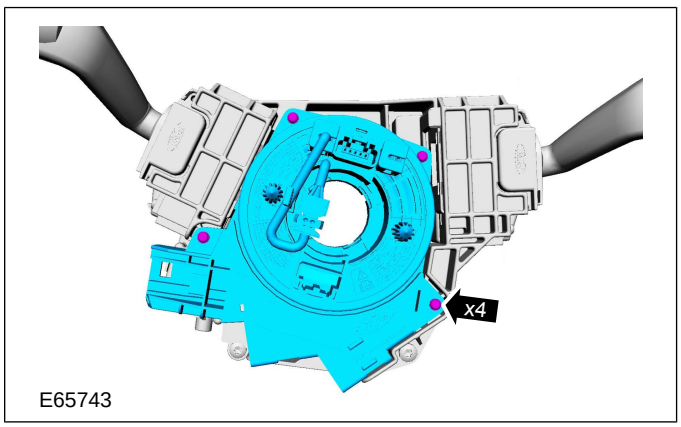
1. Align the steering wheel rotation sensor locating tangs to the clockspring.
2. Make sure that the steering wheel rotation sensor retaining clips lock into position on the clockspring.



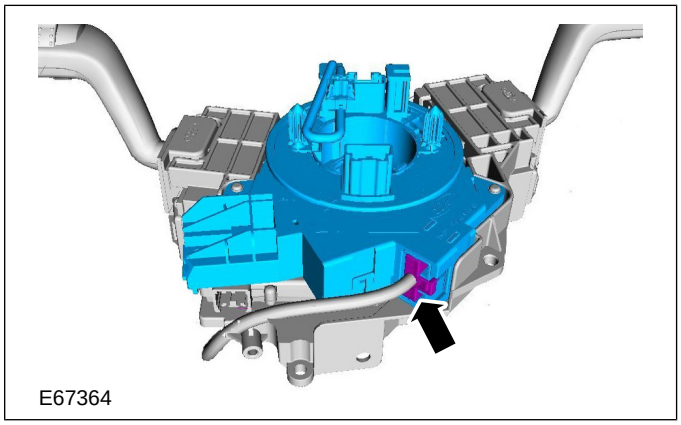
Vehicles without stability assist

2. **NOTE:**Make sure that the road wheels are in the straight ahead position.

NOTE: Make sure that the turn signal lamp switch is in the off position.



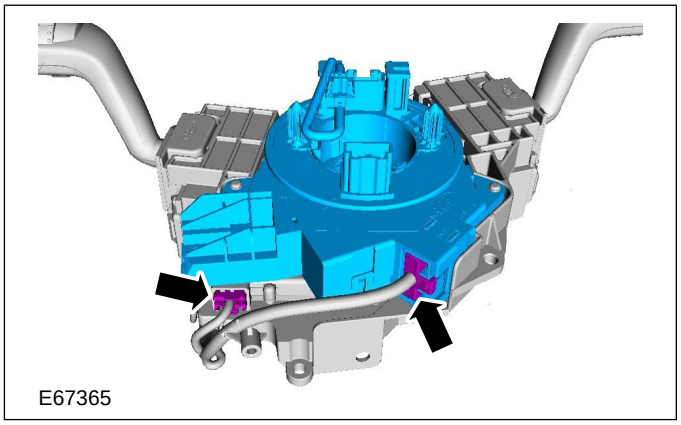
3.



REMOVAL AND INSTALLATION

Vehicles with stability assist

4.



All vehicles

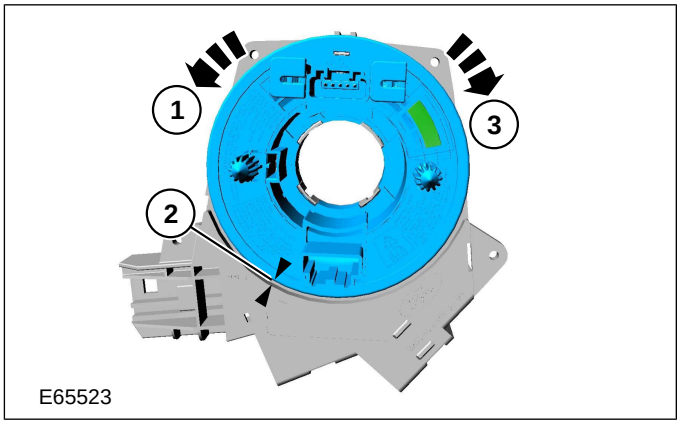
5. WARNINGS:

If there is a break between installing the clockspring and steering wheel rotation sensor assembly and installing the steering wheel, the centralizing of the clockspring must be repeated.

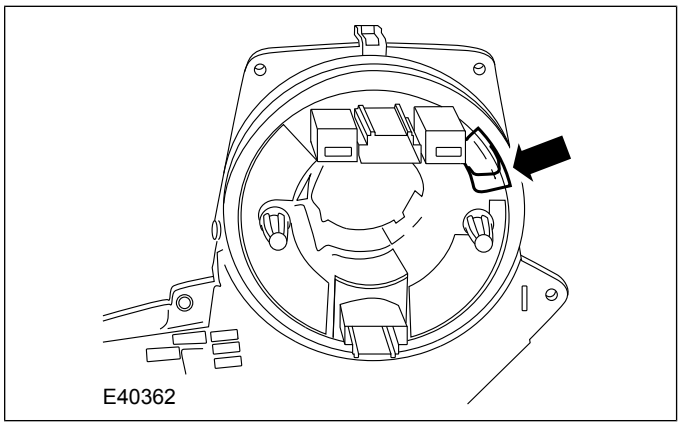
If the centralization of the clockspring is in doubt, the centralizing of the clockspring must be repeated.

CAUTION:The clockspring and steering wheel rotation sensor assembly must not be rotated in a clockwise direction more than 3 revolutions.

1. Turn the clockspring rotor in a counterclockwise direction until a resistance is felt.
2. Turn the clockspring rotor in a clockwise direction, until the arrow marked on the clockspring rotor aligns with the raised 'V' section on the clockspring body at approximately the 195 degrees position.
3. Turn the clockspring rotor in a clockwise direction three turns.



6. CAUTION:Make sure that the clockspring rotor does not rotate.



7. Install the steering wheel.

Refer to:Steering Wheel (211-04 Steering Column, Removal and Installation).

Vehicles with stability assist

8. Configure the electronic stability assist program.

General Equipment: Worldwide Diagnostic System (WDS)

SECTION 501-25 Body Repairs - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 501-25-3

DESCRIPTION AND OPERATION

Description and Usage of Body Repair Literature 501-25-4
Symbols 501-25-5
Health and Safety Precautions 501-25-7
- General 501-25-7
- Personal protection 501-25-7
- Protection of the vehicle 501-25-7
- Protective equipment 501-25-8
- Electronic components 501-25-8

Environmental Regulations 501-25-9
Body Construction 501-25-10
- General 501-25-10
- Integral body-frame 501-25-10
- Frame structures 501-25-12

Diagnosis and Damage Evaluation 501-25-13
- Visual recording of the damage 501-25-13
- Hidden damage 501-25-13
- Light commercial vehicles and off-road vehicles 501-25-13
- Convertible-specific crash characteristics 501-25-14

Body Sheet Metal 501-25-15
- Types of steel 501-25-15
- Aluminum 501-25-17

Tools and Equipment for Body Repairs 501-25-20
- Alignment systems 501-25-20
- Measuring systems 501-25-21
- Panel beating tools 501-25-23
- Welding gear 501-25-25
- Separating tools 501-25-26

Establish Repair Method 501-25-28
- General 501-25-28
- Planning 501-25-28
- Chronological sequence of repair 501-25-28

Alignment Check 501-25-29
Straightening 501-25-31
- General 501-25-31
- Off-road vehicles 501-25-31

Complete Panel Replacement/Partial Replacement 501-25-33
- Complete replacement 501-25-33
- Sectional replacement 501-25-33

Corrosion Prevention 501-25-35
- Corrosion protection measures during repair work 501-25-35

Corrosion Damage/Corrosion Repair 501-25-38

Sealer, Underbody Protection Material and Adhesives 501-25-39
Cutting Technique 501-25-40
Spot weld milling tool 501-25-40
Rod sander 501-25-40
Short stroke saw 501-25-40
Orbital saw 501-25-41
Panel Beating Technique and Smart Repairs 501-25-42
General 501-25-42
Hollow leveling (removing dent without a dolly) 501-25-42
Dent removal using hammer and dolly 501-25-42
Dent removal from the outside using the slide hammer 501-25-43
Dynamic puller with counter bearing 501-25-43
Dent removal using special panel beating levers 501-25-44
Heat working of panels 501-25-44
Heat-induced material shrinking 501-25-44
Lead loading 501-25-45
Paintless Dent Removal 501-25-47
Joining Techniques 501-25-49
Welding 501-25-49
MIG brazes 501-25-53
Rivets 501-25-54
Brazed connections 501-25-54
Lead loading 501-25-55
Bonding 501-25-55
Bonding and welding 501-25-56
Bonding and riveting 501-25-56
Plastic Repairs 501-25-58
General 501-25-58
Plastic welding 501-25-60
Adhesive bonding of plastics 501-25-60
GRP repairs 501-25-61
Special Repair Techniques 501-25-63
Cabriolet vehicles 501-25-63
Liquefied gas vehicles 501-25-64
Refrigerated conversion vehicles 501-25-64
Impact of Insufficient Repair Quality 501-25-66
Water Leaks 501-25-68
Diagnosis 501-25-68
Execution 501-25-68
Sequence 501-25-69
Test equipment 501-25-69
Wind Noise 501-25-70
Diagnosis 501-25-70
Test equipment 501-25-72
Noise, Vibration and Harshness 501-25-73

SPECIFICATIONS

Description	Finis Code	Specification
Underbody protection	5 030 492	-
Anti-corrosion wax	1 219 834	WSK-M7C89-A
Cavity wax	5 030 081	-
Profiled butyl seal	1 128 983	S-M3G4620-A
Weld primer	1 205 996	-
Clinched flange protection	1 136 479	WSK-M4G245-B
Seam sealing compound	1 205 817	WSS-M4G364-A
Body sealing compound	1 143 255	-
Metal adhesive kit	1 203 241	-
Windshield sealant	1 613 838	WSK-M4G329-A

DESCRIPTION AND OPERATION

Description and Usage of Body Repair Literature

The purpose of this document is to inform the vehicle body specialist of the latest technology and also the materials and repair techniques currently used in body making. It provides information on workshop equipment and tools and on the most fundamental body repair methods.

Vehicle specific information is provided in the FordEtis workshop manual. In addition, ongoing information will be provided in the Technical Service Bulletins.

The Ford Service Organization offers basic and more in-depth training on much of the content of this general manual. As well as the practical part of the training, a further component is the Student Information document, which offers supplementary information in the form of a brochure.

You will find an overview of the complete range of training offered in the Ford Service Organization Brochure, which is published yearly.

The general section is divided into the following chapters:

- **Specification** lists technical information about the various materials used in current body applications.
- The chapter **Description and Operation** provides information on the fundamentals of vehicle body construction and materials. In addition you will also find there notes about tools, materials as well about fundamental body repair methods.

DESCRIPTION AND OPERATION

Symbols

Various symbols, signs, instructions and illustrations are used in this literature. Warnings and cautions have different meanings and require different ways of proceeding. Diagrammatic representations are provided with instructional signs for improved clarity.

When reading this handbook, you will come across the points WARNING, CAUTION AND NOTE. These points are always immediately before a single job step or a series of job steps.

These are briefly explained below:

WARNING:This caption is used when failure to follow instructions exactly or failure to follow them at all may result in a hazard to persons or in persons being injured.

CAUTION:This caption is used when incorrectly following the test procedures or instructions or failure to follow them at all could lead to damage to the vehicle or components.

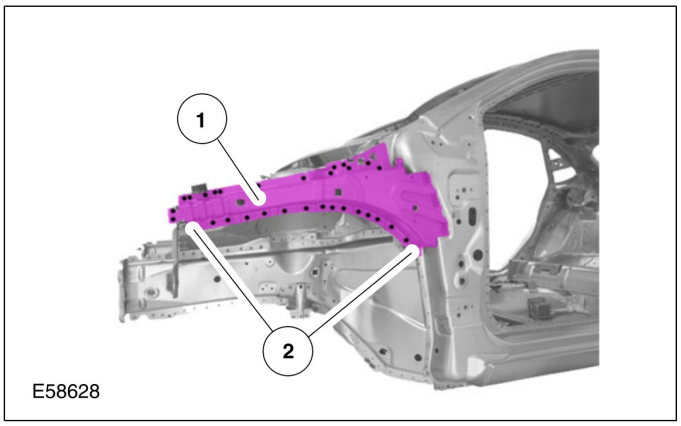
NOTE: This heading is used when the technician should be made aware of special or extra information.

Item numbers

Item numbers are inserted into a diagram when details need to be emphasized.

Item numbers with one indicator line

An item number and an indicator line point to a special location or a component. In this diagram a component and a row of spot welds are indicated.



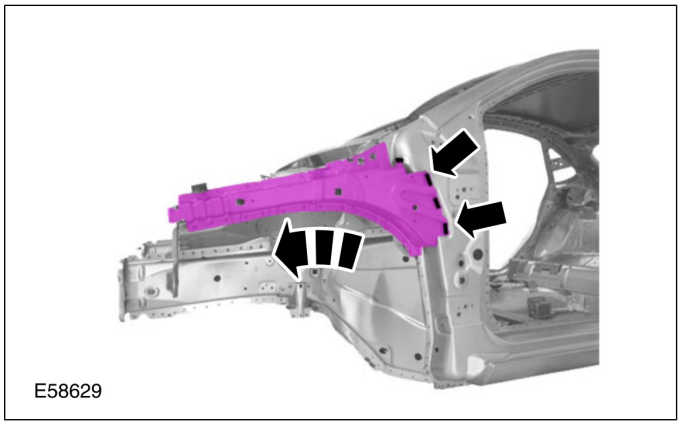
Item	Description
1	Apron panel reinforcement
2	Spot welds

Item numbers with two indicator lines

If two indicator lines lead away from one item number, then an area is being referred to. In this case the area with the spot welds to be separated is shown.

Black arrows

If the illustration of a detail is unambiguous, or there is only one detail shown, then no item number is used. A black arrow is used for this.



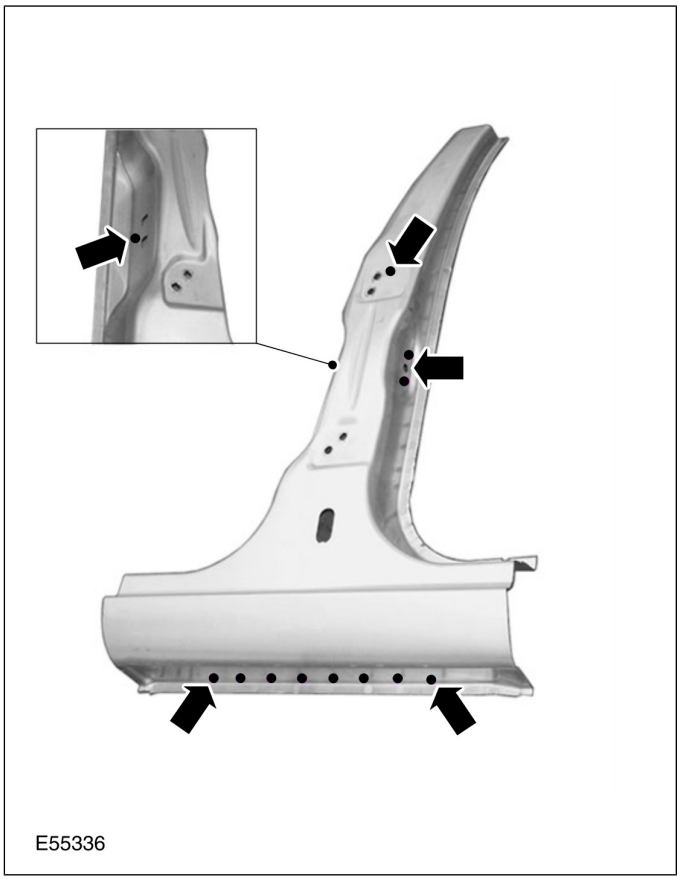
Broken arrows

Broken arrows represent movement. In this case the component must be removed in the direction given.

Enlargement/detail

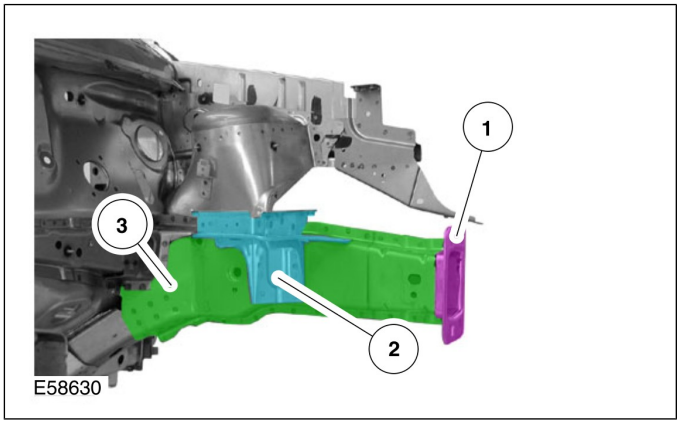
If a detail cannot be clearly seen in the illustration because of its size or location, it is shown enlarged in a separate window. In this case a detail on the back of the B-pillar cannot be seen, and is therefore shown separately.

DESCRIPTION AND OPERATION



Different colors or shading

Different colors or shading are used to depict special areas. In an assembly operation, the colors show the sequence of removal steps.



Item	Description
1	Magenta - 1st stage
2	Turquoise - 2nd stage
3	Dark green - 3rd stage

In the repair specifications, the first component or the first partial replacement component is always shown in magenta. The second component in an illustration is shown in turquoise and a third component is shown in dark green. Spot welds, weld seams and cut lines are shown in black.

This principle also applies to line drawings. In these, illustrations under the same topic will always show the same colors for the same components.

DESCRIPTION AND OPERATION

Health and Safety Precautions

General

Appropriate repair methods and carrying out repairs correctly are particularly important for the operating safety of vehicles and for the safety of people.

WARNING:There is danger of injury through:

- High voltage when electrical welding.
  - Do not perform welding work in a damp environment or on a wet substrate. Use suitable insulation underneath.
- Flammable substances in the welding area.
  - Remove flammable substances from the danger area. Remove the fuel tank and components which supply fuel. When welding in the battery area, the battery must be completely removed.
- Welding fumes, which are harmful to health.
  - Ventilate the workplace well and use the welding fumes extraction system.
- Welding spatter and UV radiation.
  - Wear protective clothing, gloves and welding mask or welding goggles.
- Pyrotechnic components.
  - Disconnect the battery negative clamp and cover the battery terminal. Remove any airbag components.

All the regulations governing Health and Safety at Work must be complied with during body repairs.

Personal protection

Welding gases and grinding dusts can be harmful to the health. For this reason, make sure that rooms are well ventilated and work using the welding fumes extraction system.

Sealants, underbody protection and paint residues must not be burnt down with an unshielded flame, as this will produce gases which are damaging to health. A dedicated extraction system must always be used when welding or brazing.

When working with substances containing solvents, good ventilation must be provided, respiratory protection must be worn and an extraction system must be used.

Do not weld in damp areas, if necessary use an insulation mat.

Welding and grinding work near the battery presents the danger of explosion. For this reason, it must be removed before the work is started.

Cutting, grinding and alignment work on metal panels can cause a noise level of 85 to 90 dB (A) or even more. For this reason, you must always wear ear defenders.

The various body areas are subject to very high forces during realignment work. Should any component suddenly become detached during this process, there is a very great danger of injury. For this reason, pulling chains and pulling shackles must be secured with arrester cables.

NOTE: Work on airbag systems may only be performed by persons who have a relevant certificate of competence.

Some special instructions must be followed when working on airbag systems:

- Always stand to the side of it when removing or installing an airbag.
- Always store an airbag or an airbag/steering wheel with the airbag side pointing upwards and in a safe place.
- Only install the airbag again when the vehicle is fully repaired and the complete electrical systems has been tested.
- Take into account the location of air curtains and shoulder airbags.

Protection of the vehicle

Protect affected areas from weld spatter and dust during all welding and grinding work on the vehicle. If metallic dust stays on the vehicle for some time, there is the likelihood of film rust formation. Grinding or sanding work produce tiny spots of damage to the paint surface, which may cause corrosion.

For this reason, make sure to:

- Use carbon fibre blankets to protect the vehicle body.
- Use covering film to protect the vehicle body from sanding dust and metal dust.

Use suitable protective measures to protect the interior when performing repair operations which relate to the inside of the vehicle.

DESCRIPTION AND OPERATION

Carbon fibre blankets are used directly around the working area. They offer maximum protection to the areas of the vehicle.

In addition, take into account:

- Remove fuel supply components as necessary.
- Protect working areas which are in danger of catching fire with a fireproof blanket.
- The welding must not cause components of the air conditioning system to become heated.
- Removal of any attached components in the space adjoining the repair area.
- Use covering paper to protect the interior from grinding dust.
- Create a definite barrier between the work area and the interior by using a carbon fibre blanket.

Protective equipment

The following protective equipment must always be used:

- Protective helmet or welding mask.
- Ear defenders and breathing protection.
- Protective gloves and safety boots.
- Welding fume extraction.

Electronic components

Increased use of comfort and safety electronics in modern motor vehicles also requires the greatest attention to be paid during body work.

Overvoltages produced during welding and in alignment work during bodyshell rectification may cause electronic systems to be damaged. In particular, the safety instructions for performing welding work on vehicles with airbag systems must be adhered to.

NOTE: After disconnecting the power supply and before performing further work, a wait time of up to 15 minutes must be maintained, depending on the vehicle. Work on airbag systems may only be performed by persons who have a relevant certificate of competence.

Pay attention to the following points:

- Disconnect the battery negative clamp and cover the battery terminal.
- Disconnect the electrical connector at the airbag control module.
- If welding is to be performed directly near a control module, it must be removed beforehand.
- Never connect the negative cable of the welder near an airbag or a control module.
- Connect the negative cable of the welder close to the location of the weld.

DESCRIPTION AND OPERATION

Environmental Regulations

Orderly and responsible waste management is not only very important for the protection of health and the environment, but it also has great importance where saving natural resources is concerned.

In body repair shops, since the introduction of the EU directives on the avoidance of vehicle waste and the promotion of return, re-use and recycling of vehicles and their components (2000/53/EU), more rigorous attention than before is also paid to avoidance and recycling of waste materials.

NOTE: The organization of disposal in the operation must comply with the country specific waste regulations:

In this respect, body repair shops must take into account and comply with the following requirements:

- Separate waste according to its recycling and disposal methods.
- Produce evidence for the correct transport and disposal of waste.

NOTE: The organization of disposal in the plant must comply with the requirements of the Waste Avoidance and Management Act.

The avoidance and recycling of waste must always take priority. However, despite all measures which may be taken, waste cannot be completely avoided.

NOTE: Useable waste which is not allowed in household rubbish, must be disposed of as special waste

All remaining waste must be treated as commercial waste and disposed of according to the local requirements.

DESCRIPTION AND OPERATION

Body Construction

General

Two design principles have prevailed in body design. The body design can either be an integral body-frame or a frame with all attached superstructures. Mixed versions are also possible, with the design significantly increasing the stability of the frame. In all versions, the passenger cell must be preserved in the event of an accident. To this end, the front and rear ends are designed so that they absorb the energy of the impact via crumple zones.

The use of modern design and manufacturing methods, and the use of body panels whose reshaping and strength properties have been finely balanced, mean that despite the reduced weight, all safety-related aspects and requirements can be met.

Integral body-frame

In the car market, the integral safety body-frame is the result of this technological development and manufacturing technology.



E59084

NOTE: Always follow the repair instructions published in the existing workshop literature, particularly for repairs in the crumple zone. All of the specified safety requirements must be met after the work has been carried out.

The integral body-frame is completed with ancillary components, such as doors, hood, bumpers and other components. The advantages of this are:

- Maximum passive safety due to the stable passenger cell.
- Defined deformation behavior at the front and rear.
- High torsional rigidity and high flexural strength.
- Weight reduction.
- Economical manufacturing technology.

The safety of the driver and passengers is paramount for every body design. There are two key safety aspects in the body:

- Safety body cell.
- Crumple zone.

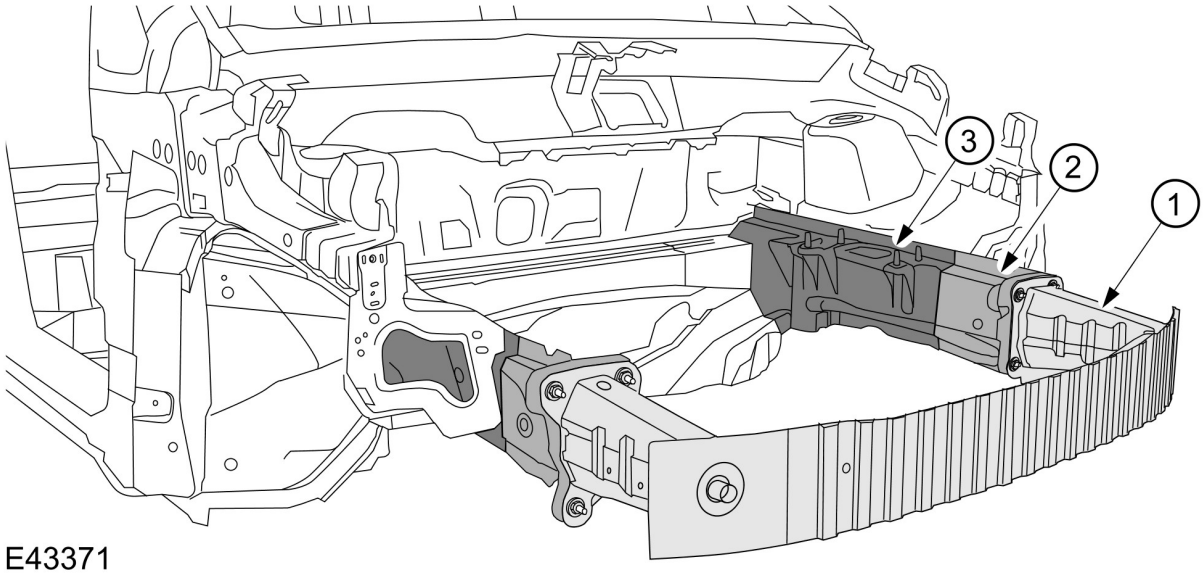
The safety body cell is characterized by the following design features:

DESCRIPTION AND OPERATION

- Stable pillars, door sills and door profiles.
- Integrated side impact protection in the doors.
- The doors are designed to open even in the event of extreme deformation.

Deformation behavior

Different materials and design features lead to staged deformation of the front and rear of the vehicle in an accident. The passenger cell remains undamaged, and the driver and passengers are not shut in.



E43371

Item	Description
1	Bolted sheet metal crash element
2	Front side member
3	Rear side member

NOTE: For more information on types of steel, please refer to the section on body materials.

The bolted crash element is made of high-strength steel. Built-in pre-determined folding points prevent damage to the cross member during gentle impacts. The use of bolts means that this can be quickly and cheaply replaced.

Side members can be manufactured from panels of different thicknesses. These are joined together through laser welding. These panels are called tailored blanks.

NOTE: Please note the model-specific instructions when repairing tailored blanks.

The rear of the vehicle, like the front of the vehicle, has structures which protect the passenger cell through staged deformation in the event of an accident. The design layouts, however, are adapted to the requirements of the rear area.

MPVs

The body of an MPV has largely the same design layout as a passenger car body. However, due to the different requirements of an MPV, the floor pan in particular had to be designed in a more stable manner. It is therefore produced as a frame construction with particularly high torsional rigidity and flexural strength.

If repair is required, the process is similar to the process for a passenger car body.

Convertible

The body of a convertible differs from the principle of the integral body-frame of a saloon due to the lack of a roof construction. To guarantee the high safety requirements, particular design changes are required within the floor pan structure.

These are:

DESCRIPTION AND OPERATION

- Reinforcements of the floor pan, in particular in the sill area.
- Reinforcements in the pillar area.
- Due to the lack of a roof construction, the so-called bridge design principle used in saloons cannot be applied here. Longitudinal and torsional rigidity must therefore be provided by other components.

Frame structures

Frame structures are used for off-road vehicles and light commercial vehicles. With these structures, a distinction is made between a separate frame structure, as on an off-road vehicle, and the composite structure of a light commercial vehicle.

The entire body structure of the commercial vehicle body differs fundamentally from that of the saloon car. The requirements of such a body cannot be compared with a passenger car body. The payload is paramount here. Accordingly, the stability requirements must also be taken into account in the body design.

These are:

- Floor pan as frame structure with high torsional rigidity and flexural strength.
- Thicker materials and greater reinforcements in the frame area.
- Partly large surface panels and high volume shaped parts.
- Side panels only make a small contribution to the overall stability of the body.
- Longitudinal crimping, reinforcements and bonded connections prevent the panel surfaces from oscillating during drive mode.

Off-road vehicles

The body designs of off-road vehicles are not subject to the principle of the integral body-frame. Their basic construction corresponds to a chassis frame with an attached body.

This stable chassis structure has significant advantages for off-road vehicles:

- High torsional rigidity for off-road use.
- High payload and large trailer capacity.
- High ground clearance.
- Stable attachment possibilities for all drive assemblies.

If repairs are to be carried out, a different repair technique is required for this body and frame structure.

A deformed frame structure requires high suction power during straightening repairs. Frequently, the body also has to be detached from the frame structure in order to carry out separate repair.

Due to the very stable frame structure, please note that the straightening behavior is completely different to that of a passenger vehicle. The frame and the attached body must be repaired independently of each other.

DESCRIPTION AND OPERATION

Diagnosis and Damage Evaluation

In order to correctly determine the extent of the damage caused by an accident, in-depth technical knowledge, practical experience with the technical equipment and the testing and measuring devices is required.

Assessment of the extent of the damage includes visual inspection and dimensional inspection of the vehicle. If damage to the chassis geometry is visible even during the visual inspection, the vehicle is to be inspected on an axle alignment jig.

Visual recording of the damage

From a profitability perspective, the possibility of a sectional replacement must be taken into consideration when assessing the damage to a vehicle damaged in an accident.

NOTE: Training courses are offered on this subject. For an overview, please refer to the Ford Service Organisation's training course brochure.

Positive accidental damage assessment can only be achieved if the service technician is able to reconstruct the effect of an impact on the body structure.

For example:

If the impact occurs on the front left-hand side member, the right-hand side member will usually also have been damaged. Often the length of this side member will not have changed, but because of the rigid body design, it may have become deformed. This damage can be detected through the size of the gap between the door and fender or by measuring the vehicle.

In the case of more severe impacts, in which the front part of the vehicle cannot absorb all of the impact energy, the passenger cell is also used to absorb the energy. Here, the energy is transferred via the A pillar and distributed there. This results in deformations in the roof and the door sill.

NOTE: In order to determine the damage as accurately as possible, it may be necessary to remove ancillary components, such as bumpers and inner fenders.

It is possible to draw conclusions about the extent of the damage through a visual inspection of the external damage. In general, the following areas are to be checked during the visual inspection:

- Outer panel including seam seals for cracks or flakes in the paint caused by the accident.
- Size of the gap on doors and hoods for evenness.
- The vehicle roof for folds (gap measurement on vehicles with sunroof)
- Dotted flange in door section for deformation and cracked weld spots.
- The side members and crash components for crumpling and folding.
- Trunk floor and floor pan from above and below for crumpling.

Hidden damage

In addition to external indicators, such as flaked off paint or cracks in the underbody protection, it is vital to check for deformations that are not visible from the outside (hidden body damage) during a damage assessment. Unless ancillary components are removed, it is often impossible to achieve accurate diagnosis of the underlying body parts.

Particular attention must be paid to the following components:

- The A, B and C pillars in the roof area.
- Floor pan.
- Rear ancillary components, such as bumper, lights, etc.
- Trunk floor, spare wheel cavity.
- Rear coverings, such as interior trim, carpet, etc.
- Lower rubber seals, e.g. in door area (welded flange).
- Area under the rear seat.
- Attachment points of transmission system, steering, engine, drive shafts, front and rear axles.
- Electrical components, e.g. radio (damage through shaking).

Light commercial vehicles and off-road vehicles

The basic body design of light commercial vehicles and off-road vehicles corresponds to a chassis frame with an attached body.

DESCRIPTION AND OPERATION

Therefore, both vehicle components, the frame and the body, must be checked thoroughly during damage assessment.

As with all vehicles, it is important to inspect the impact area and the shock absorbing areas closely for damage.

With these vehicles too, simple inspections can also reveal indicators of possible deformations.

In addition, you must check for the following for vehicles with frame structures:

- Cracks in the paint on the frame welds.
- Traces of deformation on frame components.
- Check attachment points (silent blocks) for position changes and damage.
- Changed position of rubber seals.
- Fit and function of the ancillary components.

Convertible-specific crash characteristics

Due to the convertible design, the deformation paths arising during an impact are larger than the actual permanent deformations.

In the case of severe impacts to the front or rear end, deformations may even extensively deform the passenger cell with no recognizable permanent damage. This is referred to as a large compression characteristic.

NOTE: Visual and functional inspections of the doors and convertible roof must be performed during damage assessment.

Adjacent mechanical components may nevertheless be damaged owing to these deformations. The following should particularly be inspected:

- Doors and door hinges.
- Lock pins and door guides.
- Cover mechanism.

DESCRIPTION AND OPERATION

Body Sheet Metal

Types of steel

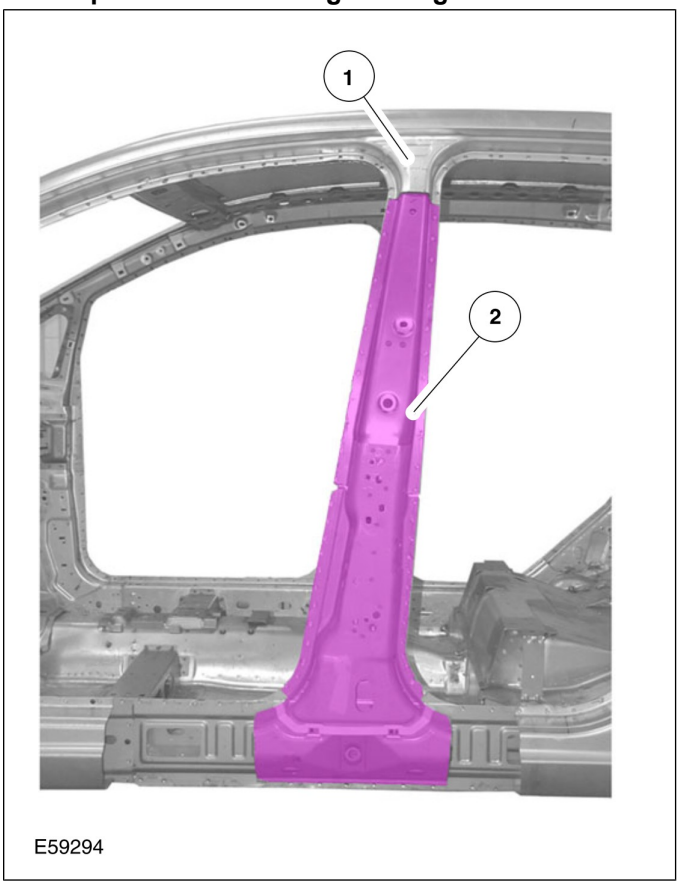
Steel body panels are still the most important materials used in the fabrication of stressed skin vehicle bodies. In addition to the familiar types of steel, reinforced high-strength and also ultra-high-strength special steels are used in vehicle body construction.

Types of steels are classified by their properties of strength and elasticity.

- Normal strength steel has a minimum yield strength of up to about 210 N/mm².
- High strength steels have a minimum yield strength of about 150 to 600 N/mm².
- Ultra-high-strength steels have a minimum yield strength of about 400 to 1200 N/mm².

High-strength and ultra-high-strength steels are mostly installed in safety relevant locations (structural components). Among others, these are side members, pillars, roof frames.

Example of the use of high-strength steel



Item	Description
1	Normal strength steel
2	High strength steel

Normal strength steels

Normal strength steels are most often used in body construction. They are relatively soft and are therefore particularly suitable for the deep drawing processes used in body manufacturing. As well as very good reshaping properties, the panels also have a relatively high rigidity.

High strength steel panels

The strength of the material and the nature of the surface can be changed as required by different engineering processes. In order to achieve suitable configuration and a good match between construction specifications and what is possible in production, a large range of high strength panels is available.

DESCRIPTION AND OPERATION

The range of the minimum yield strength is from 180 N/mm² to 460 N/mm². High strength thin steel panels usually have a surface finish. Electrolytic surface sealing is preferred.

Within the group of high strength steels, various types of steel are used in body construction:

- **Micro-alloyed high strength steels** for very difficult drawn components such as fenders, the internal components of doors, hoods and luggage compartment lids or load bearing components such as sidemembers, crossmembers etc.
- **Bake-hardening steels** and **phosphorus alloyed steels** for external panel components with higher draw depth and subject to higher operational demands.
- **Isotropic materials** for flat shaped outer steel panels on doors, hoods, luggage compartment lids, roofs.

Ultra-high-strength steels

These steels are predominately used for body structural components which are relevant to safety. Despite the reduced thicknesses of the panels used, weight reduction is often achieved together with greater strength.

As with high-strength steels, special types of steel are used in the ultra-high-strength steels group:

- **Complex phase steels** are used for door side impact carriers, bumper carriers and body components relevant to crashes. Besides high strength, they have good cold reshaping properties and are easily welded.
- **Dual phase steels** have the same properties as complex phase steels. Because of their high strengthening properties they are suitable for body reinforcements.
- **Residual austenite steels** and **martensite phase steels** have very high strength levels of up to 1200 N/mm² and are mostly used in body structures relevant to crashes.

Because of the use of such steels, some special points must be taken into account during body repair:

- Increased force required during straightening.
- Strong springback tendency during alignment work.
- Cutting tools have a shorter useful life.
- **NOTE:**High-strength and ultra-high-strength steel panels must not be heated during straightening work.

  Work without applying heat when carrying out straightening work. Losses of strength will occur at temperatures as low as 400°C.

The basic working methods and the tools to be used are the same however.

Coated steel panels

In a similar way to high-strength steel panels, coated steel panels are finding more applications because of the better corrosion protection which they offer. There are basically two different process which are used to apply a zinc layer:

- Hot dip zinc coating (no longer used in vehicle construction).
- Electrolytic zinc plating.

The following points must be noted when welding:

NOTE: Welding fumes are harmful to health. Make certain that the workspace is well ventilated and use welding fume extraction.

- Zinc starts to melt at about 420°C.
- The zinc vaporizes at a temperature of about 900°C.
- The amount of heating determines the damage to the zinc coating, and therefore to the corrosion protection.
- **NOTE:**Coated panels have a higher electrical resistance, but this can be compensated for by increasing the welding current by 10 - 20% .

  Resistance spot welding is particularly suitable for welding zinc-coated panels, because no widespread warming occurs.
- With electrolytically zinc-plated panels there is no need for any special preparation because the zinc coating does not need to be removed.

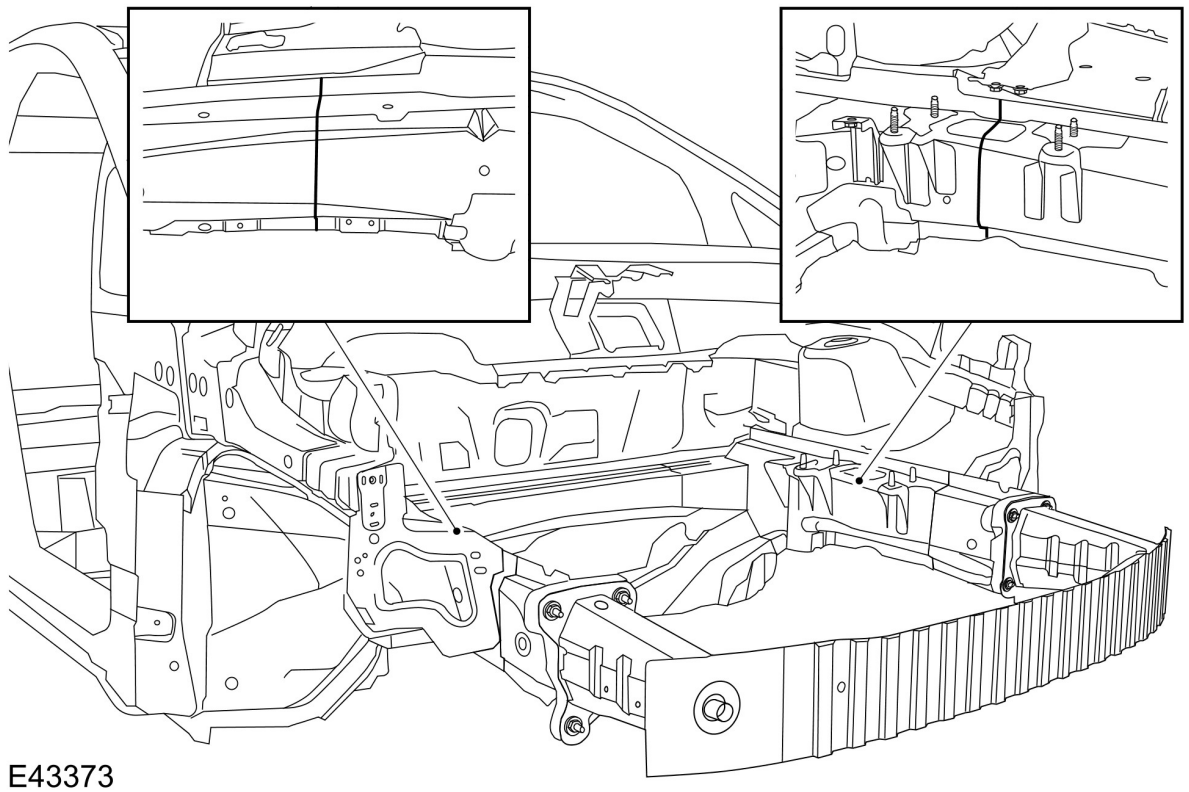
Tailored blanks

Tailored blanks are panels which are made up of at least two separate panels with different material thicknesses and/or material properties. The panels are joined together by a laser weld seam and then shaped in a press.

DESCRIPTION AND OPERATION

This technique allows panel shapes to be produced which meet special requirements with regard to deformation behavior, strength and weight.

Laser weld seams at the sidemember



E43373

NOTE: No cutting, no welding and therefore no sectional repairs are permitted in the immediate area of the laser weld seams. The model specific requirements are documented in the respective Body Repair Manuals.

Typical examples of application are:

- Sidemember.
- Door inner reinforcement/door frames.
- Wheelhouses.
- Rocker panel inner reinforcement.
- Roof rail inner reinforcement.

When repairing the vehicle body, pay special attention that such a connection is never separated. The possible cut line locations are given in the respective repair manuals.

Aluminum

Aluminum is becoming ever more important in body construction because of the trend to reduce weight. Doors, hoods and body outer panels are increasingly being made of aluminum alloy panels.

Although at the time of publication of this document, Ford of Europe has not yet introduced any aluminum body or aluminum body components, this topic is briefly described in this section.

NOTE: Fine aluminum dust may catch fire if a flame or spark touches it. All persons working in the workshop should pay special attention to this danger.

All the tools needed for body repair must be suitable for working aluminum, and they must be only used on aluminum.

The main properties of aluminum are:

- Low weight.
- High resistance to corrosion.
- High strength.
- High deformation rigidity.
- Very good heat conductivity.
- Very good electrical conductivity.

DESCRIPTION AND OPERATION

NOTE: When working aluminum components pay particular attention to avoid the danger of contact induced corrosion. The workplace must be free of steel swarf, and tools which have worked steel panels must not be used.

In the electrochemical potential series, aluminum has a negative potential of 1.23V in relation to steel. Because of this, when aluminum and steel touch and an electrolyte is present, contact corrosion occurs.

The following points should therefore be noted:

- Use only checked and coated connecting components (bolts, nuts, washers etc.).
- Always use new bolts.
- Use adhesives and sealants which are tolerant towards aluminum.
- No steel swarf in the workplace. Clean the workplace and pay attention to any steel-sanding dust from neighboring workplaces.
- Use a separate set of aluminum working tools.
- Use wire and rotating brushes made of stainless steel.

NOTE: In-depth knowledge and skill in panel beating techniques are the basic requirements for the repair of aluminum panels.

In the main, aluminum panels can be worked using the same processes as used for steel panels. There are however some special features to pay attention to:

- Do not use steel hammers or sharp-edged panel beating tools.
- Only use hammers with smooth surfaces.
- Working cold aluminum leads quickly to embrittlement. For this reason, perform more extensive mechanical deformation removal under exact temperature controlled heating.

NOTE: If uncontrolled heating is used on an aluminum panel, it will very quickly be destroyed, and a new one must then be installed. The necessary specialist knowledge cannot be given in theory, special courses must be attended instead.

In contrast to steel, aluminum does not display any surface color change when heated. This therefore means that the level of heating of the material cannot be seen.

Only once the material is overheated does a change in the material structure of the surface occur. By the time this has occurred, the structure of the material is already seriously damaged, and its strength very much reduced.

Overheated aluminum components must always be replaced.

Aluminum welding

Aluminum welding requires a welder which is specially designed to meet these requirements.

NOTE: As a rule, vehicle manufacturers require that persons who wish to weld aluminum must show evidence of having completed special training in aluminum welding. Please study the guidelines.

Both repair welding processes are based on fusion welding.

- MIG welding (metal-inert gas welding).
- MAG welding (metal-active gas welding).

Success of aluminum welding partly depends on how well the surface oxidation can be removed. Because aluminum oxide remains solid at the melting point of pure aluminum, it is important to remove it before welding.

- Melting point of aluminum (approx. 660 °C).
- Melting point of aluminum oxide (approx. 2040 °C).

The aluminum surface must be cleaned before welding. Cleaning improves the later fusion penetration and prevents contamination of the welding wire.

NOTE: If a stainless steel brush is used, it must never come into contact with steel components, so that it does not become contaminated.

The following three steps are to be performed in preparation:

- Clean the surface. Use a chemical cleaner to remove all traces of wax and other contaminants.
- Remove the oxide. This can be done using abrasive paper or a stainless steel brush.
- Wipe the oxide dust away with a lint-free cloth.

Aluminum oxide forms very quickly, therefore steps 2 and 3 should be performed immediately before welding.

Before working on the vehicle body, create a test seam on scrap which is made of identical material. Test the test piece visually and destructively, to

DESCRIPTION AND OPERATION

make certain that all welding parameters are correctly set, and an acceptable weld seam can be achieved.

An optimum weld can be recognized by the following quality features:

- All visible weld surfaces are clean, light and have the same profile.
- The weld seam should have the same height and width over its complete length.
- There must have been complete melting between the surfaces of the work piece and the weld metal.
- The correct penetration has been achieved when a thin continuous line can be seen on the reverse side.

DESCRIPTION AND OPERATION

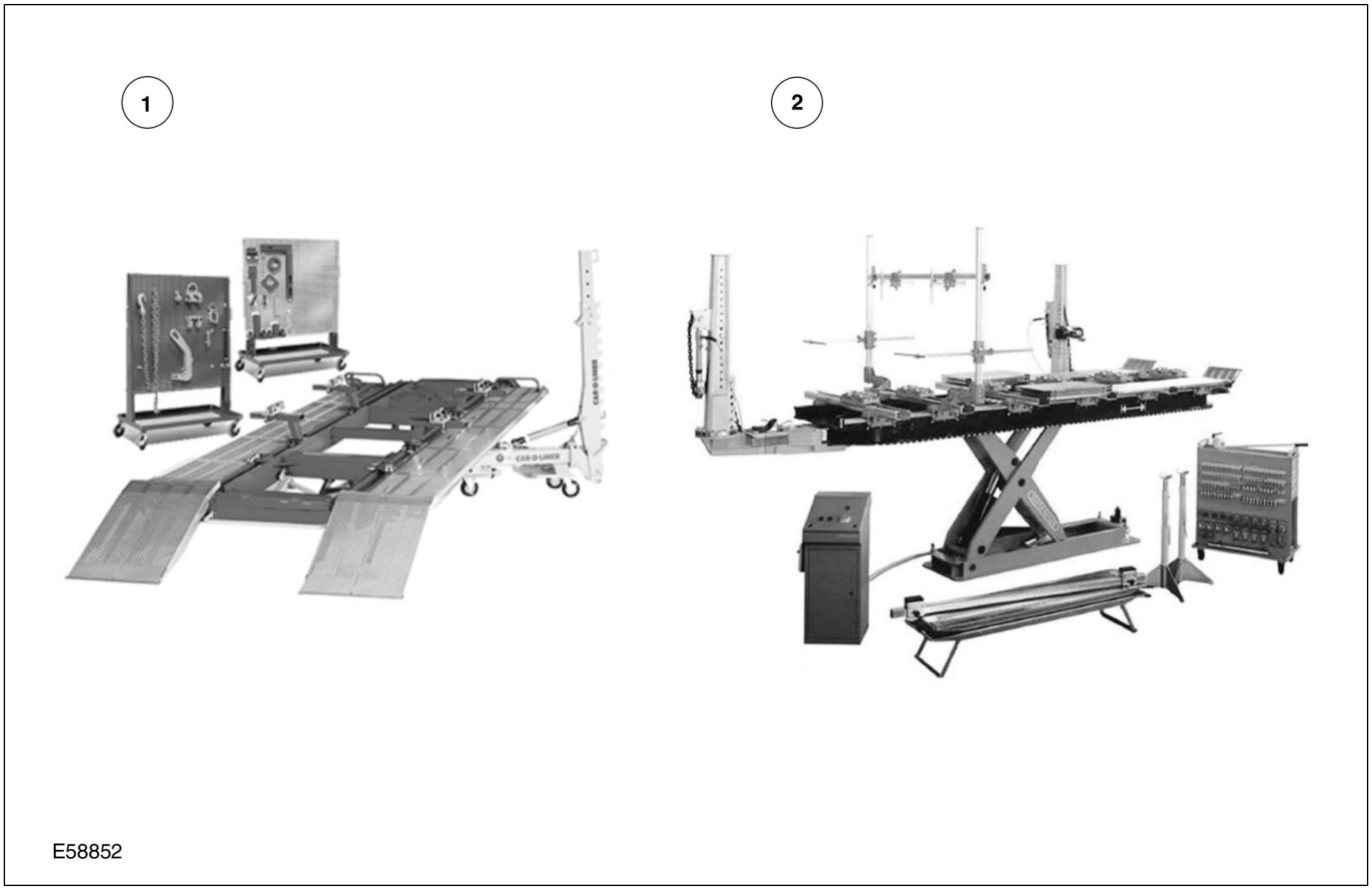
Tools and Equipment for Body Repairs

Alignment systems

NOTE: Please refer to the Ford Service Equipment Catalog for information on the body tools recommended by Ford.

Straightening and alignment repairs are often required to restore a vehicle body to its original shape after accident damage.

Universal aligning and measuring systems and universal alignment angle systems are suitable for this work.



Item	Description
1	Universal aligning and measuring system
2	Universal alignment angle system

Basically, the aligning and measuring system must satisfy the following requirements:

- Universally applicable to all types of passenger car. Can also be used on light commercial and off-road vehicles.
- Accepts the forces involved during straightening.
- High stability and mobility.
- Can accept all or part of the weight of the vehicle.
- Quick to set up.
- Simple to use.
  - Stationary design with drive-on ramp.
  - Height-adjustable aligning platform.
  - Universal gauge extensions with fast anchoring ability around the whole circumference of the aligning platform.
- Facility to test individual body measurement points, with or without aggregates being removed.

Alignment angle devices survey the vehicle at several points on the body. These are usually points which are also used in production. In addition, a recording over the rocker panels is possible. A measuring system is not needed, because the necessary body points are specified with gauges. For this purpose, vehicle specific or universal gauges are available.

DESCRIPTION AND OPERATION

Universal alignment systems consist of a vehicle mounting (universal clamps at the rocker panels) and a pulling device. In addition, a measuring system is required.

NOTE: Because universal clamps are used, the rocker panel area must be reworked for optical and corrosion protection reasons after the repair is completed.

Pay attention to the following points:

- Clean the attachment areas.
- Anchor the vehicle free of stress on the relevant system.
- Support the aggregates to take strain off the body.

Measuring systems

In order to exactly diagnose a damaged vehicle body, measuring systems are required. Depending on the measuring method, the systems vary in having mechanical, optical and acoustic measuring devices. In some cases, hybrid versions of particular systems are found.

NOTE: When working with each measuring system, the manufacturer's instructions provided in the description of the measuring equipment must be followed.

Basically, the measuring systems must meet the following requirements:

- Universally applicable to all types of passenger car. Also can be used on light commercial and off-road vehicles.
- Suitable for all accident damage.
- Fast capture of body measurement points in the underfloor and external areas.
- Data catalog to record all measurement points (length, width and height) both with and without the aggregates being installed.

NOTE: Basic and in-depth training is offered on the following topics. You will find an overview of the complete range of training offered in the Ford Service Organization training brochure.

Beam compass

The beam compass is a very practical and straightforward aid for measuring bodywork and especially floor assemblies. The beam compass can be used to detect dimensional variations across the length and the width by means of comparison measurements and diagonal measurements.

As a basic principal, body reference points should be chosen which are shown in the body frame measurement data sheet.

NOTE: To be able to determine difference in measurements, the same reference points must always be chosen on both sides. For this purpose the beam compass must be positioned symmetrically.

Comparison measurements can also be made on the outside of the body. Depending on the damage, left/right measurements (symmetry measurements) and diagonal measurements can be made using the beam compass, telescopic rod or a measuring tape.

Laser measuring systems

These systems use laser beams which are projected in one or more planes.



E59220

By the use of two parallel laser heads which can be turned, symmetrical points of a vehicle body can be tested and compared. Using the linear scales which are attached to the measuring points, the measurement data is read off with the aid of the projected laser beams.

The integral inclination gauge also allows differences in height to be quickly checked.

Mechanical measuring system

The use of mechanical measuring equipment is an easy and effective way to check a vehicle frame and chassis assembly quickly, exactly and reliably.

In many cases an assessment of the damage can be made with the help of this system, without the need for elaborate setting up.

DESCRIPTION AND OPERATION



E59888

Because of its self-centering mount, measurement can be carried out by one person.

Further advantages:

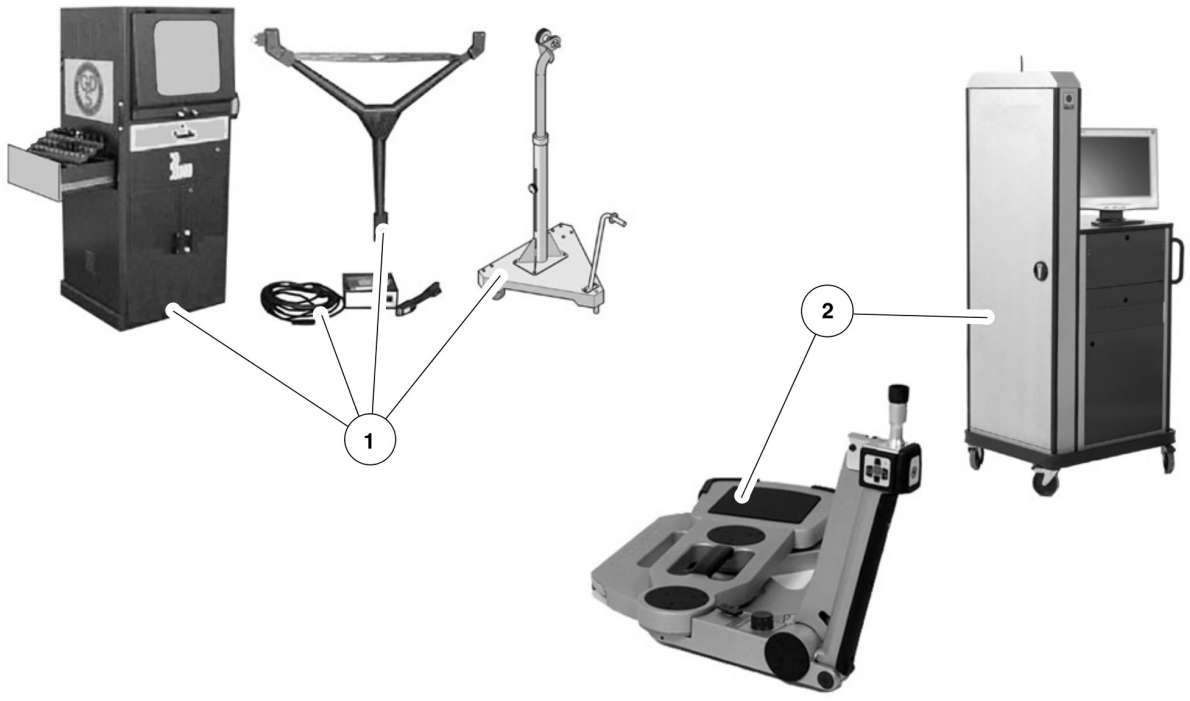
- Fast deployment.
- Simple to use.
- Can be extended using adapters, measuring probes and measuring tubes.

Measuring systems which are firmly mounted on an aligning platform require more work in setting them up. They are used to constantly check measurements during alignment work.

This type of mechanical measuring system has measuring scales and measuring slides in three measuring axes. So that the body can be measured, the vehicle is secured on the aligning platform base frame using four universal chassis clamps. The exact fixing points are given in each respective data sheet.

Acoustic-electronic measuring systems

These measuring systems can be combined with all current aligning platforms. In addition these measuring systems can be used independently of an aligning platform by using a vehicle lift or suitable support stands.



E59221

Item	Description
1	Ultrasound measuring instrument
2	Mechanical-electronic measuring system

Acoustic measuring systems use ultrasonic emitters and sensors to survey a body.

To do this, ultrasonic emitters are mounted on the vehicle using special attachments. During the measuring process the ultrasonic emitters constantly send out signals which are received by sensors (microphones) and then passed to a computer. The measurements are displayed on

DESCRIPTION AND OPERATION

the computer screen and are compared with the required values supplied by the vehicle manufacturer.

Mechanical-electronic measuring system

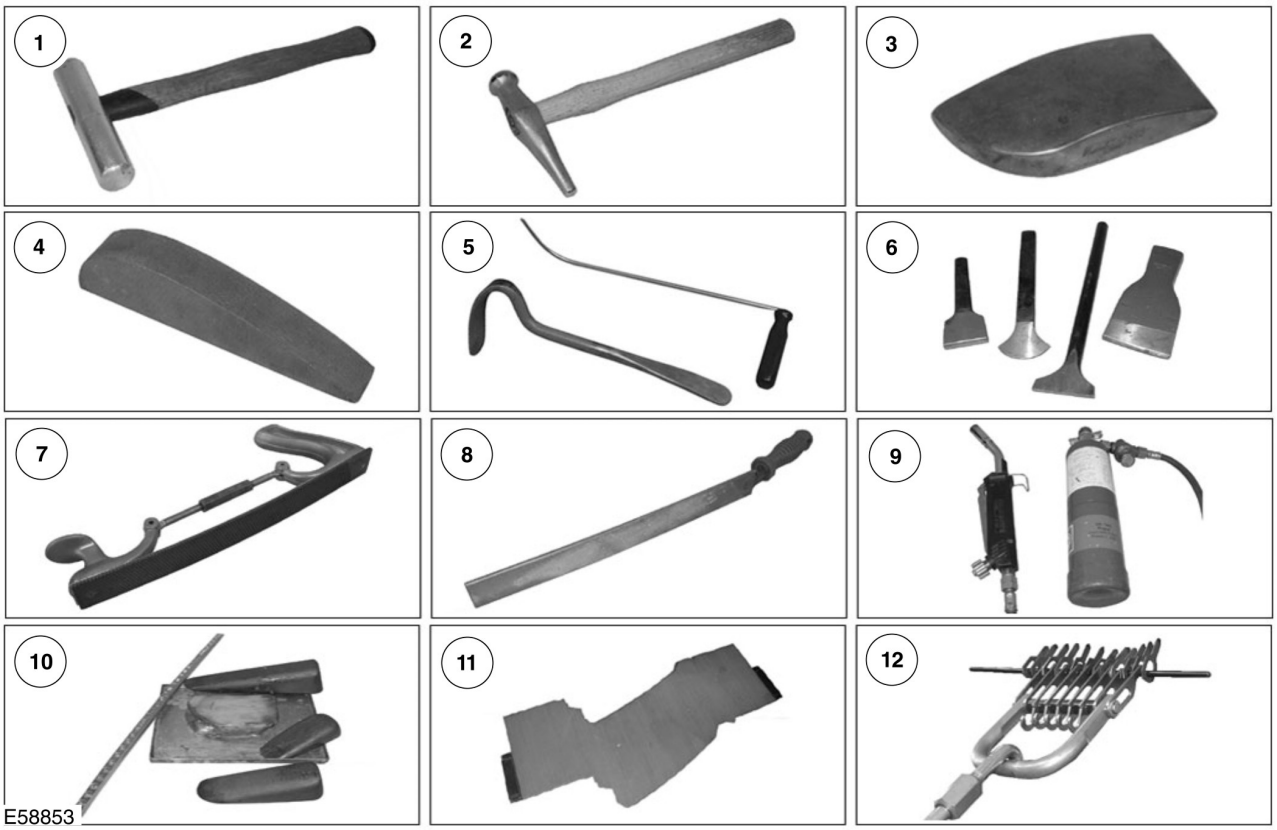
The ways in which mechanical-electronic measuring systems can be used are similar to those of the acoustic measuring systems. They can also be set up on a suitable understructure, without an alignment jig.

After this system has been arranged under the vehicle floor and adjusted to three undamaged vehicle measuring points, the measuring arm is brought up to the required measuring points and the readings compared with the reference values.

The data is transmitted to a computer where it is evaluated and the results displayed on a screen.

Panel beating tools

Depending on the type and extent of the damage to the vehicle body, very different tools may be needed to repair it. The most usual tools and the way they are used are described below.



Item	Description
1	Aluminum hammer
2	Tapered hammer
3	Universal hand dolly
4	Box file
5	Pulling lever and spoon
6	Caulkers
7	Body plane
8	Body file

Item	Description
9	Gas torch
10	Soft soldering equipment
11	Shape gauge
12	External dent remover/puller

Aluminum hammer

The aluminum hammer is the most important and most commonly used tool during body panel repair. The most usual areas of application are:

DESCRIPTION AND OPERATION

- Straightening of a dent from the inside without a counterhold (hollow leveling).
- Working a panel from outside with or without a counterhold.

Tapered hammer

The tapered hammer is chiefly used to rectify small high-spots.

Universal hand dolly

Because of its versatile shape, the universal hand dolly can be used as a counterhold in almost all areas of the vehicle body.

It is particularly suitable for use as a counterhold when rectifying material excess.

Because of its weight, the universal hand dolly can also be used as a hammer to straighten a dent from inside without counterhold (hollow leveling).

Box file

The box file is mainly used as counterhold in fine straightening work with the aluminum hammer. It is available in various shapes and sizes.

The corrugated surface (file-cut) prevents the panel from stretching during fine straightening work (barb effect).

Using the file-cut imprint on the panel surface, the effect and extent of the blows from the panel beating hammer can be judged.

Pulling lever and spoon

If access to the rear of the damage with the panel beating hammer is not possible, a panel beating lever can be employed.

Once the worst of the damage is rectified, work continues with the spoon. This also allows short striking movements to be made in inaccessible areas.

A spoon is often used as a counterhold in work with the panel beating hammer.

Caulkers

A caulker is mostly used in edge areas. In this case the caulker is inserted on the inside of the damaged area.

Selected blows on the shaft of the tool allow the damaged edge area to be reworked.

Caulkers can however also be used for straightening small areas which can only be reached from the back through small openings.

Body plane

The body plane consists of the two-faced plane blade and the solid plane body, which prevents pressure deformation of the plane blade.

The body plane is available in half-round and flat versions. The main application areas are:

- Recognition of surface high spots by creation of a so-called plane image.
- Removal of excess solder after its application to uneven areas.

Body file

The body file is used solely during heat treatment working of dents.

Because of the solid body of the file, it can absorb much heat. It stabilizes repair areas which are being straightened by warming. It does this by rapid removal of heat from the repair area, which has the effect of stabilizing the body panel.

Body files are graded by the size of their teeth (file-cut):

- The zero-cut file grade is used in the first working operation to remove the paint layer.
- The finer 1st and 2nd cut grades are used in the second working operation to remove as little material as possible from the panel.

Gas torch

The main area of use of the gas torch is heat working of small and mild dents. It is also suitable for soft soldering work on body panels.

The ready-to-use gas torch consists of the following parts:

- Gas canister with fixing.
- Burner with self-light facility.
- Small and large burner heads.

Compare with oxy-acetylene equipment, the gas burner has the advantage of easier handling due to its lower weight and shorter set-up times because of the quick-change burner heads.

Soft soldering equipment

Despite good panel beating technique, it is not always possible to rectify all unevenness. For that reason, application of filling solder is an important part of surface treatment. Similarly the surface of weld seams created during partial repairs can be optimized.

DESCRIPTION AND OPERATION

NOTE: New wooden paddles must be soaked in clean engine oil before use, so that the filling solder does not attach to the wooden block.

A complete soft soldering kit consists of tinning paste, soft solder and brush. In addition, a set of wooden paddles with a variety of shapes and a lint free cloth rag are needed.

NOTE: Since 07/2003, no lead compounds are permitted to be used in production. In the workshop suitable lead-free solder must also be used.

Shape gauge

The shape gauge is used to check the contours of the area to be reshaped, when there is no other way of recognizing and checking the basic shape.

There are various designs of shape gauge. The short design made of steel is used for smaller repair areas. Because its segments are very thin, it allows a very exact fit at a contour. The longer design made of plastic is applied to larger areas. Because of its wider segments, it is better suited to large surface contours.

External dent remover/puller

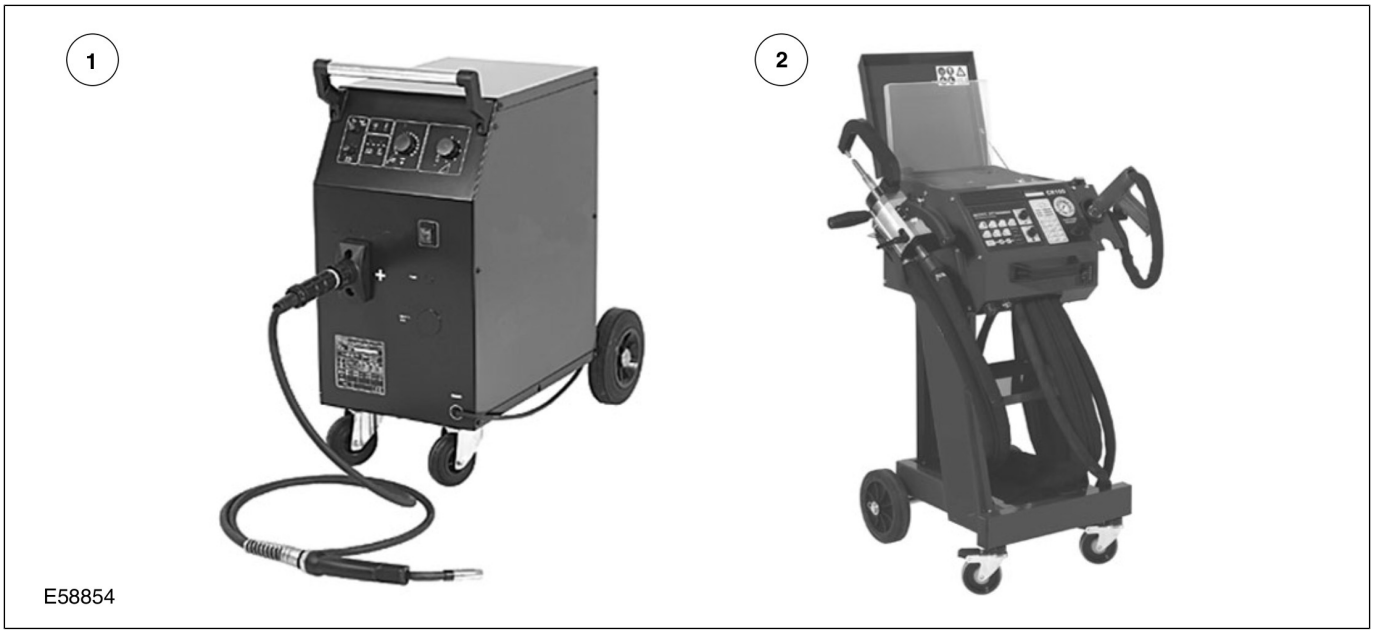
Because of their multi-purpose nature, external dent removers and pullers are very useful in achieving an economical repair to a vehicle body outer skin. These repair methods are used on vehicle body components which are inaccessible from the inside. Small dents such as those caused during parking and larger areas of damage such as on the side panel, rocker panel etc. can be rectified.

Basically there are three different methods:

- Straightening using a slide hammer attached to U-washers, pull bits or corrugated wire.
- Straightening using the slide hammer attached to a pull electrode.
- Straightening using a pulling assembly and fulcrum.

Welding gear

As in the past, the dominant process in body construction is resistance welding, in particular spot welding. Depending on body type, up to 5000 spot welds are applied, either by welding robots or in the multi-point welding machine.



Item	Description
1	MIG welding machine
2	Resistance spot welding machine

During repairs the resistance spot welds used in production must be re-created accordingly.

NOTE: If a suitably powerful welding machine is not available and multi-layer panel joints with a total thickness of over 3 mm need to be made, puddle welding must be used.

Although in principle high-strength panels are adequately- or well-suited to resistance spot welding, problems may arise, especially where

DESCRIPTION AND OPERATION

large panel thicknesses or three layers of panel need to be welded together in the workshop, but these problems can be overcome.

In particular, older welding equipment does not have the latest welding technology nor welding power and therefore cannot reliably join panel thicknesses greater than 3 mm.

Modern equipment with inverter technology allows better spot weld quality because of a constant high welding current. In addition the high welding current makes shorter welding times possible and the electrodes therefore have a longer working life.

In the case of resistance spot welded connections, faults in the weld are difficult to see from the outside. It is therefore absolutely vital to know the particular properties of the welding machine being used. A test weld with subsequent peeling test will provide information on the quality of the weld. The spot weld itself must not separate, it must tear away leaving a hole.

In the production of vehicle bodies, MIG welding plays a minor role as a joining technique. It is used for components subject to high demands, such as threaded plates for axle mountings, or at locations which cannot be spot welded for access reasons.

Separating tools

NOTE: Without exception, before starting work you must read the safety and warning instructions in the chapter "Safety Instructions". In addition, pay attention to the warning instructions of the particular equipment manufacturer.

A variety of tools are available to the body specialist for the separation of body components. The use of the different tools depends on the joining technique involved and the access available to the repair location.

Spot weld milling tool

The spot weld milling tool is suitable for releasing spot welded connections.



E58790

In contrast to a normal drill, the milling depth can be set. This prevents the underlying panel from being damaged. In addition a safety fixing system prevents the milling cutter from slipping while working.

Rod sander

Spot welds which are not accessible to the spot weld milling tool can be ground out using the rod sander.

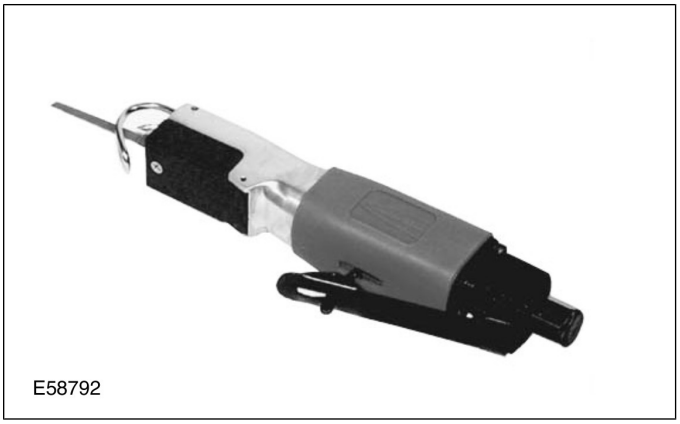


E58791

It is also suitable for releasing MIG spot welds and MIG seam welds.

Short stroke saw

The short stroke saw is most often used to separate vehicle body components.



E58792

DESCRIPTION AND OPERATION

It is also very flexible in its ability to access hard-to-reach areas.

Orbital saw

Among other things the orbital saw is suitable for the creation of narrow and straight cuts.



E58793

In addition the cut can be made to an exact depth limit. This prevents damage to underlying components.

After any work with swarf producing machines, all swarf must always be removed from cavities, otherwise there is the danger of corrosion.

DESCRIPTION AND OPERATION

Establish Repair Method

General

Before starting an accident repair, a sequence plan must be compiled, containing an outline of the individual job steps.

Similarly, the availability and preparation of all the necessary materials, spare parts, tools, workshop equipment such as alignment and measuring systems must also be checked.

Planning

NOTE: The body interconnection is to be maintained if possible. Repair is preferred to renewal of body components. Furthermore, check if it is possible to perform a partial repair.

During planning the following job steps must be observed and adhered to:

- Determine the direction of the main impact and the extent of the damage.
- Establish the repair method.
- Work out which repair components will be needed and obtain them.
- Establish what disassembly work is needed.
- Check for specific features such as airbags, route of water drain hoses, electric cables and the location of NVH elements.
- Cut out the old parts (only when the new parts are waiting ready).
- Install the new parts.
- Apply solder/seal the repair location.
- Recreate the corrosion protection.
- Constantly check all the job steps.

After the scope of the work has been determined, before making the repair, check all own technical prerequisites:

- All tools required must be to hand.
- The same applies to materials, replacement parts, sealants and adhesives.
- You must have the knowledge needed to use all the necessary technology.
- Look for additional information in eTIS.

Chronological sequence of repair

The actual sequence of repair can be divided into the following steps:

NOTE: Refer to each vehicle specific chapter in the workshop literature for details on the individual points.

Job steps:

- Establish separating cuts and mark them.
  - Take into account the requirements given in the repair instructions.
  - Place the new part ready for use and include it in the repair plan.
  - Decide on the joining method.
- Separate and remove the old part.
  - Take into account the special features particular to the vehicle.
- Prepare the joint locations.
  - Sand and align the weld flanges.
  - Offer up the new part.
  - Apply corrosion protection measures.
- Weld the new part into place.
- Perform sealing and corrosion protection measures.
- Create an outer surface ready for painting.
- Insert cavity protection.
- Perform a quality control check.

DESCRIPTION AND OPERATION

Alignment Check

General

If there is concern that the body has been deformed, the body must be measured. Several measuring procedures and tools can be used for this purpose.

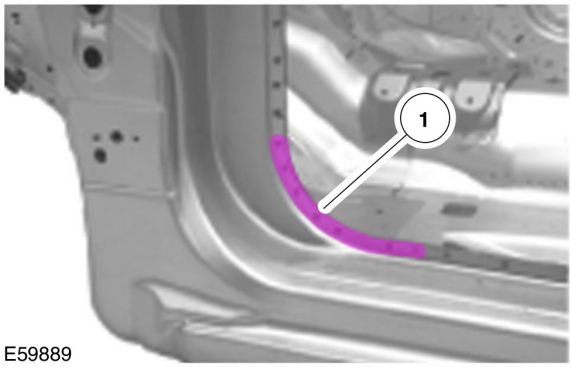
With simple measuring systems, it is possible in most cases to draw a conclusion about the extent of the damage through a quick measurement without time-consuming assembly work (straightening jig).

NOTE: For the floor pan and the exterior of the vehicle, measuring data is contained in the vehicle-specific repair instructions for each vehicle. Manufacturers of measuring and straightening jigs create corresponding measurement sheets for each vehicle.

Data sheets with the body frame dimensions for body measurement are specified in the model-specific repair instructions in each case.

All dimensions were measured with the aggregates removed, starting from the center of the hole, using an electronic measuring system and are specified in mm.

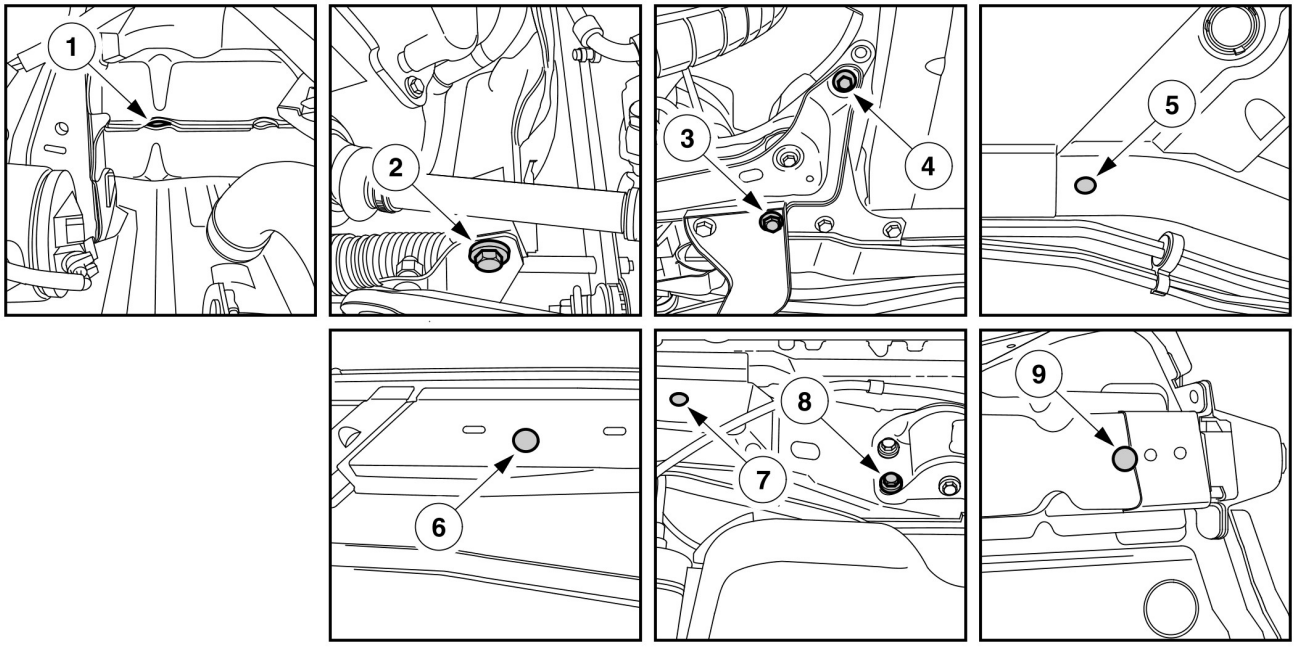
A tolerance of ± 3 mm applies to all specified dimensions. All detailed illustrations correspond to the left-hand side of the vehicle.

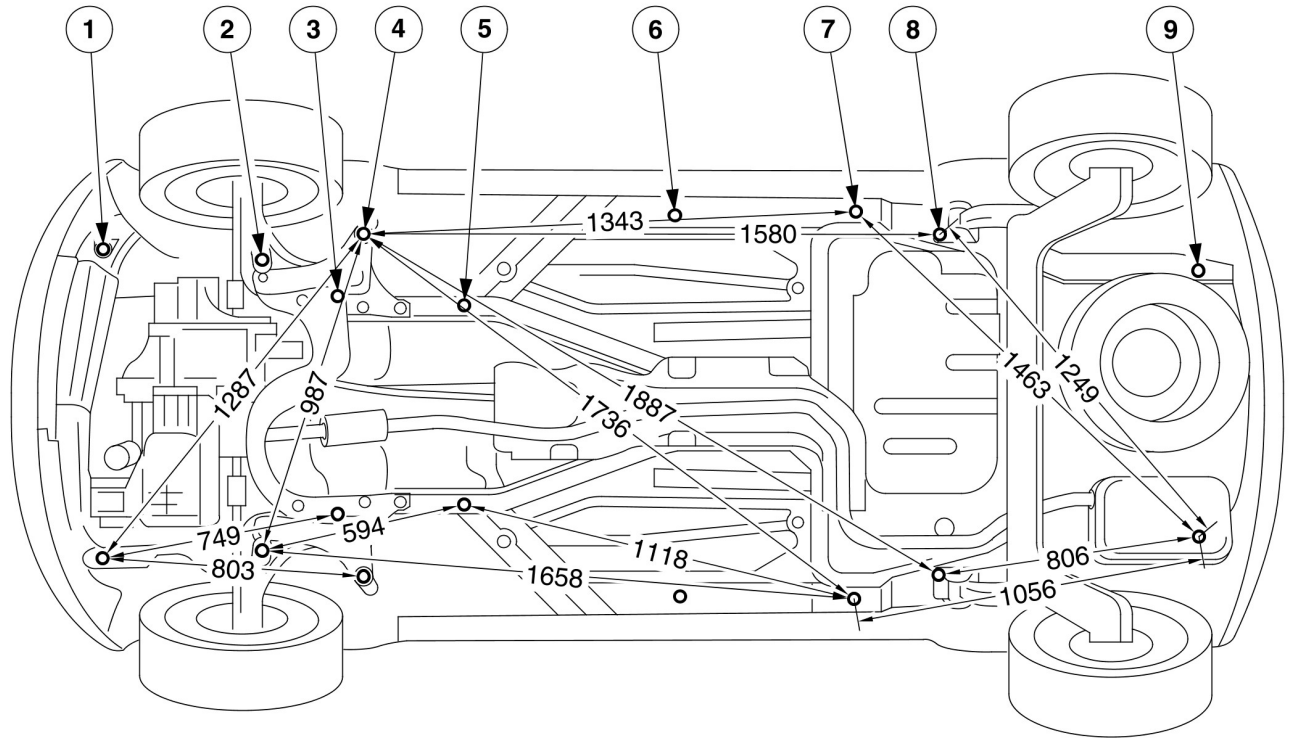


Measuring points that are specified in a curve are to be measured so that the greatest distance from the opposite measuring point is reflected.

DESCRIPTION AND OPERATION

Measuring data example





E49444

For exact determination of the measuring points, enlarged sections are shown.

DESCRIPTION AND OPERATION

Straightening

General

Straightening repairs are often required to restore the original body shape.

NOTE: Basic and advanced training courses are offered for the following contents. For an overview of all training courses offered, please refer to the Ford Service Organisation training course brochure.

For damaged bodies, straightening is to be considered as the process of pulling out the deformed body parts up to cutting out the parts that need replacing. As soon as straightening work is carried out on body parts, this is referred to as repair work.

Straightening with pulling equipment

In order to restore the damaged body to its original shape, the deformed part must remain on the body during the straightening repairs.

NOTE: Check dimensions and gaps continuously during straightening.

While the deformed parts remain on the body, the pulling equipment can be attached anywhere. Only in this way can damaged parts of the body which have to be straightened be pulled into the original position without problems.

Straightening sequence

Body straightening requires practice and experience. Before starting, the exact direction of impact must be determined.

The straightening force must have the exact opposite direction of the impact force. Only in this way can it be guaranteed that the original shape will be achieved again.

The pulling forces only work with their full impact if the pulling direction is direct. Using the wrong pulling direction could lead to additional deformation, which is difficult to correct afterwards.

Please note the following points:

- Secure the pulling unit with a safety cable.
- Do not remove bonded glass prior to straightening.
- Never apply heat during straightening.
- If necessary, open doors or hoods/lids/liftgates during straightening.
- Check dimensions and gaps continuously during straightening.
- High-strength steel panels have a stronger tendency to retain their deformed shape.
- During the straightening repairs, monitor the attachment of the pulling unit to the vehicle.
- Carry out the straightening work in several stages, never in one pulling process. This prevents the risk of overstretching and of joints tearing out.

During individual straightening steps (under a pulling load), relieve tension by striking the deformed areas with an aluminum hammer while they are still under tension.

Off-road vehicles

Straightening repairs on off-road vehicles are different to repairs on normal bodies due to the two-part construction of the vehicle.

This means there are two areas that must be taken into consideration separately:

- Straightening the body.
- Straightening the body with chassis frame.

Straightening the body

If only the body is damaged in an accident, light straightening repairs can be carried out.

NOTE: With strong straightening forces, these bolted connections may be damaged. Monitor the bolted connections continuously during the straightening work.

If a straightening jig is used for straightening work, the holding clamps or alignment angles must be attached directly to the chassis frame. During the straightening work, the pulling forces must not become too high. The bolted connections are to be monitored continuously.

Straightening the body and chassis frame

NOTE: High-strength steels must not be heated.

DESCRIPTION AND OPERATION

If the body and chassis frame have to be straightened, they must first be separated from each other.

The following conditions must be met:

- The repair must be economically justified.
- The quality and stability of a frame after production must be restored after carrying out the repair.
- In principle, the driving and operating safety of the vehicle is paramount.
- Cold straightening of deformed areas with sharp edged folds cannot be carried out.
- Straightening with the application of heat (welding torch) requires much experience and accurate knowledge of the behavior of steel panels when heated.
- The temperature and duration of application of the heat are to be considered in particular.
- Individual components of the frame, such as cross members, brackets, etc. can be replaced.

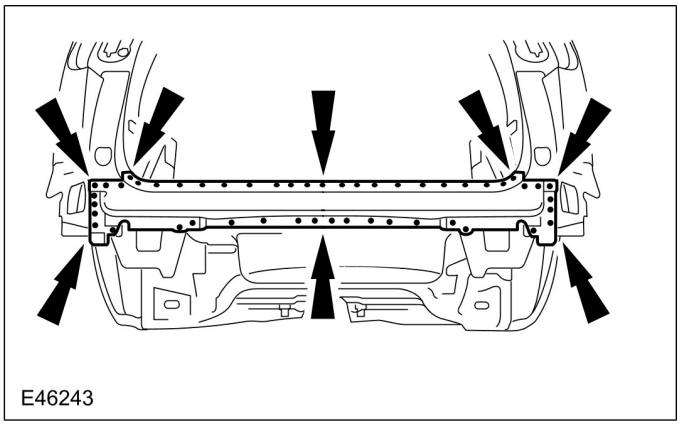
DESCRIPTION AND OPERATION

Complete Panel Replacement/Partial Replacement

Repairs always mean intervention in the body shell structure and thus also intervention in the vehicle's passive security system. The use of complete replacement or sectional replacement as the best solution must always be weighed up before starting a repair.

Complete replacement

In a complete replacement, the original connections are largely reused.



A complete replacement is advantageous if the damaged body part can be detached from its original connections and a completely new part can be fitted without creating additional joints (e.g. liftgate).

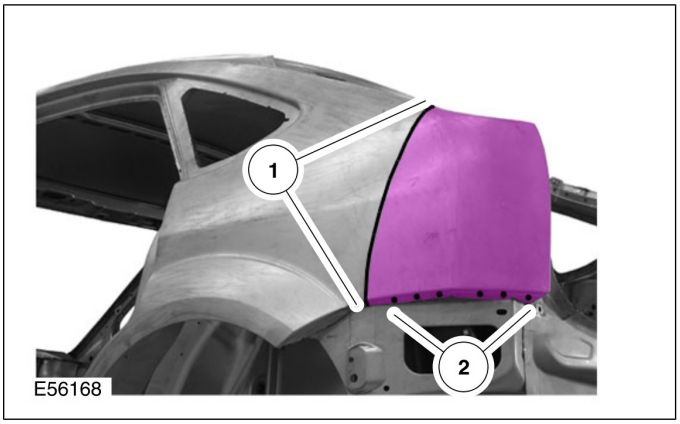
A complete replacement is necessary if there is no sectional replacement solution.

Sectional replacement

Sectional replacement (sectional repair) means the replacement of a section of the body shell structure.

NOTE: Basic and advanced training is offered for the following contents. For an overview of all training courses offered, please refer to the Ford Service Organisation's training course brochure.

Sectional repairs fulfill their purpose above all if the replacement of a complete part is too time-consuming and thus not economical.



Item	Description
1	Join area
2	Original welding

Approved sectional repairs are clearly defined in the model-specific body literature. These requirements must be complied with.

Advantages of sectional repair

Sectional repair offers many advantages for correct repair of accidental damage.

- Repairs can be made both in the outer panel area (e.g. side frame) and in the inner areas (e.g. structural member, trunk floor).
- The repair can be limited to the actual damaged area.
- Reduction of repair costs, as aggregates and other components can usually remain in the vehicle.

For the sectional repairs approved by the factory and described in the model-specific body workshop literature/technician's information, some spare parts (service parts) specially prepared for sectional repairs are offered via the spare parts sales department.

Decision-making criteria

Depending on the type and extent of the damage, the advantages of carrying out sectional replacement in the area concerned must be weighed up against complete replacement.

The following are always crucial for the decision:

- How economical the repair is.
- Retention of the original join.

DESCRIPTION AND OPERATION

In addition, Ford must have given its approval for a sectional replacement solution in the damaged area.

Depending on the damaged areas, further facts are to be taken into account when deciding for or against sectional repair:

- Severance cuts should be as short as possible.
- The effort for follow-on work on the connections must not be too great.
- It must be possible to reproduce the optical path of visible edges on door openings.
- Inner reinforcement panels must not restrict the straightening repair.
- Inner reinforcement profiles in the pillar areas must allow for separation.
- The Ford regulations on sectional repairs on supporting frame sections must be taken into account.
- The large surface welding seams at the connections must be restored.

DESCRIPTION AND OPERATION

Corrosion Prevention

The corrosion protection provided in production must be carefully maintained and reproduced during body repair work, in order to ensure the long-term warranty for Ford vehicles.

NOTE: Please take the notes in the model-specific repair descriptions into account. Please also note the manufacturer's instructions when handling the different anti-corrosion agents.

Only Ford original bodywork components and Ford approved repair materials are to be used for body repairs. The Ford logo is stamped onto every Ford original spare part.

All Ford bodywork components have a cathodic primer. Moreover, most parts are zinc-plated on one or both sides. If possible, these protective layers must not be damaged.

Corrosion protection measures during repair work

All new components must be inspected for transport or storage damage. Eliminate any existing damage, such as dents and scratches. Depending on the damage, different operations are to be carried out.

Scratches in new component:

- Sand out scratches.
- Finely sand the surrounding surfaces.
- Clean thoroughly with a metal cleaning agent and wipe dry.
- Apply corrosion protection primer to bare areas.

Damaged new component:

- Beat out the dented area and sand down to bare metal.
- Apply and work polyester filler.
- Apply fine filler.
- Lightly sand the whole component.
- Clean thoroughly with a silicone remover and wipe dry.
- Apply corrosion protection primer to bare areas.

If the new component is not damaged, any grease and wax must be thoroughly removed with a silicone remover.

During repair work, body panels are often heated at very high temperatures, which results in the destruction of the corrosion protection. Reworking of the affected areas is therefore vital.

Interior surfaces of the new body components which are no longer accessible after installation must be primed.

Before welding

The joint areas are not always accessible from inside later. Therefore, prepare these areas so that no soot is produced by burning paint during welding.

NOTE: In order to ensure that the corrosion protection produced in production is not destroyed, the working area must be kept as small as possible.

In the case of butt joints with a metal insert, soot from the burning paint prevents coating of the panel with cavity wax. With this connection technique, the welding area is to be prepared more thoroughly, as it is to be assumed that more heat will be applied here.

NOTE: Do not touch cleaned, bare metal. The humidity of your hands will corrode the metal.

Procedure:

- Remove the primer in the welding area using a tress wire brush to prevent the formation of soot from the paint.
- Thoroughly clean the welding area with a metal cleaning agent and rub dry.
- Coat the welding flange with welding primer on all sides and let the welding primer dry.
- **NOTE:**During puddle welding, the direct welding area is not coated.

  Directly after welding, coat the gap between the still warm metal panel flanges with wax using a brush. Capillary attraction forces the liquid corrosion protection wax deep into the gap between the metal panel flanges.

After welding

The corrosion protection previously applied is partially damaged after the welding, so some reworking is required.

NOTE: Too much metal cleaner forces its way between the flanges and washes the corrosion protection wax out. Soak a cloth with metal cleaner and use it to clean the metal panel flanges.

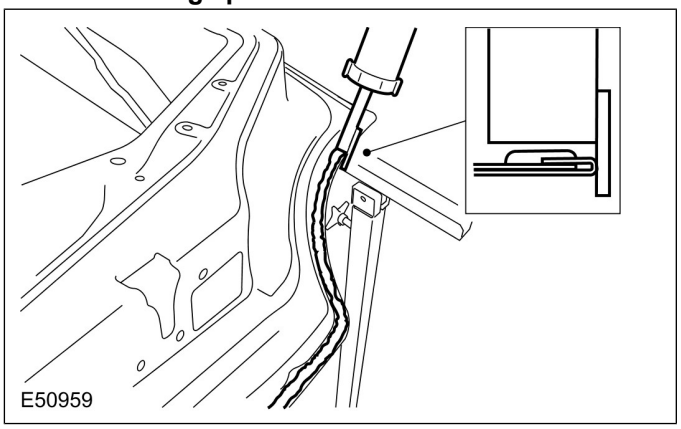
DESCRIPTION AND OPERATION

- Sand the welding seams and clean thoroughly with silicone remover. Dry with a lint-free cloth.
- In the join area, sand the transition area to the paint so that a good paint bond of the anti-corrosion primer is guaranteed.
- Carefully apply two coats of anti-rust primer to all the cleaned bare metal areas using a brush and allow to dry.

Sealing work

Depending on the vehicle, the clinched flanges on the hood, doors, tailgate and trunk lid must be sealed with clinched flange sealer.

Clinched flange protection with flat nozzle

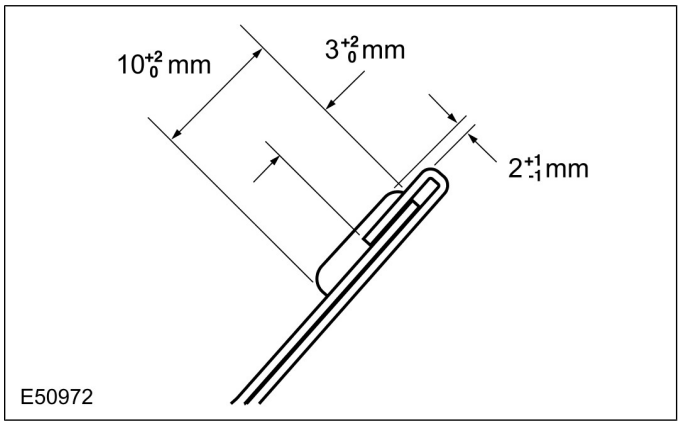


NOTE: The primer must be dry before the sealing compound or the underbody protection are applied. Do not use thinner to apply the sealing compound, as the sealing compound will not dry completely.

Likewise, the sealing compound used in production is to be renewed in the area of a repair weld. The sealing compound is to be applied so that it matches the original condition visually.

- When the primer has dried, apply clinched flange protection to the clinched flange with the aid of the flat nozzle provided.
  - The flat nozzle allows the sealant to be applied to the correct width and thickness and at the same time ensures easy guidance along the outer edge through the side guide stop. The clinched flange must be covered with an overlap of at least 3 mm.
  - Where areas cannot be reached due to the shape or position of the clinched flange, cut the guide stop off the flat nozzle to get at these areas.
  - In corners, coat the seal using a clean finger.
- Cover the metal panel flanges completely with sealing compound.

Clinched flange protection applied to the correct width and thickness.



Underbody protection

The underbody protection is used as corrosion protection and must also be applied such that it matches the original condition, from a visual perspective.

Two main application methods are used in production:

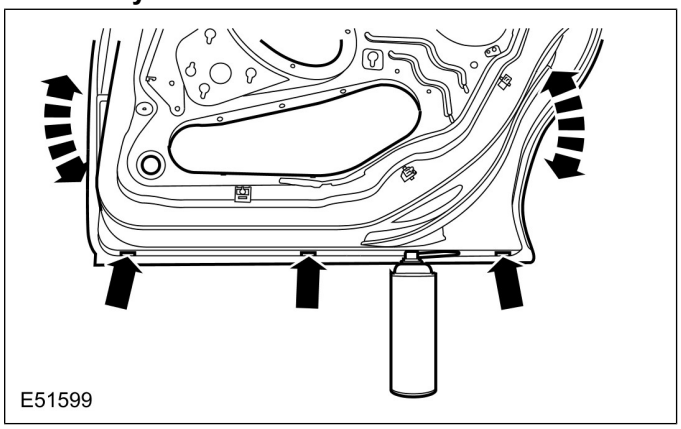
- The underbody protection is applied as a sprayable sealing compound.
- In the area around the structural members, the underbody protection is sprayed on and spread across a wide area.

Cavity protection

After painting, treat all cavities in the repair area with cavity protection. Please pay particular attention to the welded seams.

In the case of butt joints with a metal insert, the wax is to be applied so that the metal insert is also reached.

Wax entry



DESCRIPTION AND OPERATION

Seal the inner flanges with the corrosion protection wax as far as possible. To do this, ensure the doors are upright and spray the corrosion protection wax into the water discharge holes in both directions for at least 10 seconds. Then tilt and turn the component to spread the wax over the whole flange.

Noise Insulation

Noise insulation mats and cavity insulation applied during production must be applied again.

DESCRIPTION AND OPERATION

Corrosion Damage/Corrosion Repair

Modern vehicle bodies are protected from corrosion by elaborate measures. Multilayer coatings on the panel surface prevent direct contact between the metal and oxygen, and so protect it from corrosion.

NOTE: Basic and in-depth training is offered on the following topics. You will find an overview of the complete range of training in the Training Brochure issued by the Ford Service Organization.

If the protective layers become damaged, electrochemical conversion processes are initiated, which allow the metal to oxidize. This leads to the formation of corrosion.

The following factors lead to corrosion:

- Damaged protective layers.
- Damp interiors.
- Salt and dirt.
- Insufficient corrosion protection after repairs.

In order to maintain long-term corrosion protection, the vehicle must be checked at regular intervals.

In doing so, the follow areas must be inspected and any damage rectified:

- Damage to the paint surface cause by scratches or stone impact must be suitably rectified according to the specifications.
- Damage to the PVC underbody protection or the PU stone chip protection must be refinished.
- Incomplete or damaged sealing at clinched flanges must be renewed.
- Check the cavity protection and renew it if incomplete.
- Poorly installed or damaged covers and stone chip protection fixtures must always be renewed.
- Check seals and seal carriers for wear and correct mounting. Any damaged seals must be renewed.
- All rubber grommets and blanking plugs must be present and correctly installed.
- A damp or wet floor inside the vehicle indicates that there are leaks in the bodywork. The interior must be dried out and the leaks must be completely rectified.

The corrosion formation can vary in extent.

With rust film or edge rust formation, the surface of the paint has small traces of corrosion present.

The traces of corrosion can be removed in such cases by polishing the paint surfaces.

If this is not possible however, the traces of corrosion must be rectified by using a touch-up technique.

If rust is already under the paint finish to the steel panel, then the whole paint finish in the affected area must be sanded away.

Furthermore, the existing traces of corrosion in the body panel must be carefully and completely removed.

Finally a new paint finish must be applied in this area.

In the case of rusting through, the affected body panel is already completely destroyed. Such damage requires complete or at least partial replacement.

NOTE: In the general section there are several chapters which present the techniques necessary for a professional corrosion repair.

The outcome of this is the following repair sequence:

- Remove the rusted-through part.
- Remove the remaining traces of corrosion.
- Offer up the new part.
- Prepare the joint areas.
- Weld the new part into place.
- Produce the corrosion protection.

For a professional repair it is essential to reproduce the corrosion protection during and after the repair.

DESCRIPTION AND OPERATION

Sealer, Underbody Protection Material and Adhesives

Sealants, adhesives, cavity wax and underbody protection materials are used during the various body repairs. In this area Ford offers a range of products which have been tested and matched to each other.

CAUTION:Always be extremely careful when handling solvents, sealants and adhesives. Some products contain substances harmful to health or give off harmful or poisonous vapors. Always follow the manufacturer's instructions. If there is any doubt as to whether a particular solvent is suitable, it must NOT be used.

Clinched flange protection

This is a 1-component PU adhesive sealant applied through a flat nozzle. It is fast setting and is very resistant to ageing. After application it is easily sanded and stretched and it can also be painted over.

Seam sealant T Anthracite

This is a 1-component sealant material for sealing joints and seams. It is also suitable for gluing HVH elements into position in their respective body areas. It is a solvent-free, odourless adhesive which does not contain silicone or isocyanate.

Body sealant T beige

This sealant, which contains solvent and has a long service life, is particularly suitable for visible seams. It can be painted after it has set.

Underbody protection

Underbody protection is necessary for permanently elastic corrosion protection of vehicle underbodies. It is very durable and has good resistance to abrasion,

Cavity wax

This touch-proof, transparent corrosion protection wax is used for the preservation of cavities and flange joints.

Anti-corrosion wax

Anti-corrosion wax is a coating material which can be applied in fine spray, forming a very thin and grease-like protective film, therefore offering very good corrosion protection.

Metal adhesive

For joining metal to metal and plastic to metal. The adhesive reduces droning noises and improves corrosion protection.

1-component window glass adhesive kit

For direct glazing. The vehicle is ready to drive after 6 hours (passenger airbag). Prevents contact corrosion.

2-component window glass adhesive kit

For direct glazing. The vehicle is ready to drive after 1 hour (passenger airbag). The adhesive is not an electrical conductor and permits interference-free radio reception. Prevents contact corrosion. Using a 150ml additional cartridge, the adhesive can also be used for large windows or to produce a double seam of adhesive.

DESCRIPTION AND OPERATION

Cutting Technique

NOTE: Without exception, before starting work you must read the safety and warning instructions in the chapter "Safety Instructions". In addition, pay attention to the warning instructions of the particular equipment manufacturer.

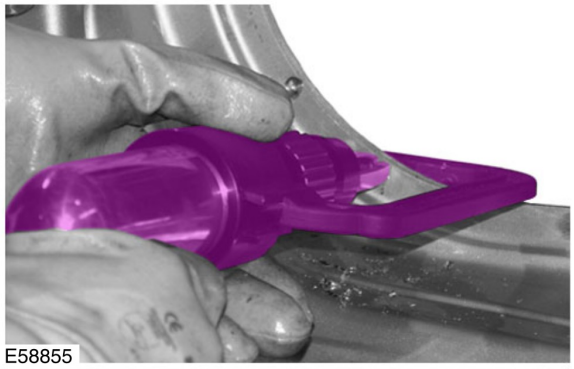
NOTE: After all separation work, make certain that the metal swarf is completely removed from the vehicle body.

Depending on the separating tools used, there are some fundamental points to bear in mind:

- Only start the cutting work once the new part is to hand.
- Compare the new part with the old part for shape and size.
- The straightening work must be completed before any body components to be replaced are cut out.
- Before separation work is started, all welded connections which cannot be seen must be freed of underbody protection, sealant etc.

Spot weld milling tool

Resistance spot welds are best separated using a spot weld drilling machine or a spot weld milling tool.


E58855

NOTE: Steplessly variable machines increase the working life of the cutting tool. Use of a suitable lubricant can increase this even further.

The spot weld milling tool is particularly useful. It usually has an adjustable depth stop and a safety fixing system. These prevent the machine from drilling too deep and the cutter from slipping while working.

When using an ordinary drill, the depth of the drilled hole must be judged by the operator. Because of this, there is the danger of injury and also the danger of drilling right though the workpiece.

Rod sander

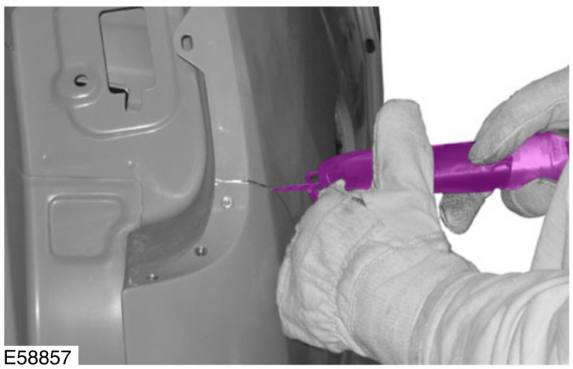
Another option for separating resistance spot welds is to use the rod sander.


E58856

For welded connections which have a large diameter, or are difficult to reach using the spot weld milling tool, the rod sander offers a useful alternative. MIG weld seams can be worked using this machine.

Short stroke saw

The short stroke saw is suitable for separating vehicle body components and for making a separating cut for partial repairs.


E58857

NOTE: In order not to damage panels, wiring harnesses, hoses or similar components which lie behind, remove them beforehand as necessary.

DESCRIPTION AND OPERATION

The narrow design of the saw blade permits cutting in tight curves. Straight cuts require a relatively great deal of practice.

Orbital saw

Where use of the short stroke saw is difficult because of the body construction, the orbital saw can be used.


E58858

The cutting depth of the orbital saw can be set. This allows separating cuts to be made, despite panels or other components lying in danger behind. Straight cut lines can be more easily made using the orbital saw.

DESCRIPTION AND OPERATION

Panel Beating Technique and Smart Repairs

General

Smaller scale body repairs, where damaged panels do not need to be replaced, can often be carried out by realignment work. Whether the repair is economical however, often depends on the accessibility of the affected body area.

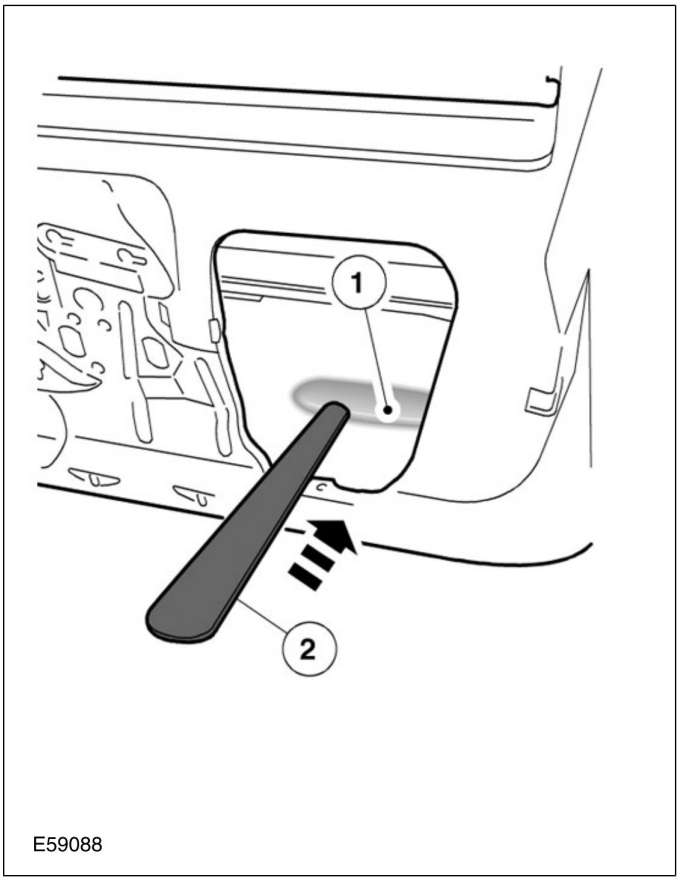
NOTE: Basic and in-depth training courses are offered on the topics which follow. An overview of the complete range of training offered is provided by the Ford Service Organization Training brochure.

During damage assessment, the following technical points must be taken into account:

- Small mild dents (without damage to the paint), which are in areas that make access from the inside possible, can be rectified using undamaged paint panel beating.
- If the inner side of the damaged area (with paint damage) can be accessed, then conventional panel beating techniques can be used.
- If the damaged area has no access from inside, then it can only be rectified using outside panel beating techniques.

Hollow leveling (removing dent without a dolly)

Hollow leveling can only be used on areas which are accessible from the rear.



E59088

Item	Description
1	Center of dent
2	Spoon

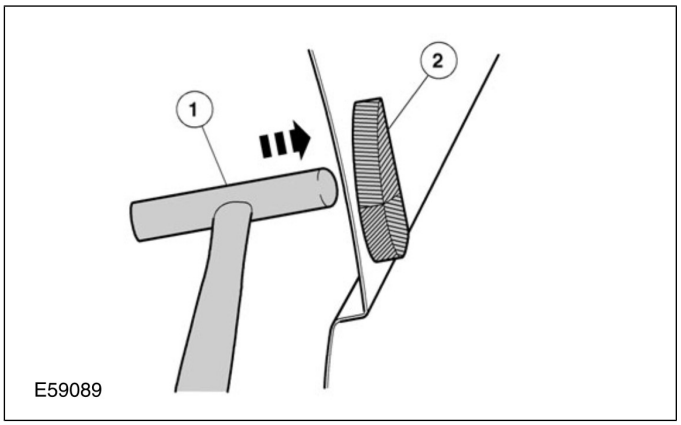
During hollow leveling, the dent is removed from the inside a using suitable panel beating tool and applying knocking or pressing movements. High spots around the edge of the dent area are flattened with blows from the aluminum or wooden headed hammer.

The usual tools are for instance hammers of various designs, dollies, levering irons and various spoon irons. The correct choice of tool is made depending on the shape of the dent and the access which is possible.

Dent removal using hammer and dolly

Panel beating can only be performed using a hammer and dolly if access can be gained from the rear side.

DESCRIPTION AND OPERATION



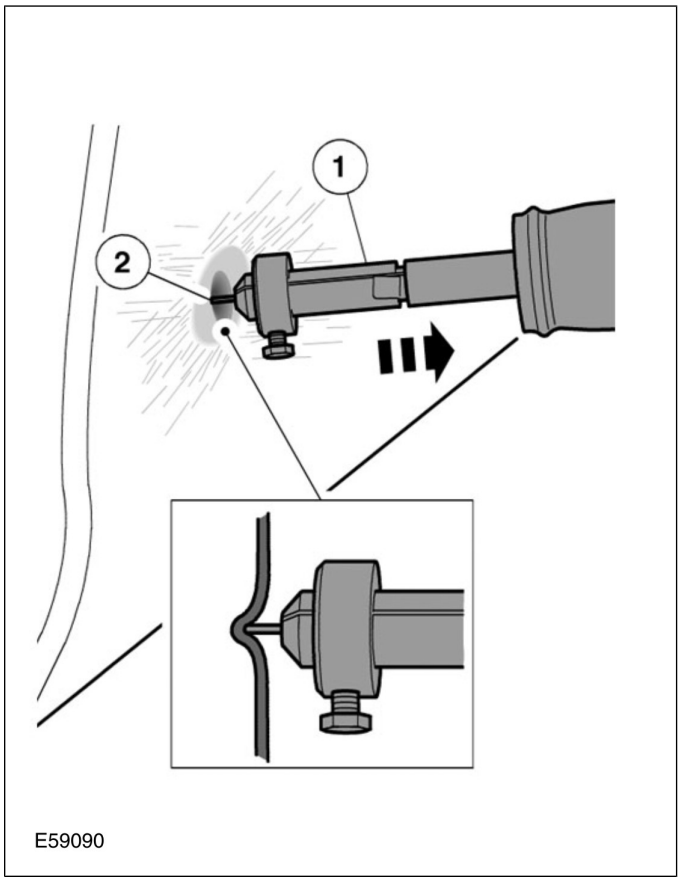
Item	Description
1	Aluminum hammer
2	Box file

The purpose of the dolly in this case is to transfer the force of the impacts from the hammer to the steel panel which is in between. As this is done, the deformed body panel is smoothed (dressed) and the tension fields in the body panel are removed.

The favored tool for this repair process is the aluminum hammer and as opposite support the universal hand dolly. To rectify minor panel damage, the box file should be used as opposite support. Because of its serrated surface, the box file prevents normal stretching of the body panel which would otherwise occur.

Dent removal from the outside using the slide hammer

The slide hammer technique is mostly used when a dent is not accessible from the rear, or a relatively large amount of disassembly would be needed to make it accessible.



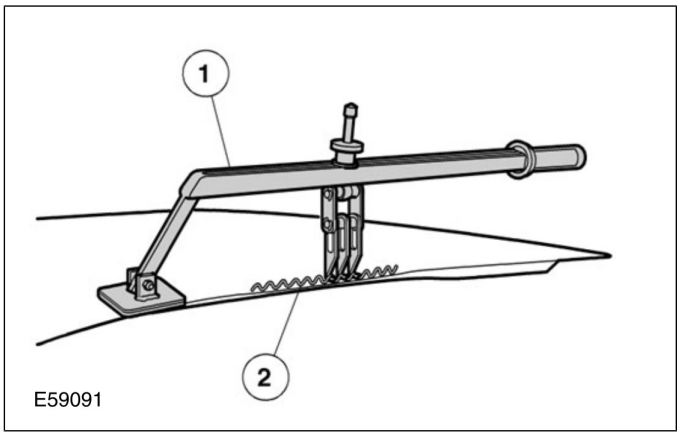
Item	Description
1	Slide hammer
2	Pulling electrode

By welding pulling rings or pulling electrodes into position using a special welding gun, dents can be removed from outside using the slide hammer.

Dynamic puller with counter bearing

The repair possibilities are much greater than with the slide hammer method. Because of the versatile puller and the variable counter bearing, a wide variety of damage can be worked and rectified using this repair method.

DESCRIPTION AND OPERATION



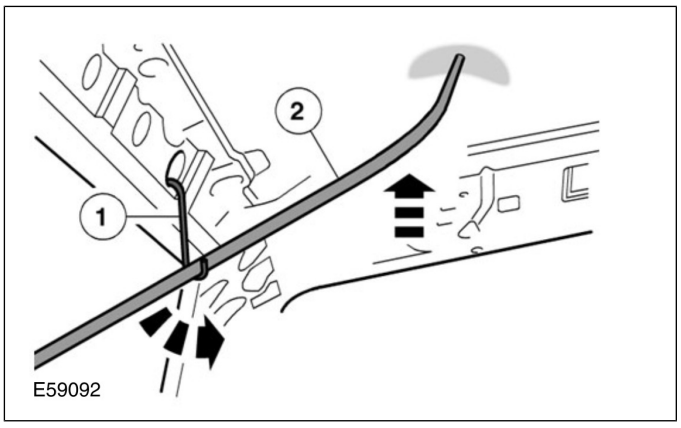
Item	Description
1	Puller with counter bearing
2	Corrugated wire as counter bearing

Because of the mechanical lever operation, the variable counter bearing and the optimum controlled application of power, this external dent removal system allows dents in almost all vehicle body areas to be pulled out.

Depending on the application area and the damage, the fixing options to the panel being worked can be corrugated wire, pulling bits or U-washers which are spot welded into position.

Dent removal using special panel beating levers

This panel beating technique with pressure is mainly used to rectify smaller dents as a result of hail impact, transportation or parking, without the paint being damaged.



Item	Description
1	Deflection by a hook arrangement
2	Pressure tool

Small dents are removed from the inside of the body panel by pushing them outwards in a mechanical process using panel beating levers.

Because of the great variety of shapes of these levers, it is possible to use this panel beating technique on almost all areas of the vehicle body.

Heat working of panels

This repair method allows small and mild dents to be rectified without additional panel beating.

During the repair process, a flame is used to selectively warm areas of the panel to relieve the stresses in the metal. This can cause the dented area to return to its correct shape.

NOTE: Before this method is used, for economy reasons you should check whether it is in fact possible to use the undamaged paint pressure techniques to rectify the problem.

This method can only be used when the dent:

- is not too large and sharp edged.
- shows no signs of the material having stretched.
- is in a surface of the body which curves outwards.
- is not in a repair area which is too structurally solid.

Heat-induced material shrinking

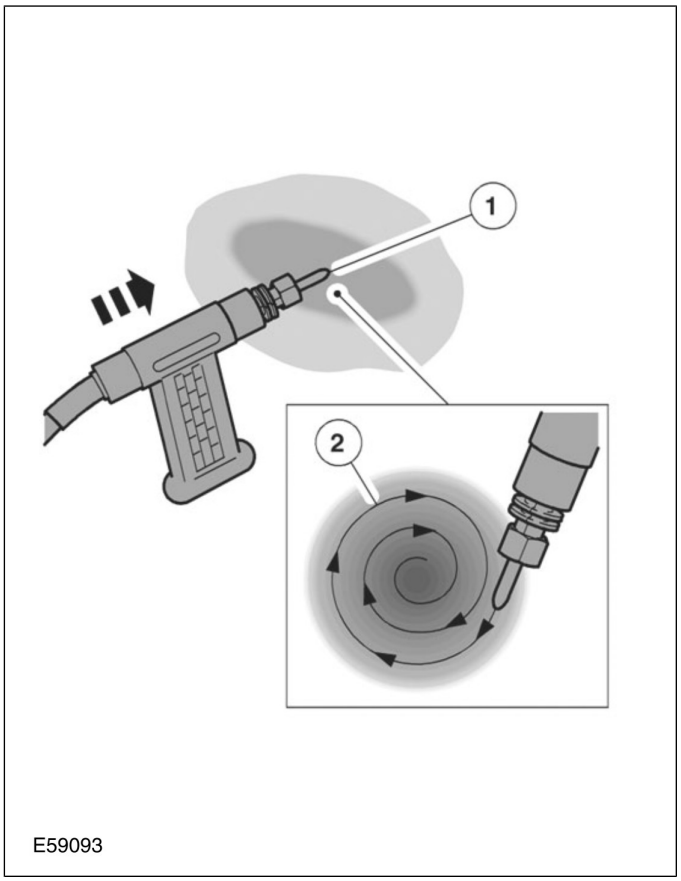
Material shrinking, also called settling in, can be performed in a variety of ways depending on the extent of the damage and the access to the repair area.

These repair processes differ depending on the type of heating and subsequent working of the heated surface. They sub-divide into two basic processes:

- Heating using a carbon electrode.
- Heating using the oxy-acetylene torch.

In the carbon electrode process the working is done exclusively by warming. In this case the access to the repair position is only from the outside.

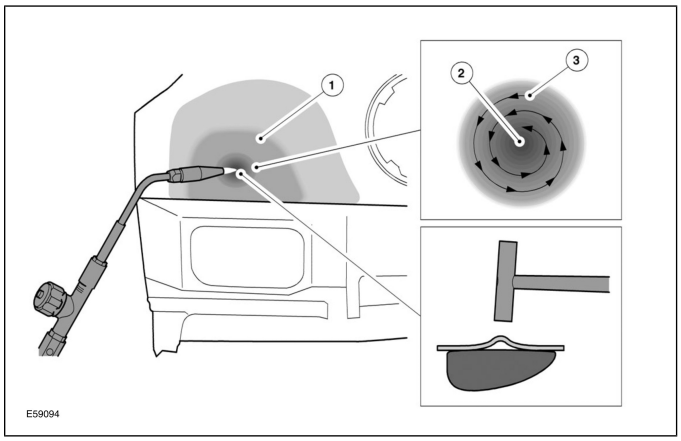
DESCRIPTION AND OPERATION



Item	Description
1	Carbon electrode
2	Spiral shaped heating pattern

If the damage is concentrated in a spot and is in the form of a more rigid raised area, then the carbon electrode must be replaced by a copper electrode. As heat is applied, slightly more pressure is applied to the raised area.

In the method using heating by the oxy-acetylene torch, material shrinking is achieved by a combination of heat and mechanical working of the damaged area.



Item	Description
1	Overstretched area
2	Point heating using the oxy-acetylene torch
3	Spiral shaped knocking back with dolly

The repair area must always be accessible from both sides, so that the heated area can be properly worked mechanically.

The combination of heating and mechanical working is very effective.

As soon as the warm point is established, hammering is immediately started using the aluminum hammer together with a suitable dolly on the inside of the repair surface, working in spiral movements towards the warm point. This causes material to build up in the center of the warmed area.

Lead loading

Despite good external panel beating techniques, it is not always possible to rectify every surface unevenness. For this reason, application of lead loading is an important part of panel beating.

NOTE: You will find additional important advice on the topic of lead loading in the joining techniques section.

For corrosion protection and adhesion reasons, on body components subject to more demands, such as doors or hoods, it is preferable to apply lead loading rather than stopper.

In addition, lead loading application is suitable for creation of surface contours when the options for panel beating are limited.

Typical application areas:

DESCRIPTION AND OPERATION

- Body components with limited or no access from the rear.
- Body components with very narrow cross-section.
- Body components which are particularly exposed or which can move.
- Weld seams of partial repairs.
- Rocker panel areas, wheel arch edges, side panel areas.
- Doors, hood, luggage compartment lid.
- Swage lines and joint areas.

DESCRIPTION AND OPERATION

Paintless Dent Removal

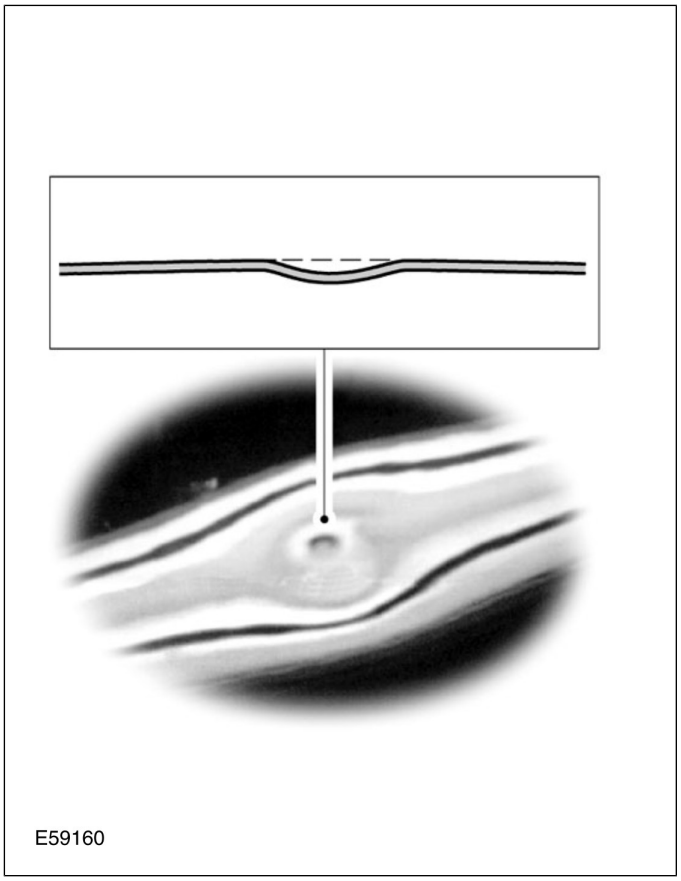
NOTE: Basic and in-depth training is offered on the following topics. You will find an overview of the complete range listed in the Training brochure published by the Ford Service Organization.

General

In the past all damage to body surfaces had to be rectified by time-consuming and cost-intensive repair work. New techniques allow small mild dents without paint damage to be corrected.

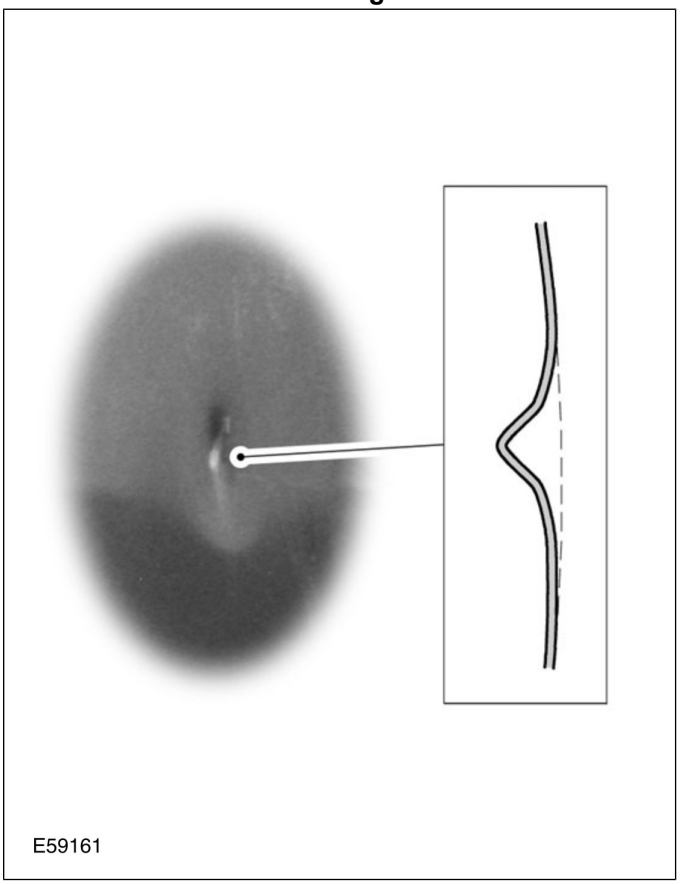
Using special levering tools (pressure tools) the dent is worked from the inside in such a way that the damaged area can be returned to its original shape.

Mild dent



If strong and direct force during the damage process causes the material to stretch in the middle of a dent, then the result is a small and sharp edged dent. Such damage cannot be rectified without visible deformation.

Dent with material stretching



Preconditions for a successful repair are a definite diagnosis and the correct allocation of repair method.

Furthermore, sufficient experience in the use of special tools and knowledge of materials are also requirements for a successful repair.

- Application is restricted to body surfaces which are accessible from both sides. This repair technique is seldom feasible on double-skinned body components or closed body profiles.
- The same applies to edge areas, swage lines and seams on body components, which are very dimensionally stable.
- Satisfactory repair results are only possible on mild dents with little depth and small deformation radii. Therefore this repair method is particularly suitable for hail, parking and transportation damage.

The following characteristics must be present for a dent to be satisfactorily removed:

- The diameter must be no more than 50 mm.
- No material stretching in the centre of the dent.
- Repair area must be accessible

DESCRIPTION AND OPERATION

The economic viability of undamaged paint dent removal must be considered in addition to whether it is possible practically. This depends on:

- Surface dimensions and depth of the dent.
- Inherent stability of the repair area.
- Material condition.
- Number of dents, in relation to a particular body surface.
- If applicable, any paint damage already present.

While carrying out the repair, the following itemized repair route and process flow must be complied with:

1. Damage diagnosis
2. Repair preparations
3. Perform repair
4. Paint finishing, corrosion protection and quality control

In order to ensure corrosion protection, all inner areas of the repair must be treated afterwards. Where it is possible, the paint is repaired. In every case the inner area of the repair must be treated with cavity wax.

DESCRIPTION AND OPERATION

Joining Techniques

Welding

Before welding work is performed on a vehicle body, all safety measures for the protection of people, modules and electrical components must be observed.

NOTE: Before beginning the work, please refer to the safety instructions and warnings in the chapter Safety Instructions. Please also note the warnings of the respective equipment manufacturer.

In body construction, the main type of welding used is resistance spot welding. In the course of repair work, this must be restored accordingly.

However, there are also fields of application for MIG welds.

MIG welding

Fields of application

- Any joins that are MIG welded in production must also be replaced by MIG welds.
- Puddle welding may be used in certain cases, if there is insufficient access.
- If the overall panel thickness is greater than 3 mm, without correspondingly powerful spot welding equipment, puddle welding should be used.
- At present, MIG brazes must still be replaced by MIG welds. See chapter MIG Brazing.

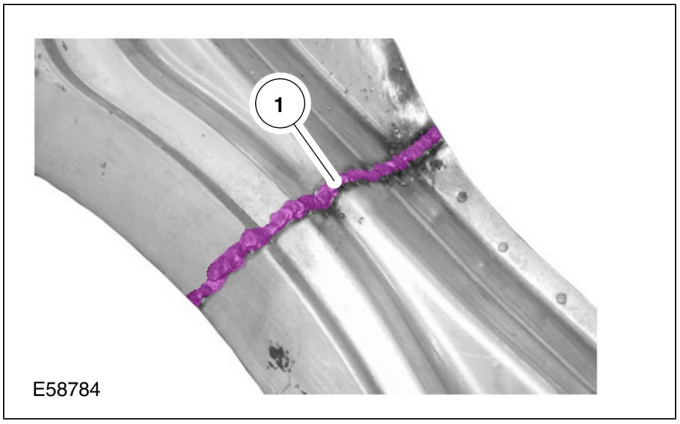
NOTE: The increased application of heat during MIG welding destroys the corrosion protection layers over a much larger area than during resistance spot welding. For this reason, greater care must be taken when applying the corrosion protection afterwards.

Welding repairs can only be carried out properly if the equipment is set up correctly and all welding-related preparations are complied with accurately.

- Please note the instructions of the respective welding equipment manufacturer.
- The hose assembly must be untwisted.
- The core must be free of abraded rod particles.
- The gas and current nozzles must be free of slag and scale residue.
- Pay attention to the quality of the welding rod and the throughput of gas.
- Ensure that the joint surface is perfect.
- Prepare a bare metal joint surface.
- Maintain the correct gaps (root formation).
- Produce a test weld.

Full seam

A welded joint with a full seam is suitable for joining highly profiled body parts. Pillar and sill areas are typical application areas.



Item	Description
1	Full seam

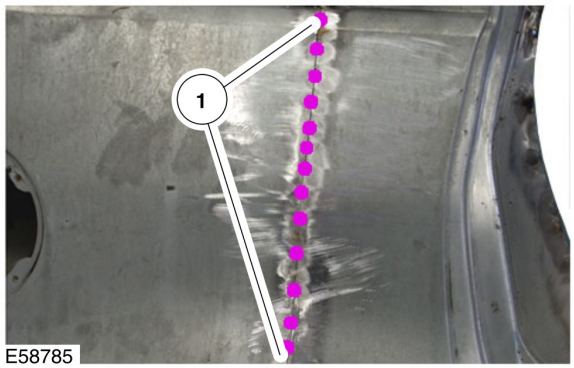
Before the welding process, you must carry out the following operations:

- Both parts of the panel must be bare on both sides over a width of 5 mm.
- Align the parts precisely with clamps.
- To prevent the panel from warping, tack longer joints before welding them.

Interrupted weld seam - intermittent seam

The intermittent seam is used for offset joint surfaces or for butt joints with a metal insert. This form of seam is mainly used on the external panel area for sectional repairs.

DESCRIPTION AND OPERATION



Item	Description
1	Intermittent seam

Please note the following welding parameters:

- Weld gap.
- Spot weld interval.
- Apply alternate tack welding across the entire length of the seam. This keeps warping to a minimum.

Puddle weld.

Puddle welding is used as a substitute if no spot welding equipment that is sufficiently powerful for the thickness of the panel is available. This welding method is also used if the welding position cannot be accessed with a spot welding gun.

NOTE:A test weld should always be carried out to ensure that the welded joint is not just a surface connection.

Please note the following welding parameters:

- The panels to be joined must lie perfectly flat to one another.
- The panel flanges must be bare at the welding position. Treat other areas with corrosion protection.
- Prepare the holes depending on the thickness and number of the panels. The hole size should be 6-10 mm, or match the original weld spot.
- Start the welding procedure on the panel at the bottom so that the hole is filled completely.

Resistance spot welding.

The basic principle for repair welds is to restore the original welded joint as far as possible.

NOTE: Before starting the work, please refer to the chapter on safety instructions.



The repair welds must have the same number of weld spots as the welds used in production with the correct diameters.

This requires that:

- The panels to be welded overlap.
- The weld spot is accessible on both sides for the electrodes.
- The shape and alignment of the weld electrodes is correct.
- The resistance welding equipment is powerful enough to reproduce the spot weld diameter used in production.

NOTE: The welding equipment settings and the adjustment of the individual parameters are to be made in accordance with the device manufacturer's specifications.

Well-prepared welding flanges are a prerequisite for a problem-free welded joint. This means:

- The welding flanges must lie perfectly flat to one another.
- The welding flanges must be clean and free of oil or grease on both sides.
- Welding primer (zinc-coated and conductive) must be applied as corrosion prevention.

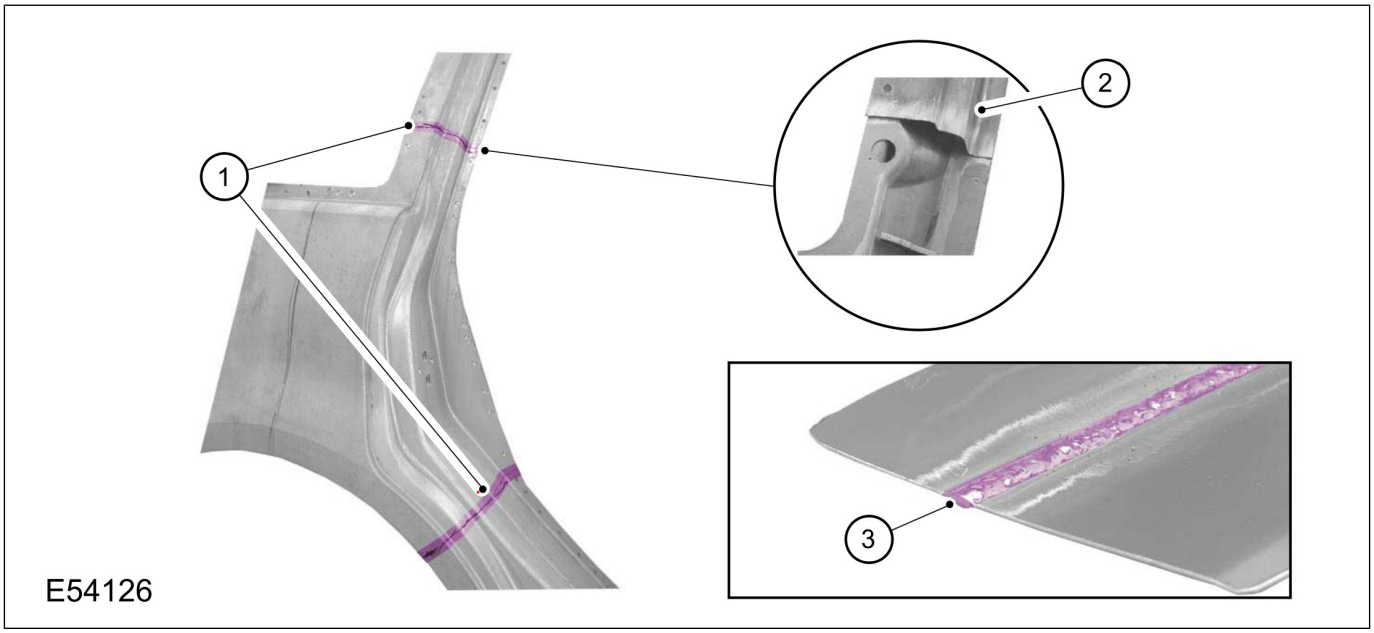
DESCRIPTION AND OPERATION

Only in limited cases can welding errors in resistance spot weld joints be detected from the outside . Therefore, a test weld should be carried out before each repair weld. The peel test carried out after the welding gives information on the quality of the welding. The spot weld must not flake off.

Joining techniques

Butt joints

The butt joint is a joining technique frequently used in body repairs. The butt joint is typically used for repairs in the pillar and rocker panel area.



Item	Description
1	Join areas
2	Profile
3	Full seam

Areas that are suitable for the use of the butt joint:

- short seam lengths.
- highly profiled structures.
- mostly thin panel thicknesses.

The edges of the panels to be joined are placed against each other and are joined with a full seam in whilst maintaining a required welding gap (welding gap same as panel thickness).

NOTE: The butt joint requires a high degree of accuracy and care when trimming and cutting. For correct execution of the welding, an exact, even welding gap must be maintained.

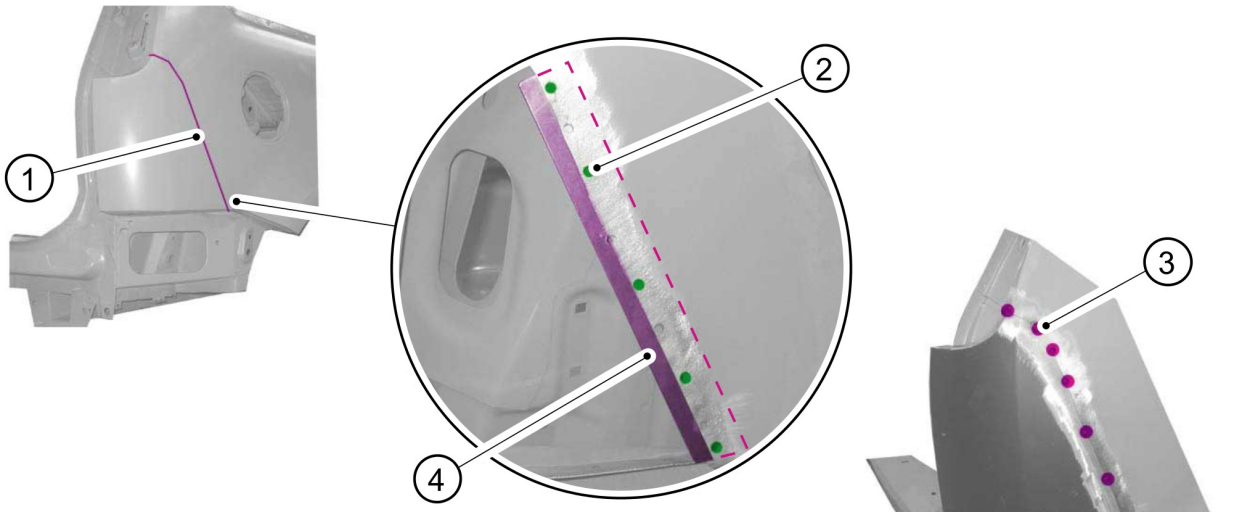
Preparation of the joint areas includes:

- Sanding the connection areas bare on both sides.
- Removal of the zinc layer in the welding area.
- Carrying out welding tests on an equivalent sample panel before the actual welding, if necessary.
- Tack welding in the join area: From the edges to the centre, then check the shape.
- Joining new and old parts with a full seam weld.

Butt joint with panel strip

As with the butt joint without a panel strip, the panels to be joined are pushed together, but are joined with an intermittent seam. A panel strip placed beneath the area to be joined stabilizes the welding area.

DESCRIPTION AND OPERATION



E54127

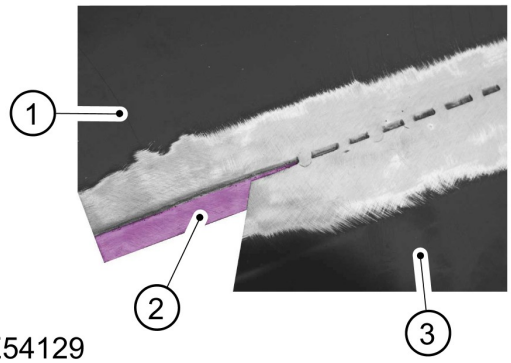
Item	Description
1	Join area
2	Tack welding
3	Spot welding
4	Panel strip

Preparation of the joint areas includes:

- Preparation of a panel strip approx. 30 mm wide.
- Grinding the joint areas and the panel strip to bare metal on both sides.
- Removal of the zinc layer in the welding area.
- Carrying out welding tests on an equivalent sample panel before the actual welding, if necessary.
- Tacking the panel strip to the old part with several resistance spot welds.
- Joining the new and old panel with an intermittent seam.
- Lead loading the weld seam.

Joggled joint

The joggled joint variant is restricted to body areas with a good surface condition without beads/swage lines or profiles. A sectional replacement with a joggled joint is welded with an intermittent seam. This procedure is used, for example, at the transition from the side panel to the rocker panel (3-door vehicles).



E54129

Item	Description
1	Body part
2	Joggled area
3	New panel

The amount of reworking required is kept to a minimum, by avoiding the use of a full seam. Other advantages are:

- Heat-induced warping caused by the welding procedure is low, as intermittent seam welding only applies a little heat.
- When cutting the new part, slight measuring tolerances are permitted, as these are covered by the joggled area.

Preparation of the joint areas includes:

- Sanding the connection areas bare on both sides.
- Removal of the zinc layer in the welding area.
- Preparation of a joggled strip.

DESCRIPTION AND OPERATION

- Carrying out welding tests on an equivalent sample panel before the actual welding, if necessary.
- Joining the new and old panel with intermittent seam welding.
- Lead loading the weld seam.

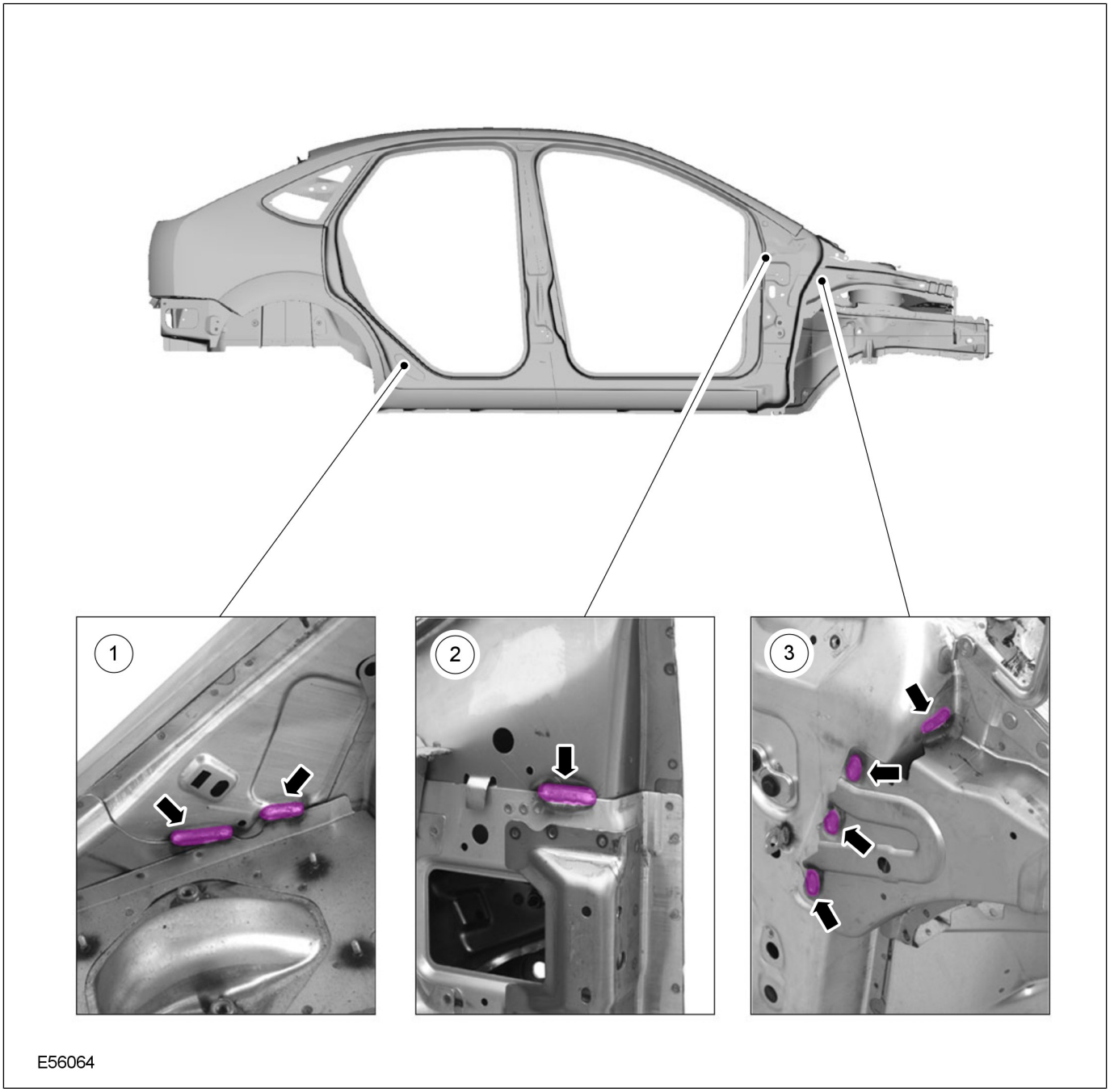
MIG brazes

Metal Inert Gas (MIG) brazing is increasingly used in production for certain body areas.

In areas in which resistance spot welding is not possible due to limited space or higher strength requirements, MIG welding was previously used.

Increasingly, these MIG welded seams are being replaced by MIG brazes.

NOTE: At the time of printing, MIG brazing has still not been approved for repair in the workshop. Please find out the current status.



DESCRIPTION AND OPERATION

Item	Description
1	Outer wheelhouse / rocker panel reinforcement (inner)
2	A-pillar reinforcement / A-pillar inner panel (inner)
3	Bulkhead reinforcement / A-pillar (outer)

MIG brazed connections are partly used in production for the following areas: Inner fender reinforcement to A-pillar, A-pillar reinforcement to A-pillar inner panel and outer wheelhouse to rocker panel reinforcement.

The temperature range used during MIG brazing is significantly lower. This keeps the damage to the anti-corrosion zinc layer on zinc-coated panels to a minimum.

This results in the following advantages of the MIG brazed seam:

- No corrosion of the brazed seam.
- Low erosion of the zinc coating in the joining area.
- Minimal destruction of the coating on the reverse side of the panel.
- Low level of heating and thus little warping.
- Easy finishing of the brazed seam.
- Good for bridging gaps.

NOTE: MIG welds must not be carried out on or near existing MIG brazed seams as even the smallest amount of brazing solder can result in a reduction in the strength of the weld seam.

Alternative repair methods are specified in the model-specific body literature.

MIG brazing requires a new generation of welding equipment and training in the technique. For this reason, MIG brazed joints must be replaced by MIG welds at another place if a repair is performed.

When carrying out these repairs, the requirements in the corresponding repair instructions must be taken into consideration.

Rivets

With riveting, two or more panels are joined together using a joining element (rivet). In body construction, pop rivets and punched rivets are used.

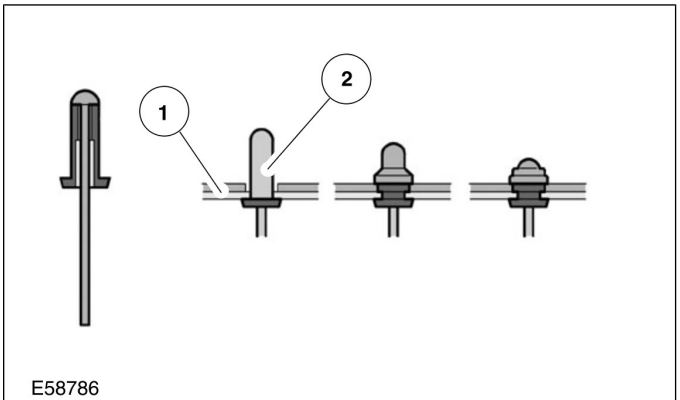
Advantages of riveted connections:

- Metallic and non-metallic materials can be joined together.
- Different thicknesses of materials can be used.
- The material does not have to be heated, and therefore does not warp.
- Low level of preparation required.

NOTE: For detailed instructions on the procedure, please refer to the equipment manufacturer's operating manual.

Disadvantage:

- During dismantling procedures, swarf/rivet remains can fall into inaccessible cavities, which can lead to rattling and rusting.



E58786

Item	Description
1	Panels
2	Pop rivet

Pop rivets are used if only one side of the panel is accessible. In this process, overlapping panels are drilled and connected with a pop rivet.

Pop rivets can be inserted pneumatically, hydraulically or manually with rivet guns.

Brazed connections

Brazing is a procedure for connecting metallic materials using a further melted metal.

The melting point of the brazing material is lower than that of the basic material. The basic material is covered with the brazing material and not melted.

As the material is heated to a lesser extent than during welding, brazing is particularly suitable for parts that are sensitive to warping, oxidization and heating. Brazing means it is possible to join together all common metals.

Brazed connections can be detached again through heating.

DESCRIPTION AND OPERATION

Brazed parts have a limited strength, low thermal resistance and a certain risk of corrosion due to the difference between the basic materials used and the brazing material (difference in potential).

NOTE: All connections that are brazed in production must also be brazed if a repair is performed.

Watertight, permanent connections must be produced at the transitions between A or C pillars and the roof. Continuous welded seams in visible areas require time-consuming finishing. For this reason, such connections are not welded, but brazed.

Brazed connections are:

- Very stable and yet elastic.
- Watertight.
- Easy in surface processing.

NOTE: Brazed connections require careful preparation. It is extremely important that the joint surfaces are exactly aligned and that a bare metal joint surface is prepared.

This means:

- Thorough cleaning of the surfaces to be brazed.
- Close contact of the panels at the brazing position.
- The connection/repair position is heated to the melting temperature of the brazing material (approx. 900° C).
- The brazing material is applied to the connection area and heated on the panel to the melting temperature.
- The liquid brazing material is drawn between the panels through capillary action.
- The materials join together at the edges of the panels (alloy formation).

Lead loading

Lead loading with tin is the best repair method for smoothing joins on sectional replacements or for rectifying small uneven areas on the panel surface. Tin has the following advantages:

- Excellent bonding on bare metal surfaces.
- Good moulding properties.
- Good properties for the production of shapes and contours.
- Permanent shape.
- Heat expansion is the same as steel.

WARNING:Brazes are metal alloys (usually lead and tin). Poisonous gases and dust can be produced during processing. Use an extraction unit and, if required, a protective mask.

NOTE: Since 07/2003, lead compounds have been ruled out for production. In the workshop too, lead-free tin solders must be used.

For correct repair, the panel is beaten out almost to the original shape and then the rest is smoothed out through lead loading. First, the panel to be lead loaded must be properly prepared.

To create a basis for the actual lead loading process, a lead loading paste is first applied to the panel. The paste is then heated and wiped away with a cloth. Now the tin can be applied and moulded with a brazing block.

After the repair site has cooled slowly, it is worked with the body plane until the surface is smooth and has no visible joints.

Bonding

Bonded connections are used more and more in modern body designs. Here, a distinction is made between bonds for stabilization purposes and bonds for adhesive strength. Bonds for stabilization purposes are found on clinched flanges and on cross beams in doors or on the roof.

WARNING:Risk of poisoning! Adhesive can be harmful to health. Ventilate rooms well and use breathing protection. Where possible, work with an extraction unit.

NOTE: Adhesives are chemical products and are subject to the safety regulations of the manufacturer.

The repair adhesive is an elastic 1K adhesive on a polyurethane basis. Bonds that rely on adhesive strength are used instead of conventional metal connections. Here, the hardening 1K epoxy resin is used.

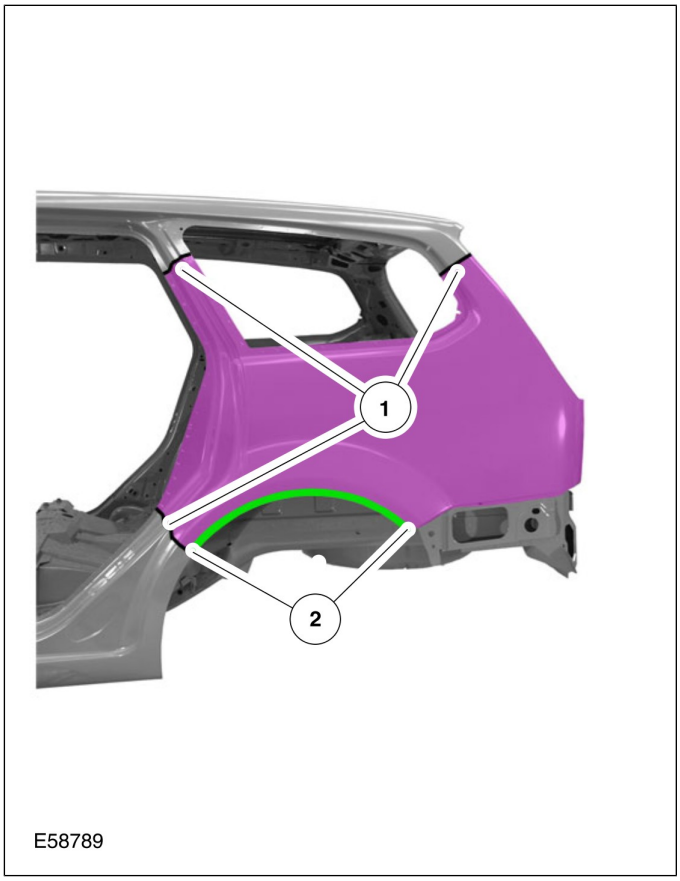
Bonded connections have the advantage over conventional connection procedures that no heating is required. This means it is not necessary to remove heat-sensitive parts, such as the fuel tank, electronic modules or plastic parts.

In addition, bonded connections have further advantages:

- They are air and watertight.
- High corrosion protection

DESCRIPTION AND OPERATION

- Different materials can be connected.
- Bonding can be combined with resistance spot welding.



E58789

Item	Description
1	Butt joints
2	Bonded connection

NOTE: The quality of the bonded connection is largely dependent on the care taken during preparatory work.

Different adhesives are used in body repairs. Please refer to the repair instructions for the specific adhesive to be used. Please also take into consideration the instructions of the adhesive manufacturer.

Body bonding requires the following steps:

- The processing temperature of the parts to be processed must comply with the adhesive manufacturer's specifications.
- The connection surfaces must be even and perfectly flat to one another.
- Sand the connection surfaces bare. Use only completely dirt and grease-free tools to do this.
- Clean the connection surfaces with the special cleaner provided by the adhesive manufacturer. Do not use thinner, petroleum ether or other cleaning agents.
- Leave the connection surfaces to dry.
- **NOTE:** Use protective gloves when applying the adhesive.

  Apply the adhesive to one or both surfaces to be bonded, according to the manufacturer's instructions, using a suitable tool.
- Join the parts as precisely as possible immediately after applying the adhesive so that only minor corrections are necessary.
- Fix the parts in the final position with clamps.
- Depending on the adhesive, the hardening process can be accelerated using a hot air blower.
- Finally, clean the area that has been bonded of leftover adhesive.

Bonding and welding

On some vehicle models, (such as the Ford Ka), bonding is combined with resistance spot welding. This connection technique has the following advantages:

- Tight, anti-corrosion connection seam.
- High strength due to additional resistance weld spots.

Please note the following points during the repair work:

- Only use adhesive suitable for welding (conductive).
- Carry out resistance spot welding on the connection flanges before the adhesive hardening process.
- Carry out test welding with the adhesive applied.
- If MIG welding is carried out during a sectional repair on a connection flange with adhesive material, the adhesive material must be applied at a distance of approx. 10 mm from the weld spot.

Bonding and riveting

As with welding, bonding can also be combined with riveting. This connection technique has additional advantages. These are:

DESCRIPTION AND OPERATION

- Metallic and non-metallic materials can be joined together.
- Different thicknesses of materials can be used.
- The material does not have to be heated, and therefore does not warp.
- The rivet connection stabilizes the connected components during the adhesive hardening phase.

DESCRIPTION AND OPERATION

Plastic Repairs

General

The proportion of plastics used in vehicle construction continues to rise. Up to now damaged plastic components often had to be replaced. In the meantime plastic repair is becoming more and more accepted because of rising costs.

NOTE: Plastic adhesives are chemical products and are subject to the safety instructions of the manufacturer.

Because of the various compositions of plastics, repair work to plastic parts involves a variety of repair methods.

The following methods are used:

- Thermoplastic straightening.
- Plastic welding.
- Plastic adhesive bonding.
- Plastic lamination techniques.

In repair work, the material properties of plastics are highly significant. There are two main groups:

- Thermoplastics.
- Thermosets.

NOTE: Elastomers make up a third group of plastics. These are not mentioned below because they have no plastics repair applications.

Thermoplastics

Heat causes thermoplastics (also called TP polymers) to transform from the solid state into the thermoelastic state and then into the thermoplastic state. When thermoplastics are cooled, they return to solid state.

Thermosets

Thermosets (also called TS polymers) are much harder and more brittle than thermoplastics. Their strength remains largely unchanged when they are heated. Thermosets are destroyed when heated above the critical temperature. Also, the original state will no longer be restored on cooling.

Plastics used by Ford

Identifier	Description
PA	Polyamide
PC	Polycarbonate
PP	Polypropylene
PP/EPDM	Polypropylene/ethylene propylene diene copolymer
PC/PBT	Polycarbonate/polybutylene terephthalate
PBT/PC	Polybutylene terephthalate/polycarbonate
PUR	Polyurethane
GRP	Glass reinforced plastic

Plastic identification

Normally the identifier is marked on the plastic components used in vehicle construction.

NOTE: The identification of the type of plastic is necessary for the plastic welding process in order to determine the correct welding rod (welding material) to use.

If none is present, it can be determined using two different procedures/methods:

- Visual Inspection
- Mechanical Check

Visual Inspection

Visual inspections mainly serve to identify PUR and GRP materials. Thermoplastic components are often painted and are therefore difficult to identify.

Identification characteristics:

DESCRIPTION AND OPERATION

- When PUR cracks or similar damage occurs, pores of foam can be seen.
- GRP can be recognized by the glass fiber structure on the inside.

⚠ **CAUTION:Danger of poisoning! When burned, most plastics release vapors harmful to health. Ventilate the room well and use respiratory protection. Where possible work using an extraction system.**

A burning test allows the plastic to be determined more exactly. This involves burning a small piece of the plastic material and observing the behavior of the flame, the smoke characteristics and the dripping behavior.

Characteristics of plastics:

Plastic	Flame behavior	Smoke characteristic	Dripping behavior
ABS	No way to distinguish from other copolymers	Blackish	-
PA	Bluish, transparent flame with yellow edge	No smoke	Drips with blistering
PC, PC/PBT, PBT/PC	Yellow, very sooty flame with black-brown fire areas	Yellow-white plumes of smoke	-
PP, EPDM	Calm flame, similar to a candle	No smoke	Melts
PUR	Agitated flame	Intense sooty plumes	Hardly drips
GRP	Yellow-red, intense sooty flame	Whitish plumes of smoke	-

Another method to determine the plastic group is the sanding test. In this a place is chosen which will not be visible later, and the finger belt sander is used to sand the plastic.

The plastic group can be determined using the pattern of the dust:

- Thermosets produce a white dust.
- Thermoplastics smear and do not produce dust.

Mechanical Check

The plastic group can be determined by a sound test:

- Degree of hardness - the higher-pitched the sound, the harder the plastic.
- Elasticity - the more muffled the sound, the higher the elasticity of the plastic.

Safety instructions

In addition to the general safety instructions, the relevant regulations and accident prevention legislation must be observed.

NOTE: Without exception, before starting work you must read the safety and warning instructions in the chapter "Safety Instructions". In addition, pay attention to the warning instructions of the particular equipment manufacturer.

Information sheets, safety notices and guidelines for the processing of adhesives containing isocyanate, polyester resin, adhesives, solvent and thinners provide more details on their use.

The following instructions must always be followed:

- Polyester resin, adhesive, solvents and thinners are inflammable and must not be used near naked fire or flames.
- Sawing and grinding operations must only be carried out in rooms equipped with extraction systems.
- If no rooms with extraction systems are available, only use tools with extraction equipment.
- Protective equipment such as gloves, protective goggles, aprons and breathing masks are essential.

DESCRIPTION AND OPERATION

Plastic welding

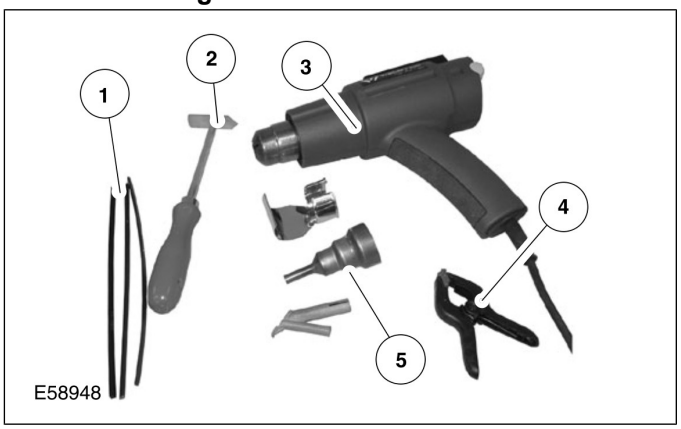
Splits formed in plastic bumpers are typical possible plastic repairs.

NOTE: Do not carry out plastic welding in the area of fixed foam backing. The foam backing will usually be destroyed and the function of the component is then no longer guaranteed.

If repair using adhesive methods is not possible because of unfavorable conditions at the rear of the repair location, plastic welding is a possible repair process.

There are two methods of welding: hot air draw welding and hot air fanning welding.

Plastic welding set



Item	Description
1	Various welding rods
2	Scraper (heart-shaped)
3	Hot air blower (approx. 1500 W)
4	Clamps
5	Welding nozzles

In addition to the components listed, plastic welding requires tools already found in the workshop such as scrapers, sanders, face cutters etc.

As with all other welding processes, only certain material combinations can be joined together using plastic welding.

NOTE: Basic and in-depth training is offered on the following topics. You will find an overview of the complete range listed in the Training brochure published by the Ford Service Organization.

Repair sequence during plastic welding:

NOTE: The manufacturer's data must be taken into account when choosing welding materials and the correct temperature setting of the hot air gun.

- To prepare the location for welding, remove paint residues and sand the weld area.
- Drill out the ends of the split to stop it spreading further. Shape the location to be welded into a V-shaped joint.
- Perform the welding. Hot air draw welding or hot air fanning welding.
- Rework the weld seam. After cooling, sand the raised weld seam.
- Clean the sanded repair surface using plastic cleaner. Apply plastic primer thinly to the repair surface and paint it.

Despite good preparation and the correct choice of welding materials, weld faults may occur. The correct choice of temperature is important for the success of the repair.

Possible causes of weld faults:

- Deformation caused by overheating of the repair area or tensions in the material while welding the component. Plastic material too thin.
- Poor weld joint because the weld temperature was too low or the welding speed was too fast. Welding different materials together.
- Weld seam dropped because the split gap was too wide or the welding temperature was too high.

Adhesive bonding of plastics

Adhesive bonding of plastics has some advantages over welding methods:

- Within the group of thermoelastic plastics, all semi-rigid ancillary components (such as bumpers, front grilles, etc.) can be repaired without identification.
- A two-component polyurethane based adhesive is used for all thermoplastic parts.
- Reinforcement strips can be attached behind splits (split length up to max. 100mm) and openings to ensure the original strength properties.

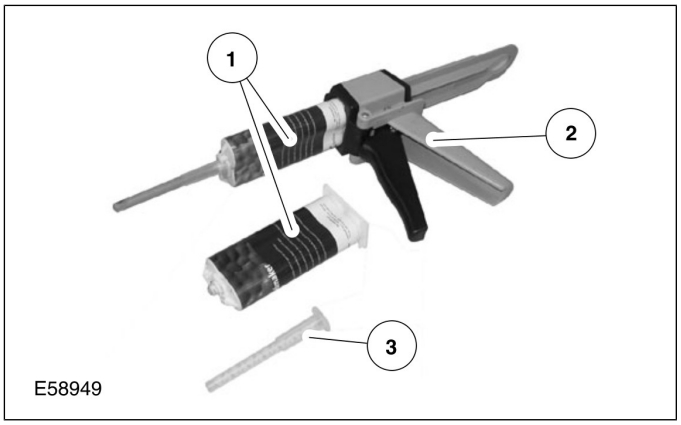
Tools and equipment also familiar from paint repairs can be used in making adhesive repairs to thermoplastic components.

Angle grinders and belt sanders can be used to grind out scratches and splits. Orbital sanders with extractors are used for fine sanding.

The infrared heater is used to provide fast and secure drying throughout.

DESCRIPTION AND OPERATION

Plastic adhesive set



Item	Description
1	2-component adhesive
2	Cartridge gun
3	Venturi tube

Apart from the components shown, other materials may be needed to bond plastics, depending on the repair position.

For large scale repairs, it may be necessary to insert reinforcement panel strips and reinforcement matting as fixing aids.

Repair sequence during plastic adhesive bonding:

NOTE: Follow the manufacturer's guidelines when using adhesives.

- Prepare the location of the bond. Remove paint residues and sand the area to be bonded. Drill out the ends of the split to stop it spreading further. Prepare the bond location into a V-shape and clean it with plastic cleaner.
- Apply the adhesive. The two-component adhesive is applied to the cleaned and primed repair location using a hand gun. Spread and smooth the adhesive using a flexible plastic spatula.
- Rework the bond location. After cooling, sand the raised adhesive. Clean the sanded repair surface using plastic cleaner. Apply plastic primer thinly to the repair surface. Apply paint.

GRP repairs

GRP material is hard and brittle in its strength properties. Because of these material properties, splits and openings often result in cases of serious damage.

The stability of GRP parts is impaired if the glass fiber reinforcement is cracked. The component must be replaced in cases of serious damage that affect the structure.

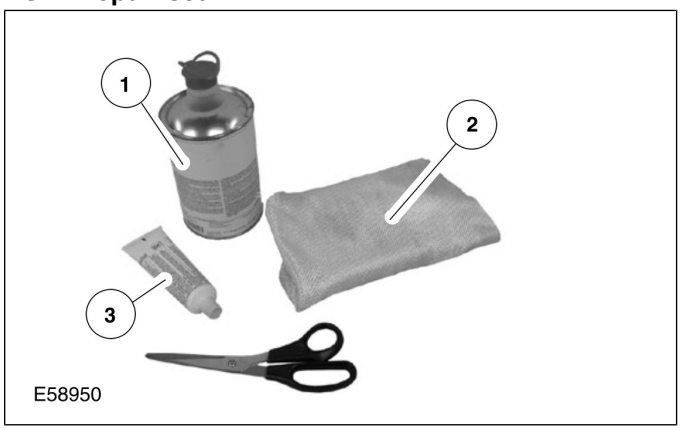
Minor damage (such as abrasion, splits up to 80mm, holes up to approx. 60mm diameter, etc.) can be repaired to a technically and visually perfect standard, provided that the damage does not occur in heavily used or hard-to-reach areas.

To ensure perfect repair results, observe the following points:

- The room temperature should be at least 15°C and the air should be as dry as possible.
- The repair location must be thoroughly dry and clean.
- Before the repair, the GRP part being repaired must be dried using an infrared heater or in a drying oven.
- In cases of large splits and fractures, the strength of the outer skin can be re-established by backing with a reinforcement material.

Tools and equipment from the paint shop can be used to carry out repairs to GRP parts. Angle grinders and belt sanders can be used to grind out scratches and splits. Orbital sanders with extractors are used for fine sanding.

GRP repair set



Item	Description
1	Polyester resin
2	Glass fiber mats
3	Hardener

Scissors, paintbrush and cleaning materials are other materials which will be needed to perform a GRP repair.

NOTE: Follow the manufacturer's instructions when using the repair materials.

The repair process for a GRP repair is as follows:

DESCRIPTION AND OPERATION

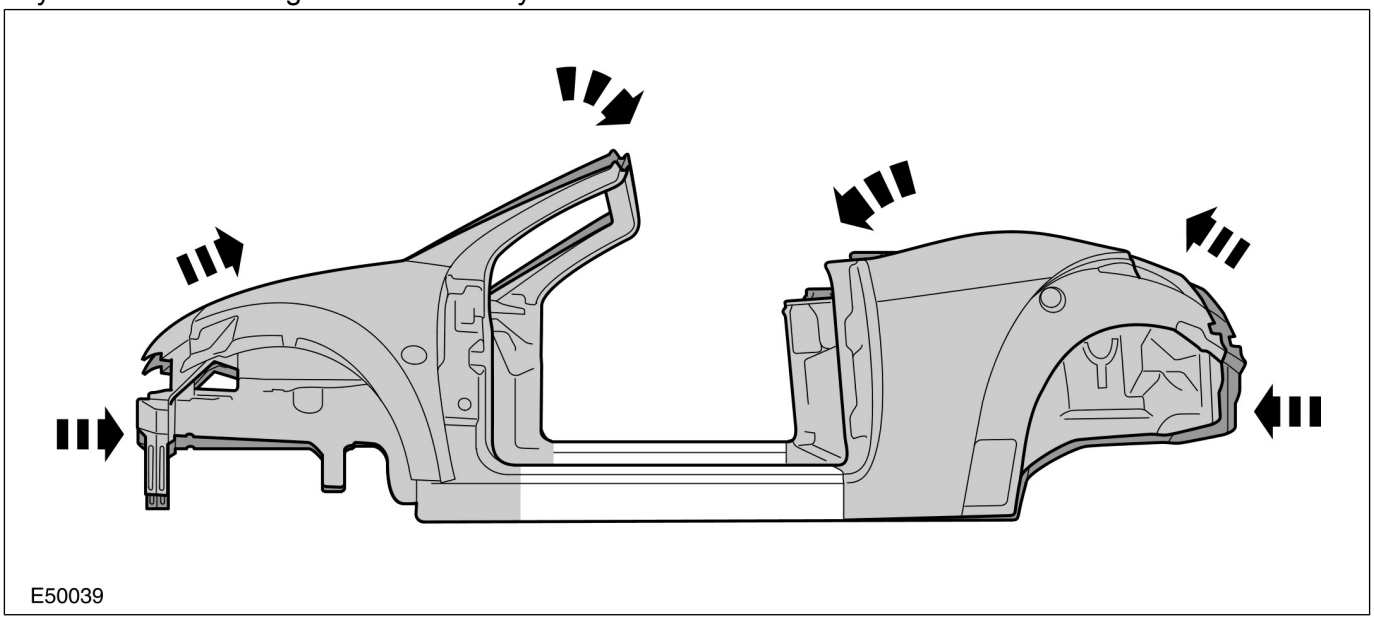
- Prepare the repair location. Remove paint residues and sand the repair area.
- Drill out the ends of the split to stop it spreading further.
- The repair location must be sanded by hand. If machine working is attempted, the resin will be heated so much that the surface structure will be changed. The result is inadequate adhesion.
- Perform the GRP repair. Apply polyester resin thinly to the repair location. Lay the glass fiber mat in place and apply polyester resin over it again.
- Rework the location of the repair. Sand away any polyester resin which stands proud after it has hardened.
- Clean the sanded repair surface using plastic cleaner. Apply plastic primer thinly to the repair surface and after it has dried apply the paint finish.

DESCRIPTION AND OPERATION

Special Repair Techniques

Cabriolet vehicles

The body of a cabriolet vehicle is different to the self-supporting body of a saloon car because of the special roof construction (folding top). The stability requirements must therefore be ensured by construction changes within the body structure.



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These are for instance:

- Longitudinal and torsional reinforcing components which compensate for the lack of the roof.
- Reinforcements to the floor assembly, particularly in the rocker panel area.
- Reinforcements in the pillar areas.
- High-strength and ultra-high-strength steel panels with single panel thicknesses of up to 2.5 mm, which in combination can become up to 6mm thick (e.g. reinforcements in the floor area, rocker panels).

If deformation to load carrying components occurs, the stability of the whole body shell can be adversely affected.

On a cabriolet, accident damage repair to the components mentioned above is considerably different in certain aspects compared with the usual repairs (closed body construction):

- A model specific alignment angle system must always be used during straightening and repair work, securing using clamps at the rocker panel area is not always adequate for the cabriolet.
- To avoid damage to the doors, they must always be open during straightening work. In the case of more severe damage, additional tension and compression spindles must be used to stabilize the door cut-outs (between the A- and B-pillars).
- In load bearing areas such as the rocker panels, side members and floor pan, increased straightening forces are necessary due to the additional reinforcements.
- **NOTE:**Additional information on welding can be found in the section Welding Equipment and Joining Techniques.

  High-power welding equipment for panel thicknesses in overall combination of up to 6 mm total material thickness.
- The fitting accuracy and longitudinal rigidity of the affected component is especially important to ensure that the doors, door windows and the roof fit and close correctly.

DESCRIPTION AND OPERATION

Liquefied gas vehicles

Alternative fuel vehicles often require special handling in the workshop area. Above all, assembly operations to some extent require particular knowledge when dealing with the special technology and the safety regulations.

NOTE: Only fully trained personnel are permitted to work on alternative fuel vehicles.

These special requirements must be understood and taken into account in the body shop as well.

CAUTION:Danger of fire and explosion. The safety instructions must always be followed when performing service work on fuel/gas systems. Failure to follow these instructions may result in personal injury.

If the smell of liquefied petroleum gas (LPG) or compressed natural gas (CNG) is noticed in the workshop, instruct everyone present as follows:

- No smoking and extinguish all naked flames.
- Shut off all electrical and air powered equipment.
- Evacuate the area.
- Ventilate the area.
- Contact the fire control authorities.
- Move the vehicle to a dedicated, well ventilated area.

Alternative fuels require special handling:

- Handle them in a specially dedicated, well ventilated area, which is only accessible to authorized persons.
- Identify the designated area with new warning notices.
- If possible close the main shut-off valve and run the vehicle on alternative fuel until it switches automatically to petrol operation. Only then is it allowed to drive the vehicle into the workshop or service area.
- If possible do not allow any liquefied gas (LPG) to escape.
- The ambient temperatures must not exceed 40°C. For this reason the LPG and CNG fuel tanks must be removed on vehicles with LPG or CNG operation before using a drying oven to dry the paint where the temperature exceeds 40°C.

Avoid situations in which fuel from an LPG or CNG fuel tank can escape. These include:

- Extremely hot ambient temperatures.
- Parking near a heating device.
- Raising the vehicle near a ceiling heater.

Refrigerated conversion vehicles

Apart from the special materials used in building the structure of the refrigerated compartment, such vehicles have special energy and refrigeration systems which require special handling during repair.

CAUTIONS:

Danger of injury. Work on the 230<SP>volt system of the refrigeration equipment must only be carried out by trained specialist personnel.

The refrigeration system is filled with refrigerant R134a. This can cause frostbite if it contacts the skin. Pay attention to the corresponding warning notices and instructions in the chapter Air Conditioning Systems.

NOTE: Work on the refrigerant circuit may only be performed by persons who have a relevant certificate of competence.

Vehicles with a refrigerated compartment are often used to transport foodstuffs. For this reason, additional hygiene regulations must be complied with during repair work.

Aluminum and plastic are used to construct the two different types of compartment found on refrigerated vehicles.

The aluminum conversion is a very stable and technically perfect variant. However, against this the relatively high production costs and a lower payload must be taken into account, because of the weight of the aluminum conversion itself.

NOTE: Basic and in-depth training is offered on the following topics. You will find an overview of the complete range listed in the Training brochure published by the Ford Service Organization.

The plastic conversion has developed into a light, clean and economical alternative because of constant further development of materials and working techniques.

NOTE: The material combinations, the workmanship and the working methods must comply with the current food hygiene regulations.

DESCRIPTION AND OPERATION

For this reason, service and repair work on the refrigerated conversion may only be performed by authorized and specially trained technicians.

Refrigerated compartment constructions are often made using both materials. The floor pan is made of structured, slip-proof aluminum panels and the wall and ceiling cladding is made of smooth surfaced plastic elements.

CAUTION:PUR hard foam is flammable. If PUR hard foam is overheated, it will burn on its own with a brilliant yellowish flame. It produces unpleasant choking and toxic fumes. Special measures must be taken when welding the vehicle body.

Polyurethane wall and ceiling elements are manufactured using a sandwich principle. An insulating polyurethane core is coated with food grade ABS plastic on one side.

PUR hard foam does not decompose, is rot resistant and is odorless. These properties make it suitable for use as insulation.

Because of its closed cell structure, water uptake by PUR hard foam is for the most part only a problem at edges. Cut edges or other mechanically worked surfaces must however be sealed with the greatest care.

The conversion to a refrigerated vehicle is performed as made-to-order production. The large surfaces of the wall and ceiling cladding can be changed and are particularly easy to repair.

If access to the back of a body panel section is needed because of body straightening work, in some circumstances it is cheaper to perform a cut-out repair instead of removing an element.

The repair process is fully described in the Student Information booklet Refrigeration System Technology, Transit 2000.5 Freshline.

DESCRIPTION AND OPERATION

Impact of Insufficient Repair Quality

Body repairs usually require a significant level of intervention in the existing body shell structure. The corrosion protection, seals and NVH components are destroyed and must be replaced.

To prevent the vehicle quality from being reduced due to an insufficient repair quality, all repairs carried out in all repair sections must be inspected during and after the accident repair.

Simply checking the vehicle at the time of delivery is not sufficient to guarantee the repair quality. Rather, continuous checking of the work carried out is recommended.

NOTE: Logs of the acceptance of individual operations are a useful tool for quality assurance. A comprehensive final inspection can be carried out based on a final acceptance log.

In the process, the entire repair sequence must be split into reasonable sections, with the creation of check points to which particular attention must be paid.

The following are some possible sections:

- Completion of the body repairs.
- Completion of the paint repairs.
- Final assembly, ancillary components, functional tests.
- Vehicle delivery.

NOTE: The following points offer an indication of possible test logs. They can be combined and supplemented differently, depending on the individual operating procedures.

Completion of the body repairs

After completion of the body repairs, the following areas should be checked:

- Manufacturing inspection for functionality and originality in the accident area.
- Check snug fitting of metal panel parts (welding and screw connections).
- Check snug fitting of ancillary components (doors, hoods, glazing).
- Check surface condition of the welded seams.
- Check seals, blanking plugs, NVH components.
- Check corrosion prevention measures
- Check that the repair work is in the correct condition for painting.

Completion of the paint repairs

The following points should be noted when checking the paint repairs:

- Originality of the paintwork.
- Transitions to the adjacent paintwork.
- Leftover paint and paint traces.
- Leftover masking materials and dirt.
- Underbody protection and cavity protection.

Final assembly, ancillary components, functional tests

After final assembly, not only a visual inspection is required, but also the functionality of many components must be checked:

- Check repair area for originality.
- Check ancillary components for correct installation.
- Check precision fitting of all parts.
- Check that the doors and flaps are working correctly.
- Check that all mechanical parts, such as the window winder are working correctly.
- Check for leaks in the repair area.

Vehicle delivery

Vehicle delivery again offers the opportunity of checking the repair quality. In the process, the following points are to be checked again:

- Check the accident area for originality.
- Visual inspection of the transitions and gaps.
- Check for corrosion prevention measures, insulation mats and rubber seals.
- Check for traces of leftover paint.
- Check the cleanliness of the vehicle.
- Functional check of the mechanical and electrical components.
- Road test the vehicle.
- Check for noise, vibration and harshness (NVH).
- Check for wind noise.

After repair work on the body and vehicle, not only the visual restoration of the damaged vehicle, but also the functional restoration must be guaranteed.

Customers are making increasingly high demands of vehicles, particularly in terms of driving comfort. Customers find noise, vibrations and harshness (NVH) as well as squeaking and rattling annoying,

DESCRIPTION AND OPERATION

particularly after repair work. It is therefore important that the condition of the vehicle at the time of production be restored after an accident repair.

After body repairs, the entire repair area must be checked for any water leaks. It is crucial that a leak test be carried out as part of the final inspection so that water leaks can be detected and eliminated even before delivery of the vehicle to the customer.

The requirements of the vehicle manufacturer are to be taken into consideration during all inspections. Only in this way can it be guaranteed that the vehicle quality is not reduced through insufficient repair quality.

DESCRIPTION AND OPERATION

Water Leaks

Water leaks can occur after body repair work, but can also occur on new vehicles. The various causes can be ascertained using the checks described below. In all cases, a systematic and logical procedure is required to locate water leaks.

Diagnosis

When searching for faults, it must be taken into account that water can enter the vehicle passenger compartment in various ways and under different conditions. Based on this consideration, it is sometimes not sufficient to perform a water test on a stationary vehicle.

Before beginning extensive checks, a thorough visual inspection must be carried out. The following points are to be taken into account in the process:

- Check the clearance and accurate fit of ancillary components such as the trunk lid and doors.
- Check for correct installation and possible damage to sealing elements such as blanking plugs, seals and rubber door seals.
- Check that the water discharge are not blocked.

Execution

Water leaks in the vehicle passenger compartment cannot usually be located at the first go, as the water frequently distributes itself across larger areas. For this reason, the passenger compartment must be dried before the leak tests. Any ancillary components that block the view must be removed.

Water test

During the water test, the vehicle is sprayed with water at the suspected location of the leak. At the same time, a second person checks the passenger compartment for places where water enters the vehicle.

- Start in the lower area and spray the whole area, working upwards in stages.
- Use a water spray nozzle with a variable water jet.
- Further techniques include the use of water mixed with some dishwashing detergent, a special mirror and the use of a UV lamp.

Car wash test

Certain leak problems only appear in a car wash or can only be simulated there. The concerned area of the passenger compartment should be inspected with a torch during the wash procedure.

Road test

Some leaks only appear when the vehicle is moving. If no leaks are detected during the above-mentioned tests, road tests should be carried out on wet roads.

- At various speeds.
- On various road surfaces (asphalt to cobbles).
- With loaded or unloaded vehicle.
- Driving through puddles (splash water).

Test with UV lamp

As already indicated in the water test section, a leak test can be executed with a UV lamp and a special contrast agent. The advantages of using the contrast agent are as follows:

- No need to dry out wet areas beforehand.
- The water entry and its subsequent path can be seen more clearly.
- No need to remove most ancillary components from the vehicle.

NOTE: Please note the equipment manufacturer's instructions when using the UV lamp and the contrast agent.

Procedure for using a UV lamp.

- Wet the test area with clear water from the outside.
- Prepare test liquid and apply it from the outside using a suitable water sprayer.
- Illuminate the relevant area from the inside using the UV lamp. The test liquid will make the leak visible.

Chalk/powder test

In this test, the contact area of the seal is checked.

DESCRIPTION AND OPERATION

To do this, the door seal is coated with powder or brushed with chalk. A thin layer of grease is applied to the contact area of the seal. The door must then be slowly closed and reopened.

The width and continuity of the imprint can now be checked on the door seal.

Smoke test

This test can be used to detect leaks visually. The process is as follows:

- Set the ventilation blower in the passenger compartment to the highest setting.
- Close all doors so that a slight overpressure can build up in the passenger compartment.
- Move the smoke pipe along the outside of the body to the areas to be checked.
- Leaks can be detected through the irregular movement of the smoke.

Stethoscope test

This procedure is very similar to the smoke test. Instead of the smoke pipe, move a stethoscope past the areas of the body that are at risk. Leaks can now be detected acoustically.

Ultrasonic detection

With this test, a leak can be found electronically. The procedure is as follows:

- Place the ultrasonic transmitter in the vehicle.
- Completely close the vehicle.
- Search the exterior of the vehicle using the detector.
- The detector will quite easily show any leaks present.

Sequence

Water leaks may only occur under special environmental influences. Thus, water entry into the vehicle may only occur when the vehicle is moving. For this reason, a detailed customer survey must first be carried out.

Sequence (schematic):

1. Customer concern
   - What is the customer's concern and what details can they supply about the water leak?
   - Under which conditions does the water leak appear?

2a. Diagnosis and corrective action. **Sequence A:** Diagnosis is clear based on the available traces:

- Carry out corrective measures to remedy the water leak.
- Water test the vehicle to check that the concern is resolved. The area at which the water leak was detected is to be checked.
- The corrective action performed based on the available traces was not successful. Further tests must now be carried out to find the fault (see Sequence B).

2b. Diagnosis and corrective action. **Sequence B:** Diagnosis is not possible based on the available traces:

- Test for faults, referring to any TSB (Technical Service Bulletin) which may be relevant.
- Visually check external seals, check gaps.
- Visually check the vehicle for traces of accident repair and after-market ancillary components.
- Draw up diagnosis based on the road test or a car wash test.
- Carry out corrective measures based on the diagnosis.
- Repeat road test or car wash test.
- If this road test or a car wash test does not show that the work has been successful, additional techniques such as powder testing, stethoscope testing or ultrasonic detection must be employed.

Test equipment

NOTE: Further testing methods and test equipment are listed in the wind noise section.

Water leaks and wind noise can have similar causes. Therefore, test methods and test equipment can be used for both problems. The test methods are:

- Stethoscope.
- Smoke pipe.
- Ultrasonic detector.
- Powder test.

DESCRIPTION AND OPERATION

Wind Noise

Wind noise and noises in general are dealt with under the label Noise, Vibration, Harshness, or NVH in short.

NOTE: Basic and advanced training is offered for the following contents. For an overview of all training courses offered, please refer to the Ford Service Organisation's training course brochure.

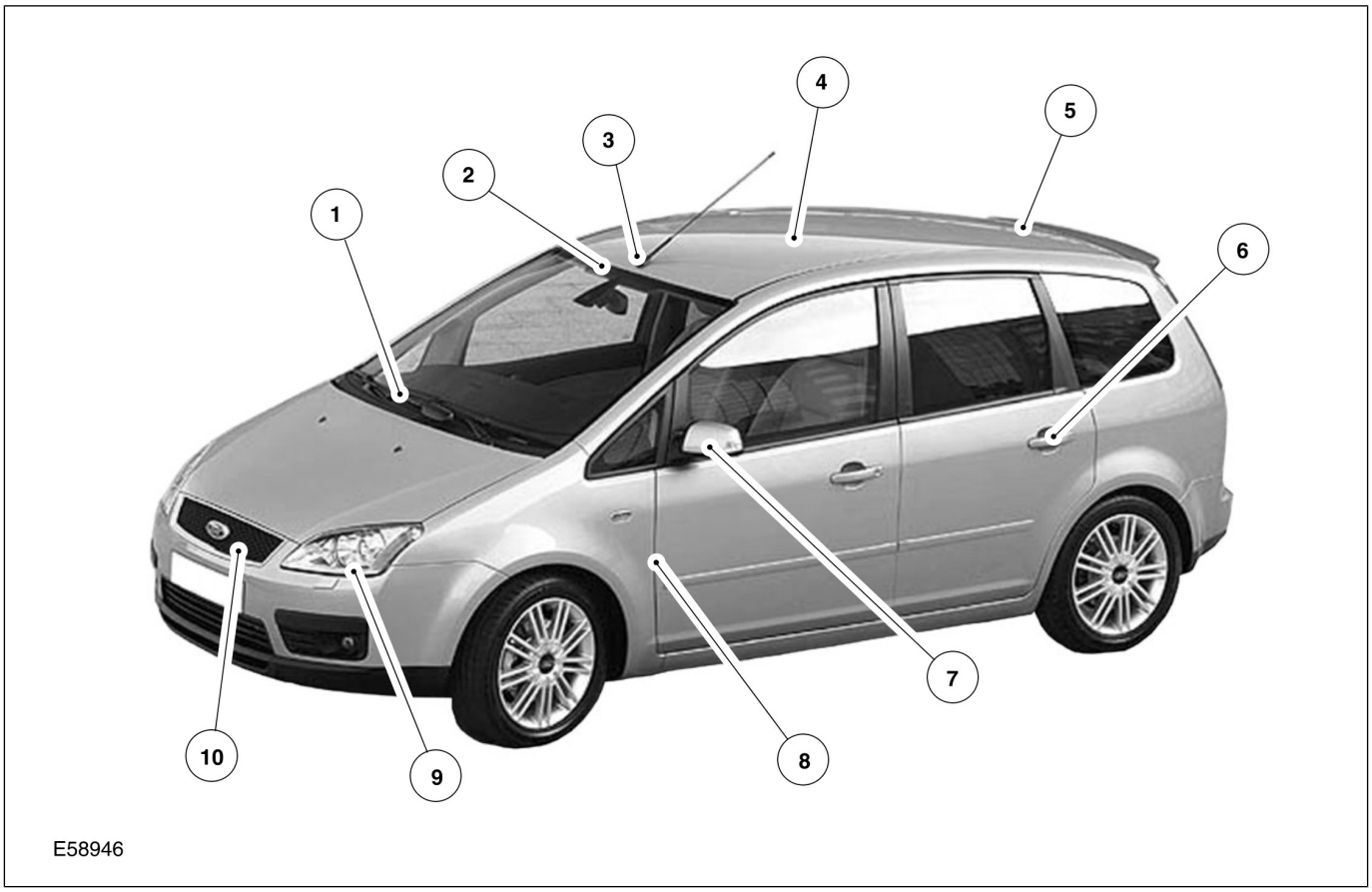
Due to the continuous reduction in drive noises, wind noise has come to the fore in the vehicle and is perceived to a greater extent by the customer.

There are various causes of wind noise. They can be due to the design of the vehicle, or they can occur after a repair. They are mostly caused by poorly mounted components, which must be located and installed in the correct position.

Diagnosis

In order to carry out targeted diagnosis, it is important to know the basics of noise formation and sound transmission.

Potential areas of wind noise



Item	Description
1	Wiper arms
2	Windscreen seal
3	Antenna/antenna base
4	Sun roof
5	Liftgate
6	Door handles
7	Rear view mirrors

Item	Description
8	Door seals
9	Headlamps
10	Radiator grille

Normal air flow noises are caused by air blowing against even, flat vehicle surfaces, such as the roof, doors and side windows. When the vehicle is moving fast, air films (turbulence) form, which cause variations in air pressure. These variations

DESCRIPTION AND OPERATION

in air pressure spread in the form of sound waves and are transferred to the vehicle interior via the side windows and seals.

If air flows over an edge on a vehicle, the air flow cannot follow the shape of the surface, but separates at the edge. Eddies are formed, which collapse again after a certain time or distance. The associated variations in air pressure create a corresponding sound wave.

Streaming noise occurs if there are leaks in the sealing system to the vehicle passenger compartment. The noise is caused when stationary air mixes with moving air. As a result, the noise increases as the streaming speed increases.

Cavity noises are noises that occur when the air column is caused to oscillate.

Workshop diagnosis

Before carrying out repair work, a visual inspection of the vehicle must be carried out. The gaps in the doors, the sunroof and at all other body parts must be checked in particular.

When the doors are adjusted to fit exactly, development of wind noise can often be eliminated at high speeds (lifting of doors off the seals).

The following points are also to be checked:

- Check that windows are completely closed.
- Check air ducts and vents for correct installation.
- Check protruding trims or plastic parts.
- Check that all blanking plugs are present.

Road tests

Wind noise can usually only be located through road tests.

NOTE: There should always be two people present during test drives to find noises. A driver who reconstructs the situation causing the noise, and a person to carry out the checks.

The following points should be taken into account for such test drives:

- Check that the tire pressure is correct.
- Remove non-standard ancillary components from the vehicle.
- Choose a dry, flat road with as little traffic as possible.
- Carry out the road test in all speed ranges. Use a high gear so that the engine noise is low.

If it is difficult to detect the noise sources, the search can be made easier by masking potential areas.

Sequence

A basic prerequisite for a problem description with subsequent diagnosis is the performance of a test drive with the customer..

Only once the customer's problem description is clear should the service technician begin with the diagnosis of the problem.

The service technician should carry out specific road tests to achieve further containment of the problem.

Sequence (schematic):

1. Customer concern

- What is the customer concern and what details can he supply about the wind noise?
- Under which conditions does the wind noise appear?

2a. Diagnosis and corrective measures **Sequence A:** The diagnosis is possible based on the information supplied by the customer.

- Carry out corrective measures to remedy the wind noise.
- Road test the vehicle to check that the concern is resolved. The vehicle must be driven in exactly same way as when the wind noise was produced earlier.
- The corrective measure performed based on the information supplied by the customer was not successful. Further fault finding must now be carried out in the workshop (see Sequence B).

2b. Diagnosis and corrective measures **Sequence B:** The diagnosis is not possible based on the information supplied by the customer.

- Test for faults, referring to any TSB (Technical Service Bulletin) which may be relevant.
- Visually check external seals, check gaps.
- Visually check the vehicle for traces of accident repair and retrospectively attached ancillary components.
- Perform a diagnosis based on the road test.
- Carry out corrective measures based on the diagnosis.

DESCRIPTION AND OPERATION

- Perform another road test. The vehicle must be driven in exactly same way as when the wind noise was produced earlier.
- If this road test does not show that the work has been successful, additional techniques such as powder testing, stethoscope testing or ultrasonic detection must be employed.

The vehicle acoustics do not always make it possible to draw up a clear diagnosis. It is therefore all the more necessary to use all methods of detecting and suppressing NVH problems.

3. Comparison of vehicles constructed in the same way.

If no clear diagnosis is possible based on a customer concern, a comparison test drive should be carried out on a vehicle constructed in the same way.

Test equipment

Diagnosis of wind noise requires good hearing, basic knowledge of acoustics and experience. Tools can provide assistance for the diagnosis and reduce the fault finding times.

Stethoscope

Here, the tightness of the vehicle passenger compartment is checked. The ventilator blower is set to the highest setting and the doors and windows are closed. There is now a corresponding overpressure in the passenger compartment.

The stethoscope is now used to listen to the door and window seals. The sound of the streaming air can be heard at the leaks.

Smoke pipe

The preparatory work is the same as for the stethoscope test. By scanning past the seal areas with the smoke pipe, a leak can be visually detected based on the changed smoke path.

Ultrasonic detector

The ultrasonic detector is a further method of finding leaks in the vehicle passenger compartment. Here, an ultrasonic noise generator is placed in the passenger compartment. The closed vehicle is then inspected from outside with the corresponding detector. The detector will show any leaks present.

Powder

Door seals that do not make close contact can be detected by coating the contact surface of the door seal with white powder. To do this, the door is carefully closed and re-opened. In this way, the door seals which do not touch will be visible.

DESCRIPTION AND OPERATION

Noise, Vibration and Harshness

Noises means noises caused by the vehicle that are audible both inside and outside the vehicle.

Vibrations are oscillations that are palpable and noticeable in the vehicle passenger compartment.

Harshness means noises caused by the vehicle that are audible, palpable and noticeable inside the vehicle.

These terms are grouped together under the label Noise, Vibration, Harshness, or NVH in short.

The task of vehicle development and production is to ensure that noises caused by the vehicle do not disturb the driver and passengers. Moreover, the the external noises emitted by the vehicle must not exceed the thresholds set by law.

The following section gives an overview of how noise, vibration and harshness can occur in the vehicle and what remedial action is possible.

NOTE: Basic and advanced training courses are offered for the following contents. For an overview of all courses offered, please refer to the Ford Service Organisation's training course brochure.

Noise types and causes

Noises in and around the vehicle are assigned specific descriptions:

- Humming and droning are perceived as low tones.
- Buzzing and whirring are middle tones.
- Howling, whistling, squeaking are assigned to the high tones.

Low to middle tones are considered to be unpleasant. They are palpable and noticeable as oscillations and vibrations throughout the body. Loud howling and whistling is painful to the ears.

Where the different notes come from in a vehicle:

- Low notes are mostly produced by the engine.
- Low tones can also be produced by the roadbed, particularly on rough surfaces. This is a form of droning which can be felt by the vehicle occupants as vibration or roughness.
- High tones however, which are experienced as howling or whistling noises, are often air currents (wind noise) or come from ancillary components such as the generator, power steering pump or drivebelt.
- There are also clattering noises which can occur when driving over an uneven road. These jerking noises are produced by, for example, the shock absorbers, chassis components or loose articles inside the vehicle.

A noise usually consists of a superimposition of different tones which spread as oscillations.

Each of these oscillations has a specific oscillating time and can be measured in frequencies. The frequency describes the number of oscillations per second. The frequency unit is specified in Hertz (Hz).

The human ear can perceive frequencies between 20 and 20000 Hz.

Noises can already be contained where they occur or, if this is not possible, can be confined with suitable measures. The basic procedures are the damping of oscillating parts, the insulation of components or the absorption of the noises through appropriate materials.

Damping

If a damper is installed next to an oscillating mass, the characteristic of the damper will reduce the movement of this mass accordingly (e.g. bumper on chassis).

Damping affects the resonance of an object or system.

Isolation

In oscillation technology, the term isolation means decoupling (separation) of components and systems.

An engine is mounted in sprung elements, so that as little oscillation as possible is passed to the vehicle.

In automotive technology, the isolation technique used is nearly always rubber mounting. The elasticity of the rubber acts like a spring.

DESCRIPTION AND OPERATION

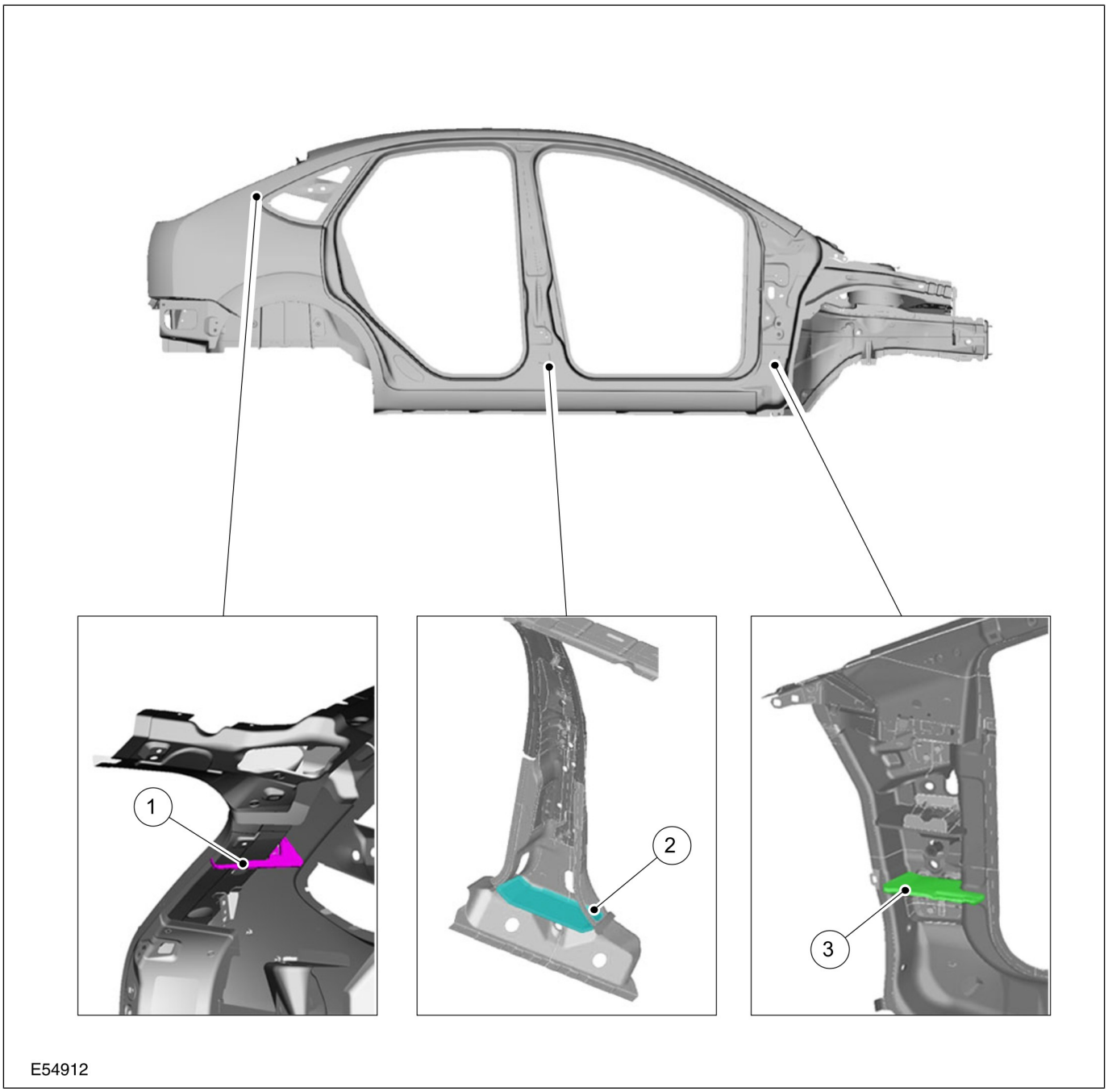
Absorption

Sound waves are reflected from hard surfaces Through the use of absorption material, sound waves hit soft surfaces and are absorbed by them. The composition and thickness of the material used plays an important role here.

A soft surface, depending on its composition, absorbs the sound waves and reduces their energy.

NVH elements

NVH elements are installed to prevent airborne sound transfers to the passenger compartment in different body cavities.



Item	Description
1	C-pillar area
2	B-pillar area
3	A-pillar area

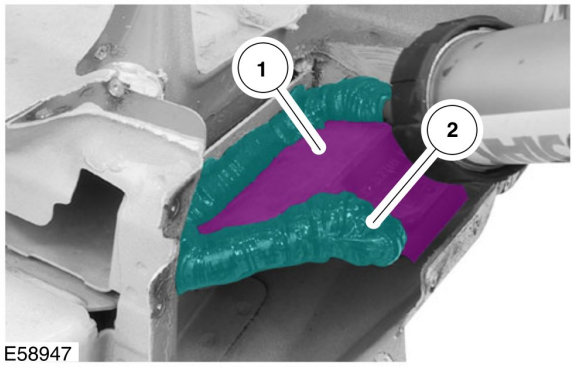
On the Focus 2004.75 (07/2004-) these elements are located in the cavities of the A, B and C pillars. On the estate version, they are also located in the D pillars.

DESCRIPTION AND OPERATION

The NVH elements consist of a carrier plate with a compressed isolation material at the edges. In the drying system of the painting equipment used in production, the body is heated to approx. 170° C. At this temperature, the isolation material expands, completely sealing the gap between the carrier plate and the bodywork.

NOTE:

- NVH elements must not be damaged during work on the vehicle body.
- NVH elements deformed through impact must always be replaced.
- PU adhesive must always be applied to the edges of new and reused NVH elements during repair work.



Item	Description
1	NVH element
2	PU adhesive

For the exact installation position of an NVH element, please refer to the vehicle-specific repair instructions.

If an NVH element is to be reused, the bonding on the body panel must be detached. To do this, the body panel must be heated in the area around the NVH element. The bonding can be detached at approx. 170° C. The damaged panel part can now be carefully dismantled.

Before installing the new panel part, PU adhesive must be applied to the contact areas between the panel and the NVH element.

Test techniques, measuring devices

The shortest route to an accurate diagnosis results from:

- general information on the problem vehicle and a comparison test with a vehicle of the same construction, without NVH problems.
- vehicle history, including repair history and usage patterns.
- condition history, especially any relationship to repairs or sudden change.
- knowledge of probable causes.
- application of diagnosis procedures in which the vehicle is split into corresponding areas.

The diagnosis and correction of noise, vibration and harshness concerns requires:

- a road or system test to determine the exact nature of the concern.
- analysis of probable causes.
- checking of the cause and elimination of the faults found.
- a road test or system test to make sure the concern has been corrected or brought back to within an acceptable range.

It is often very difficult to locate noises that are audible in the passenger compartment based on the problem description provided by the customer and the road tests performed. The direction of the noise can be detected subjectively, but the source of the noise cannot be found.

NOTE: For a selection of simple test tools, see the wind noises section.

Stethoscope

Using the stethoscope, you can listen to the entire vehicle passenger compartment to locate noise sources more easily. This test procedure can be carried out either while the vehicle is moving, or with the engine running and the vehicle stationary, depending on the concern. The noise source can be assumed to be where the stethoscope identifies the highest noise radiation.

NOTE: For safety reasons, only the passenger should carry out the stethoscope testing while the vehicle is moving.

Application examples:

- For very frequent noises in the passenger compartment.
- For engine noises that penetrate through the dashboard into the passenger compartment.
- Wind noise.
- Noise outside the vehicle that is routed inside, such as roadway, tire or water spray noises.

DESCRIPTION AND OPERATION

NOTE: With the stethoscope it is possible to locate medium and high frequency noise paths (caused by leaks) while the vehicle is moving. The stethoscope is not suitable for diagnosis of low frequency droning problems.

Ultrasonic measuring device

The ultrasonic detector is a good and reliable test method for acoustic problems. It is used in a similar way to the stethoscope. In principle, it is suitable for all high frequency interior noises and for leaks in the body seals.

The device consists of an ultrasonic transmitter and a receiver. During use, the transmitter sends an ultrasonic signal which is received at the problem zones by the receiver.

Electronic NVH tester

The measuring device described below is used for diagnosis of the solid-borne sound and solid-borne sound transmission paths. The device is particularly suitable for medium and high frequency noise analyses. In order to obtain a positive diagnosis of droning problems (low frequency noises) and their sources, you must have sufficient experience of how to use this measuring device.

NOTE: In the NVH area, diagnosis of droning problems is one of the most difficult tasks and sets high requirements of the service technicians.

The device works according to the following operating principle: Accelerometers (transmitters) are fitted on various vehicle components or body areas. The signals recorded here can be listened to one after the other on headphones or speakers via the different channels. Simultaneous illustration of several or all measuring channels (for comparison) is only possible visually on the display of the measuring device.

NOTE: Before using the NVH tester in the service, the service technician should take part in an NVH training course to ensure effective use of this device during the road test. A description of the function and application of the NVH tester is enclosed with the device.

Layout and operation:

- The test device has six different channels for noise diagnosis.
- Each channel is marked in color on the terminal, cable and test device.
- The solid-borne sound recorded is transmitted to the test device or the headphones by the magnetic accelerometers (transmitters).
- There is an amplifier on the test device with which the signal strength and the corresponding channel can be set.
- Only the noises from a transmitter are transferred to the headphones.
- All connected cables can be visually illustrated individually or simultaneously on the display.
- The test device saves the recorded data.
- The recorded data can be imported to a PC and evaluated.

SECTION 501-26 Body Repairs - Vehicle Specific Information and Tolerance Checks

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 501-26-2

DESCRIPTION AND OPERATION

Body and Frame..... 501-26-3

GENERAL PROCEDURES

Underbody Tolerance Check..... 501-26-16
Body Tolerance Check..... 501-26-38

SPECIFICATIONS

Lubricants, sealants and adhesives

Parts	Specification
Seam sealer T Anthracite	WSS-M4G364-A

DESCRIPTION AND OPERATION

Body and Frame

Introduction

With the Transit, Ford has developed a completely new bodywork concept in the commercial vehicle sector. Taking into account all active and passive safety components, current materials or material combinations have been integrated into the overall bodyshell design. The combination of various jointing techniques within the overall bodyshell design makes rationalized repair techniques possible in the service area. Technology and economy have been intentionally balanced, resulting in development of a basic overall platform with the Transit that points the way ahead for current Ford technology.

Design features, Transit 2000.5 (01/2000-05/2006) and Transit 2006.5 (04/2006-)

The Transit 2000.5 (01/2000-05/2006) will be replaced by the Transit 2006.5 (04/2006-). The bodywork of the two vehicles are identical apart from the front end. Important structural components, particularly at the front end of the vehicle, such as the side member, cross member and hood lock panel have been redeveloped or redesigned.

Front cross member and side member, Transit 2000.5 (01/2000-05/2006)

From chassis no. 4412103 to 4515866 (manufactured between 15.01.2000 and 15.05.2003), the front cross member is made of plastic. From chassis no. 4515867 (manufactured after 15.05.2003), the front cross member is made of sheet steel.

NOTE: Both versions of the front cross member (plastic and sheet steel) are available as spare parts.

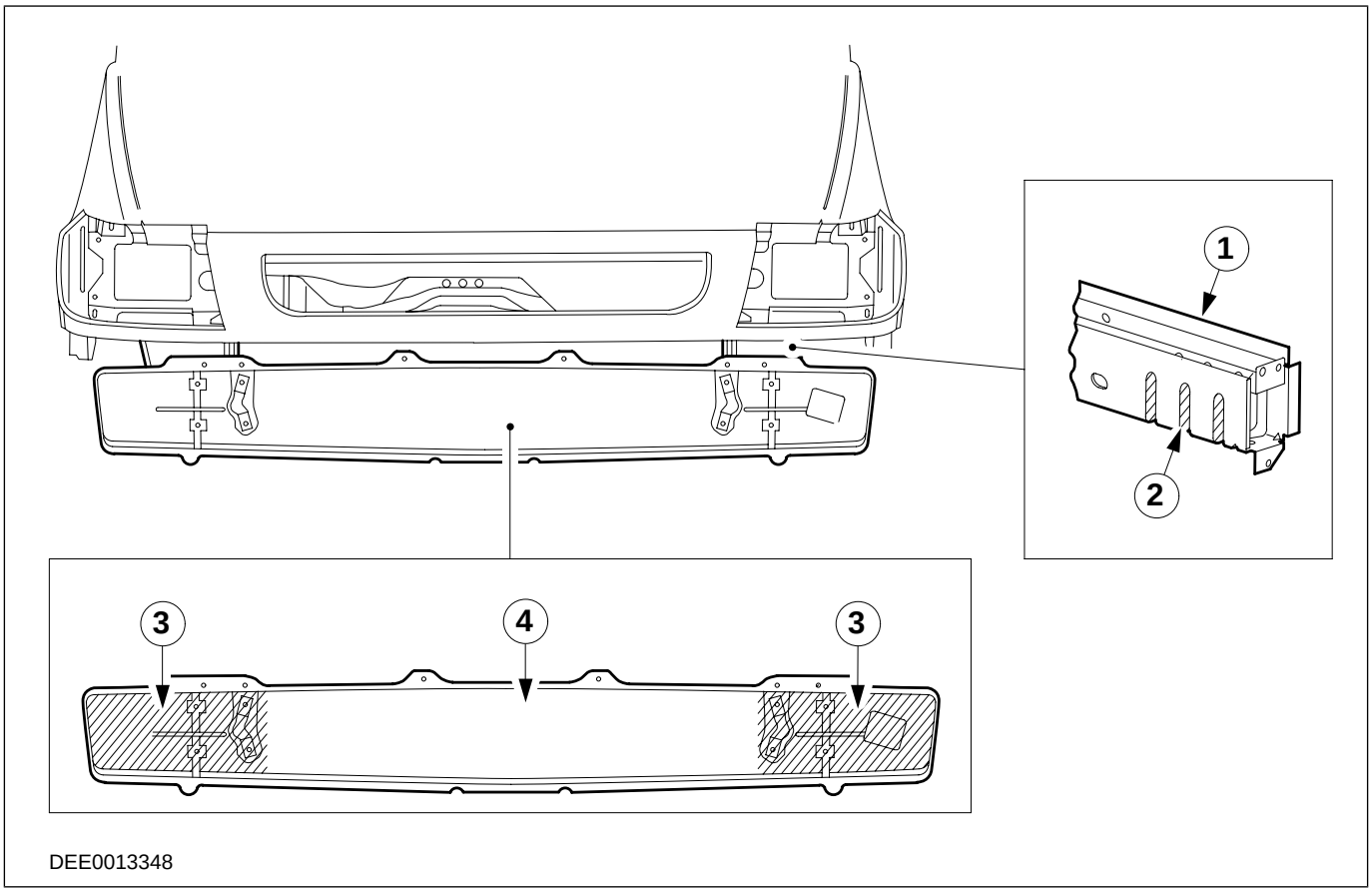
The cross member is attached to the front ends of the side members using screwed connections.

The integral deformation element in the cross member (crash element) absorbs a large proportion of the forces arising from a collision. The subsequent deformation process is pre-determined by 3 designated yield points in the front side members.

NOTE: Reshaping and repairs to the front cross member are not permitted. In the event of discernible damage, it must be replaced.

It is only possible to partially replace the side members (see subsection 501-27).

DESCRIPTION AND OPERATION



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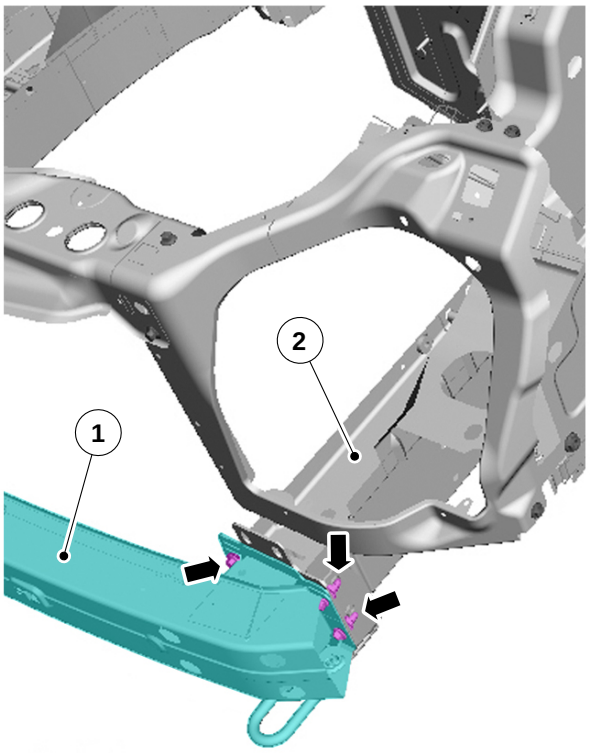
Cross member and side member

Item	Description
1	Side member
2	Designated yield points
3	Area of the deformation elements
4	Crossmember

Front cross member and side member, Transit 2006.5 (04/2006-)

The front cross member is made of sheet steel. It is attached to the front ends of the side members using screwed connections, as on the Transit 2000.5 (01/2000-05/2006).

NOTE: Reshaping and repairs to the front cross member are not permitted. In the event of discernible damage, it must be replaced.



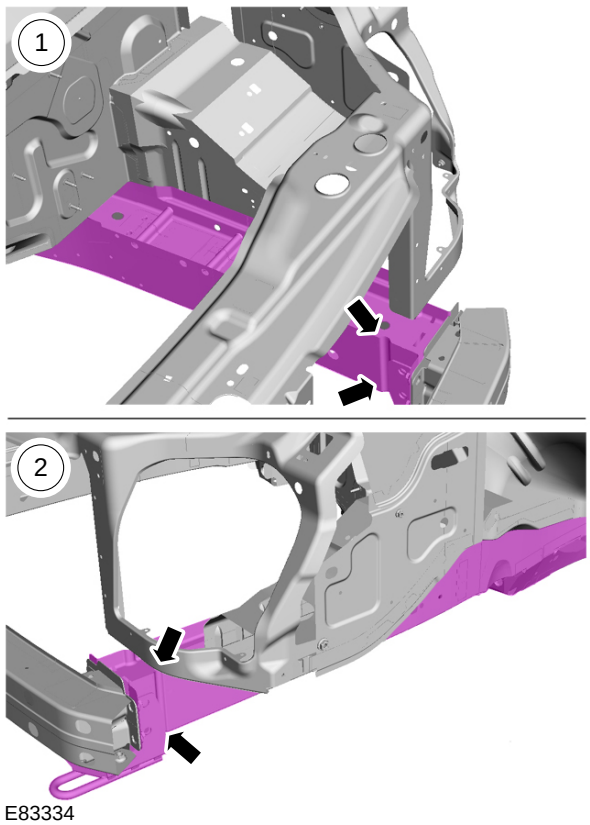
E83317

DESCRIPTION AND OPERATION

Cross member and side member

Item	Description
Arrows	Attachment points (on the inside of the side member, the second screwed connection is covered by the cross member)
1	Crossmember
2	Side member

There is only one integral designated yield point on the outside and inside of the front side members.



E83334

Front side members with designated yield points

Item	Description
Arrows	Designated yield points
1	Front side member, inside
2	Front side member, outside

It is only possible to partially replace the side members (see subsection 501-27).

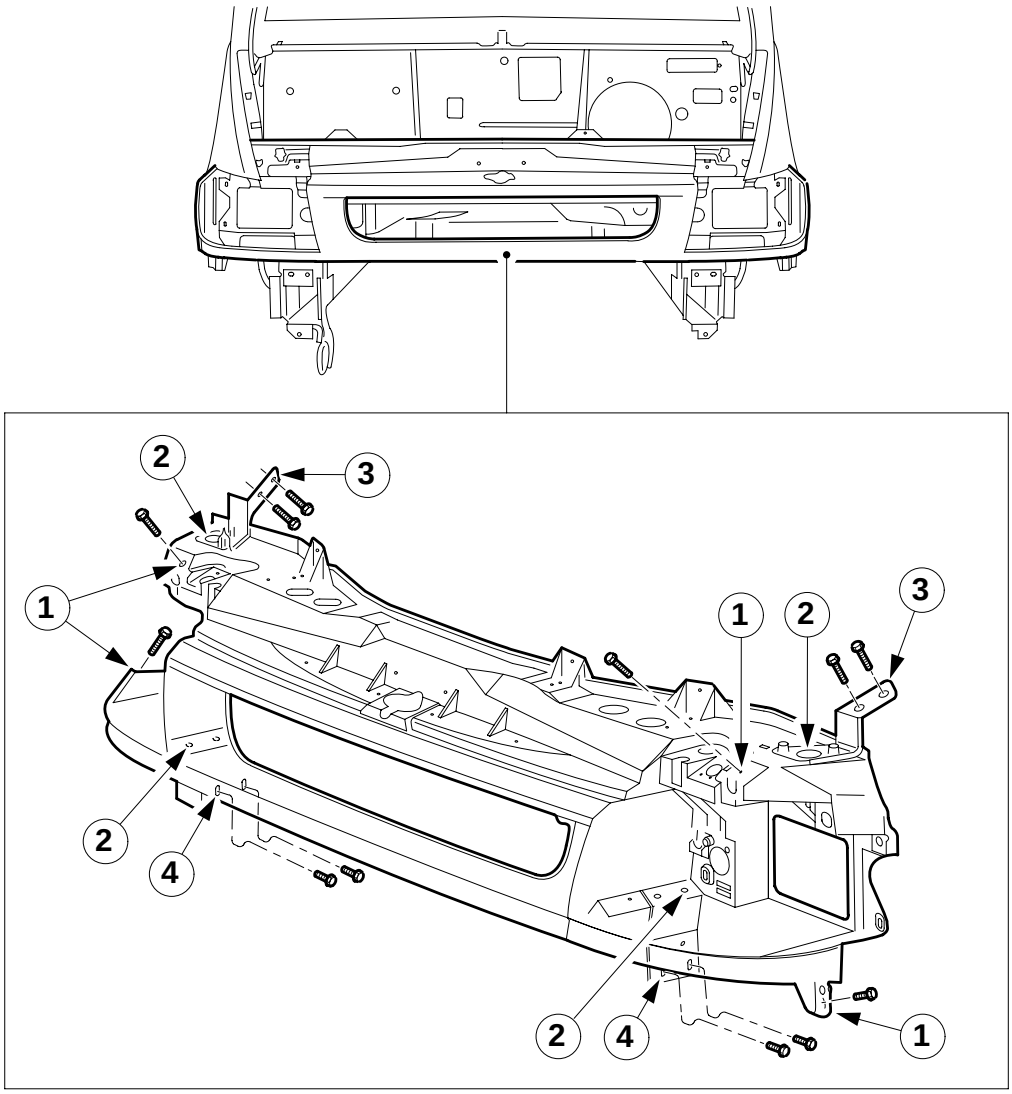
Hood lock panel, Transit 2000.5 (01/2000-05/2006)

The hood lock panel is made of a single piece of plastic and is attached to the bodywork using screwed connections. The screwed connections allow the hood lock panel to be aligned with the bodywork.

NOTE: In the event of severe damage (structural damage), the hood lock panel must be replaced.

Minor damage (cracks) can be eliminated with a corresponding GFK repair material.

DESCRIPTION AND OPERATION



DEE0013349

Hood lock panel

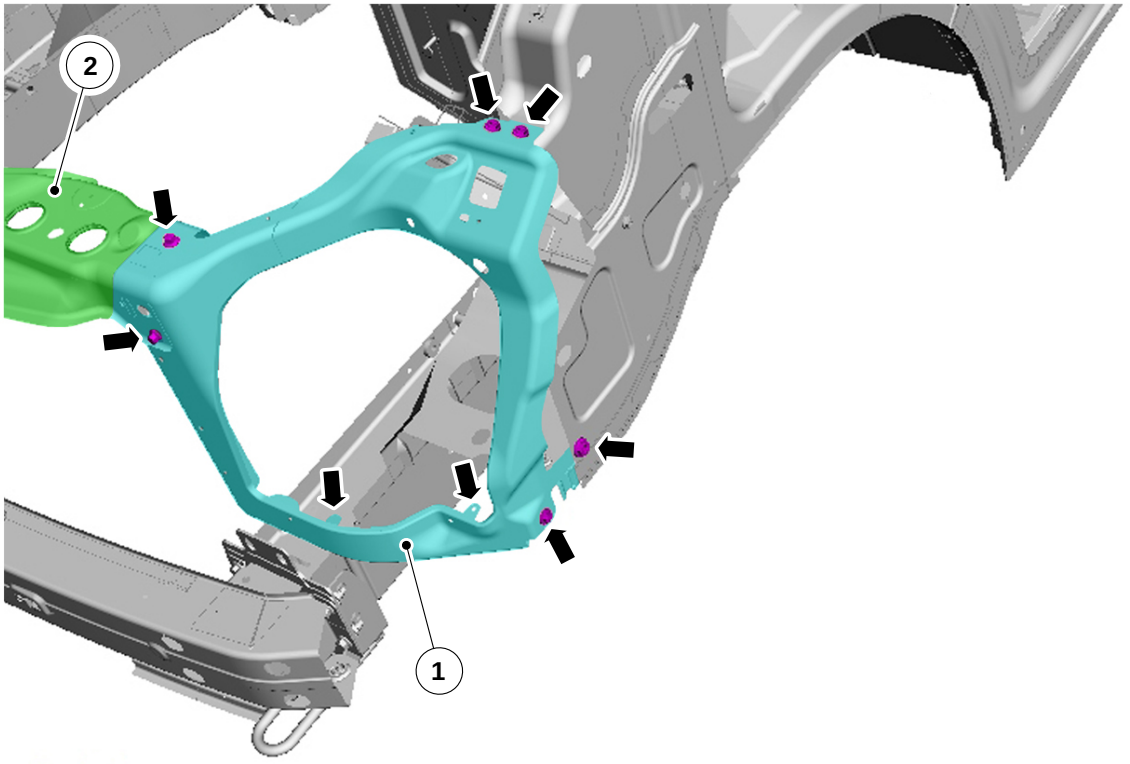
Item	Description
1	Fender attachment points
2	Adjustment points
3	Fender apron panel attachment points
4	Side member attachment points

Hood lock panel, Transit 2006.5 (04/2006-)

The hood lock panel is a three-part design and is made of sheet steel. In the event of damage, this modular construction allows individual segments to be replaced.

The segments are attached using screwed connections. The screwed connections allow the individual segments of the hood lock panel to be aligned with the bodywork.

DESCRIPTION AND OPERATION



E83318

Hood lock panel

Item	Description
Arrows	Attachment and connection points
1	Left outer section
2	Central section

Important information for use during accident repair

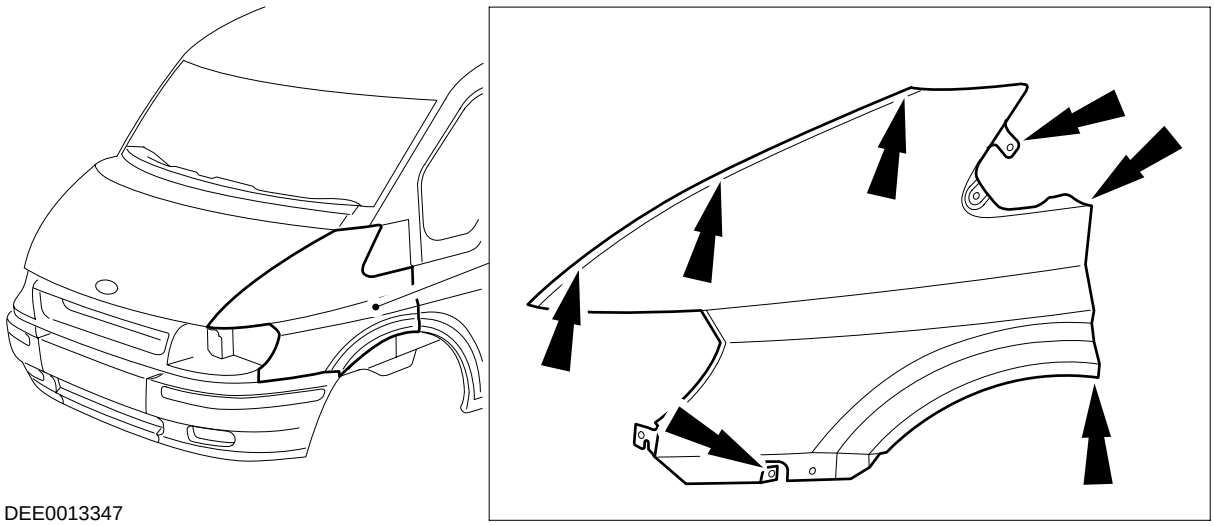
There follows some important information which is helpful during accident repair work.

front fender

The fenders are attached to the bodywork using screwed connections. The exterior mirror must be removed before the fender can be removed.

DESCRIPTION AND OPERATION

Fender attachment points



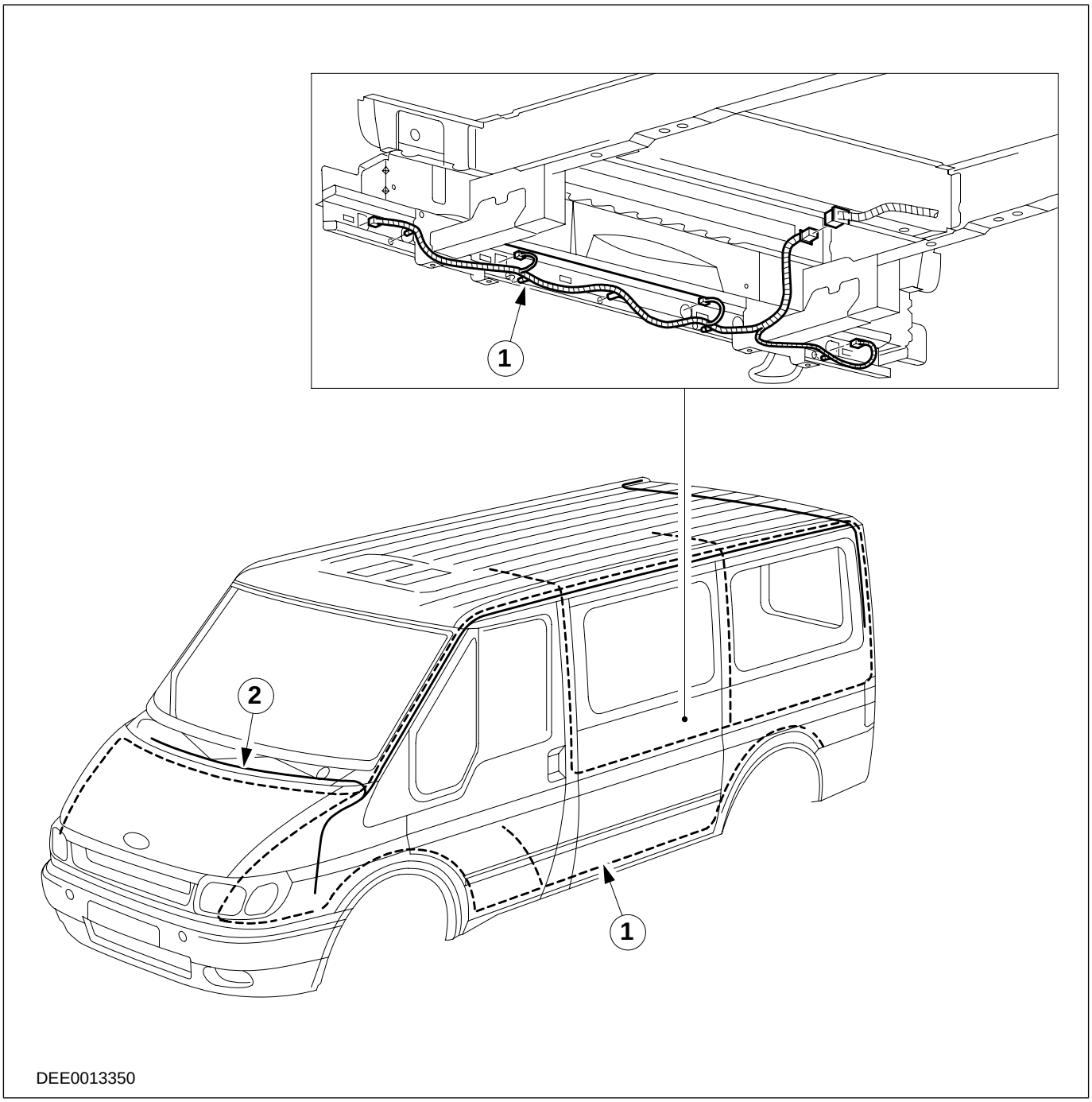
DEE0013347

Wiring harness and hose routing

During work on the bodywork, such as cutting, grinding or welding, the installation location of the wiring harness and hoses must be taken into account due to the risk of damage.

NOTE: The graphic DEE0013350 represents the most important areas in which the wiring harness and hose routing are present in the bodywork.

DESCRIPTION AND OPERATION

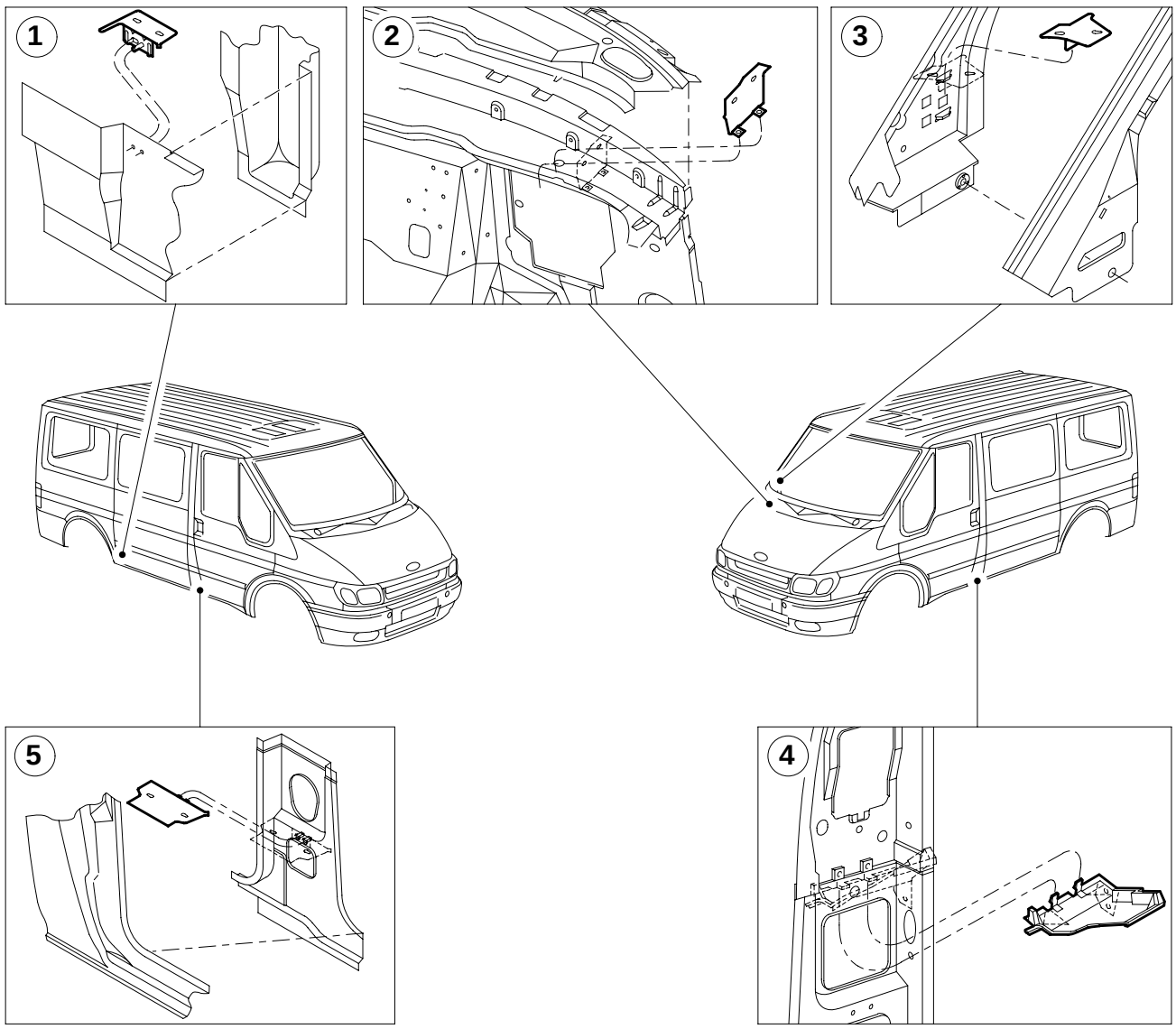


Item	Description
1	Wiring loom
2	Windscreen washer system supply hose

NVH measures

Various NVH components are installed in the A, B and C pillars in order to reduce noise. This reduces the size of the resonance space which the actual cavities present. This has been made possible by the development of new sound deadening technologies and the use of hybrid materials. During servicing, the original insulating elements must be replaced with equivalent insulating elements. The applicable replacement solutions are specified in the repair descriptions.

DESCRIPTION AND OPERATION



DEE0013351

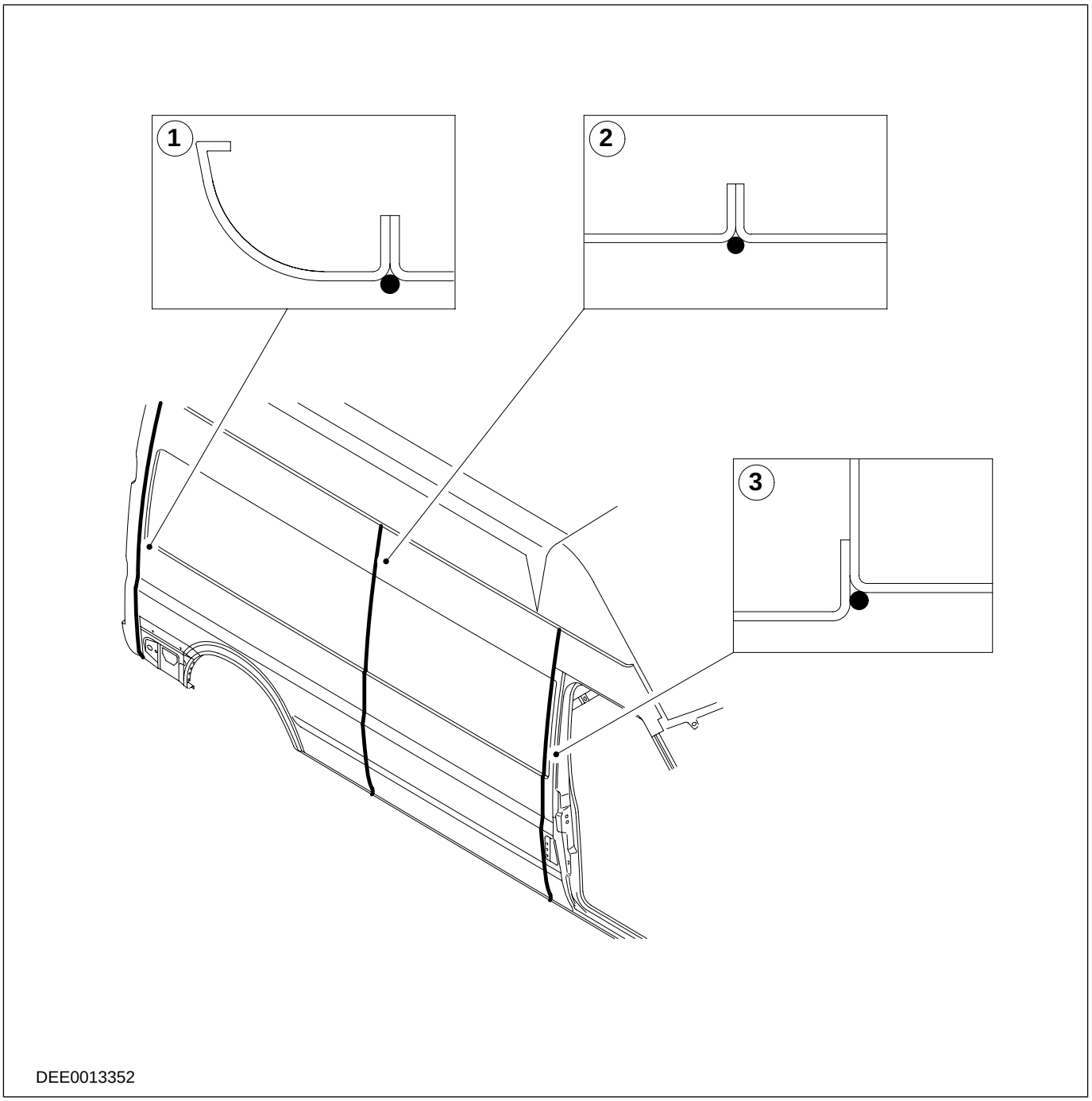
Installation location of NVH elements

Item	Description
1	Lower C-pillar
2	Outer water trap
3	A-pillar
4	Central B pillar
5	Lower B-pillar

Side panel seam seal

The seam seal for the side panels is applied after painting. This has the advantage that the sealant retains its flexibility and later sealing work is possible without extra painting work.

DESCRIPTION AND OPERATION



Outer seam seal

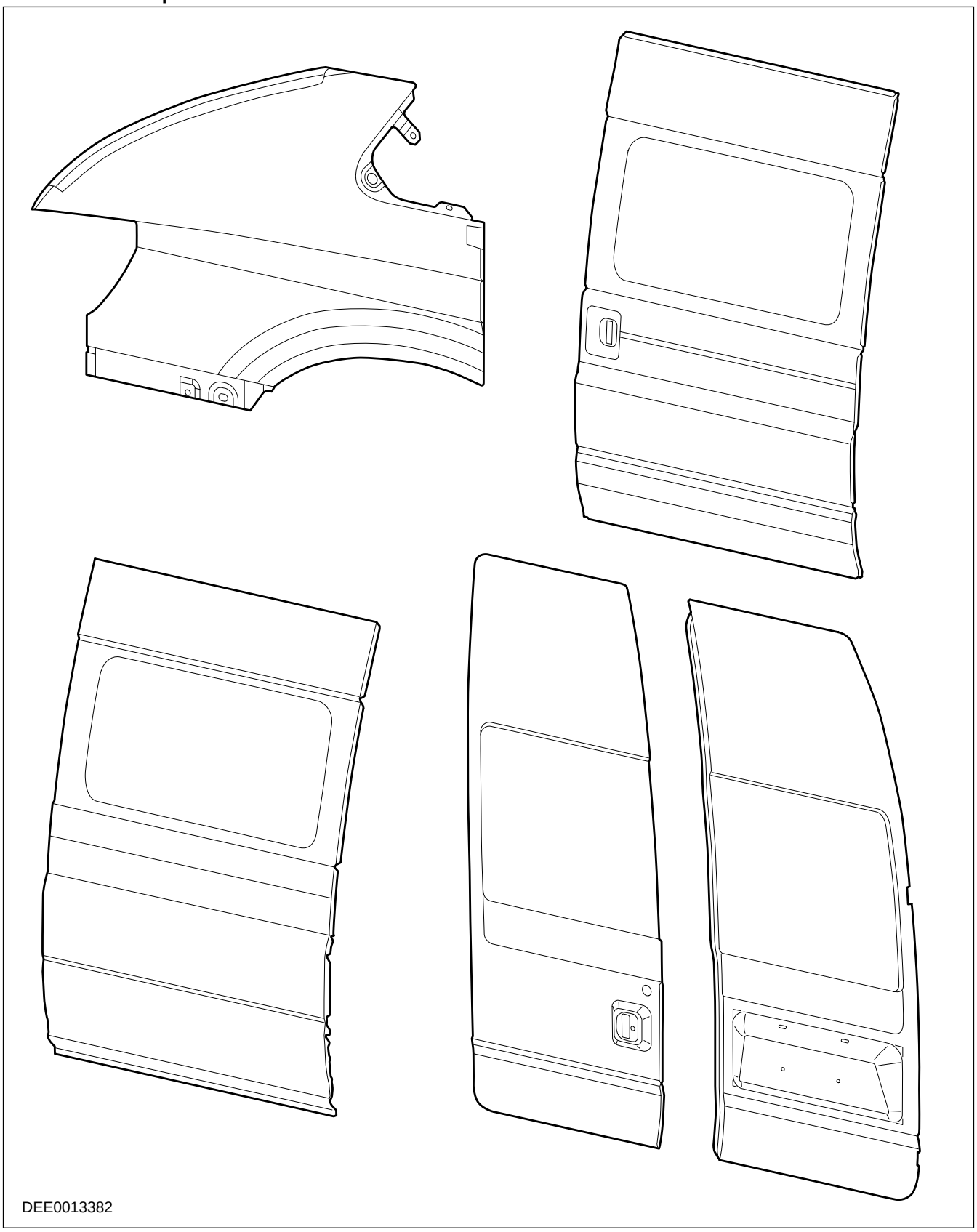
Item	Description
1	D-pillar
2	C-pillar
3	B-pillar

Corrosion prevention measures

All body parts that are liable to corrosion are zinc plated. It is therefore vitally important that the corrosion protection measures are carried out with the greatest care during bodywork repairs.

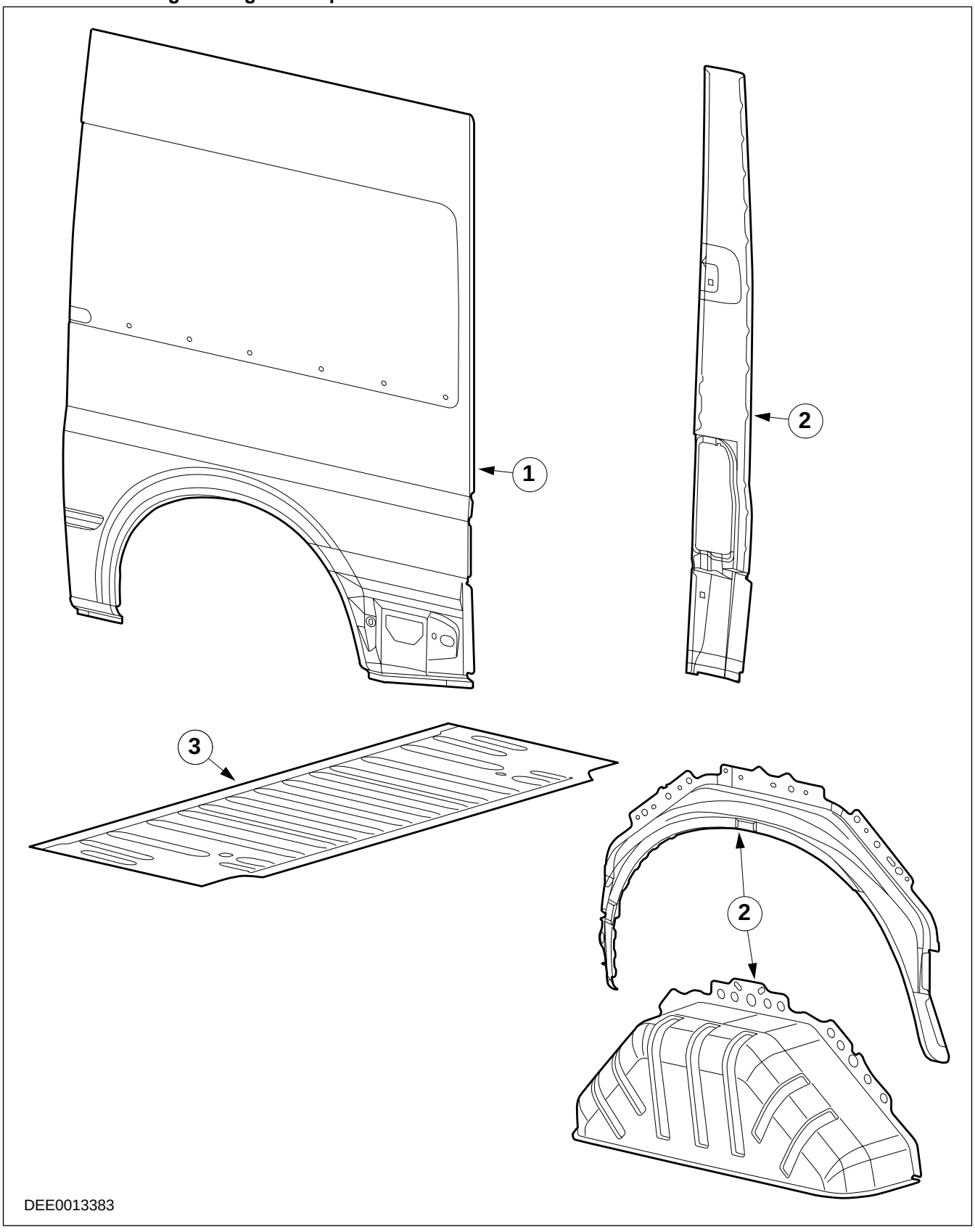
DESCRIPTION AND OPERATION

Galvanised steel panels



DESCRIPTION AND OPERATION

Galvanized and high strength steel panels



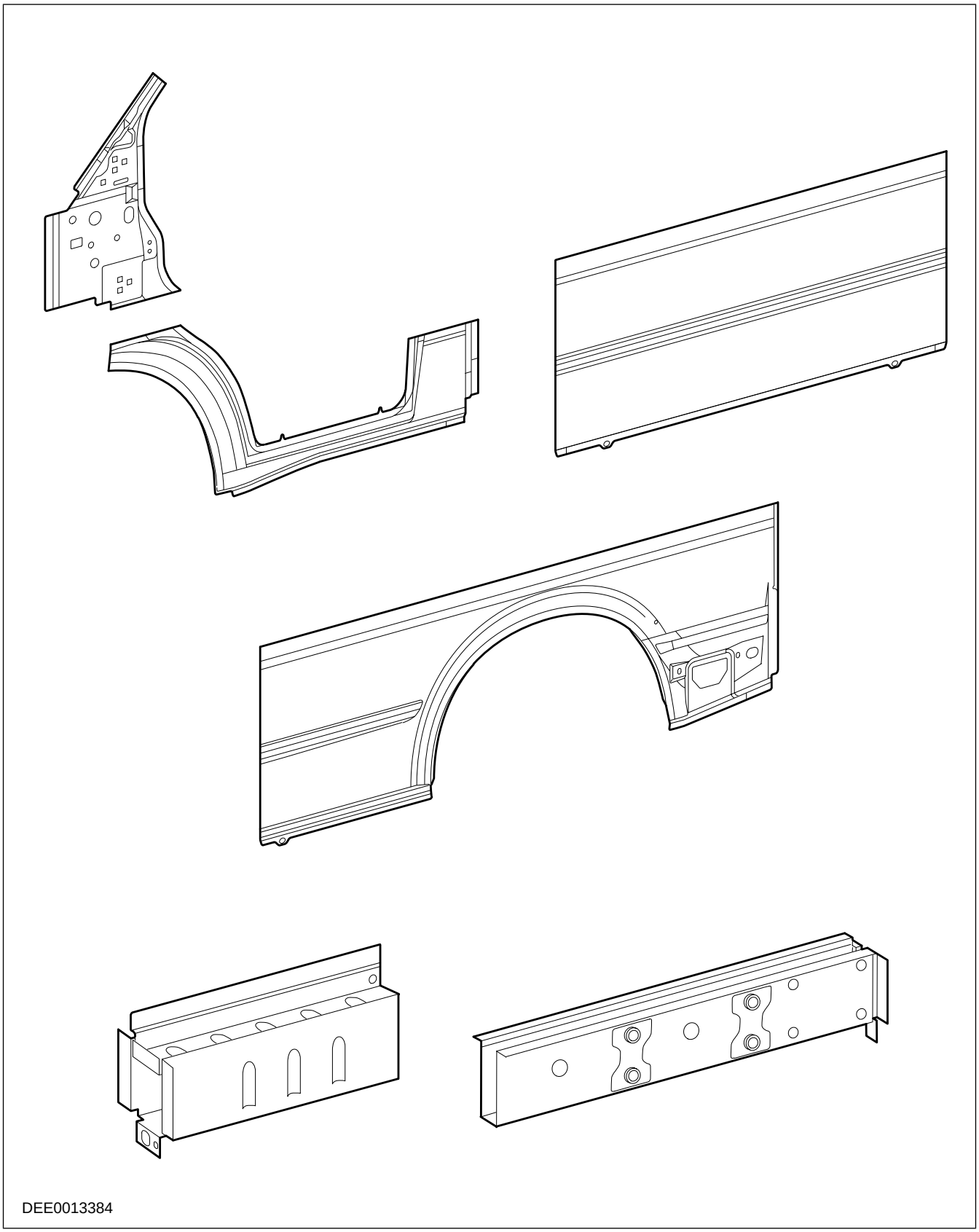
DESCRIPTION AND OPERATION

Item	Description
1	Galvanized and high-strength steel panel
2	Galvanized steel panel
3	High-strength steel panel

Sheet metal parts for partial panel replacement repairs

The following illustrations represent he current sheet metal parts available for partial panel replacement on all Transit model variants.

DESCRIPTION AND OPERATION



DEE0013384

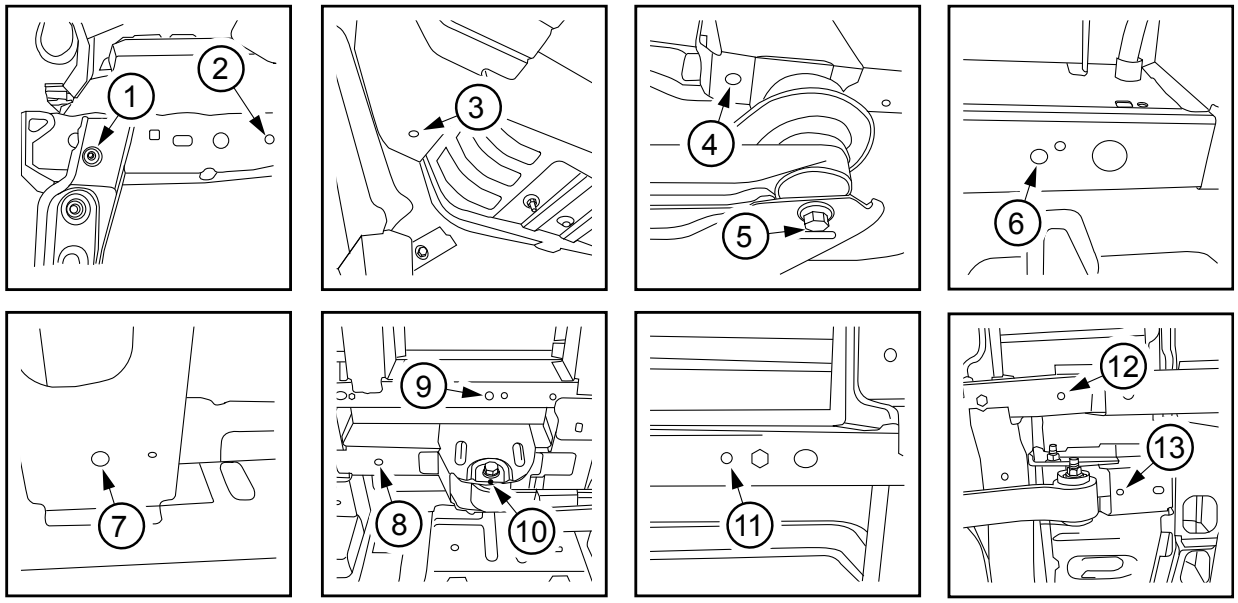
GENERAL PROCEDURES

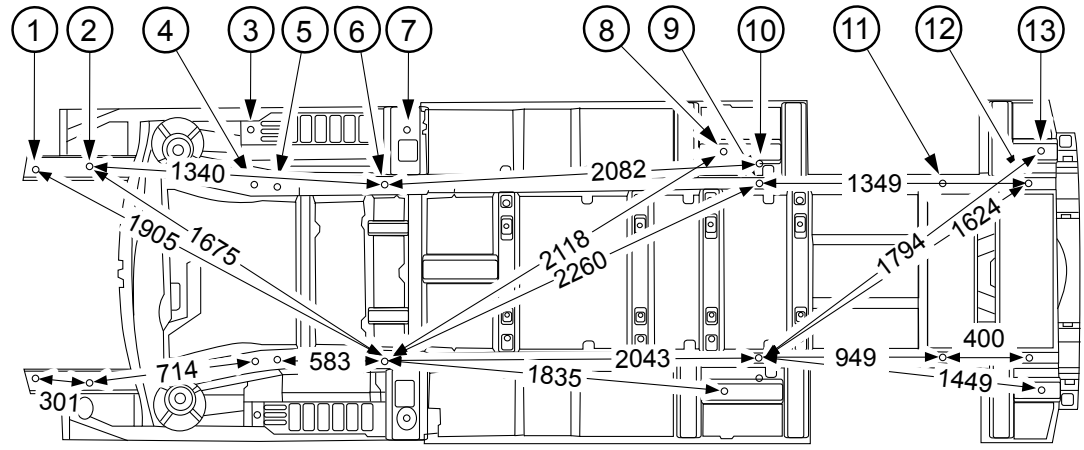
Underbody Tolerance Check

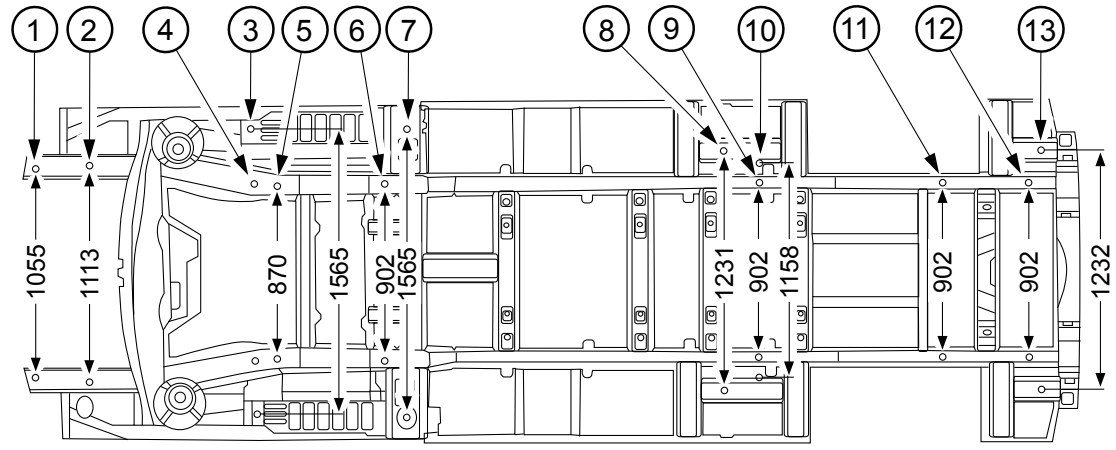
1. Body frame dimensions for Kombi/Bus/Van with long wheel base and front-wheel drive

- A tolerance of ± 3 mm applies to all dimensions given. All detailed illustrations correspond to the left-hand side of the vehicle.
- All dimensions correspond to a direct line between measurement points. All dimensions can therefore be determined using a symmetrically-adjusted beam trammel.
- The measurement points were measured with assemblies installed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (direction of travel).

GENERAL PROCEDURES







E47888

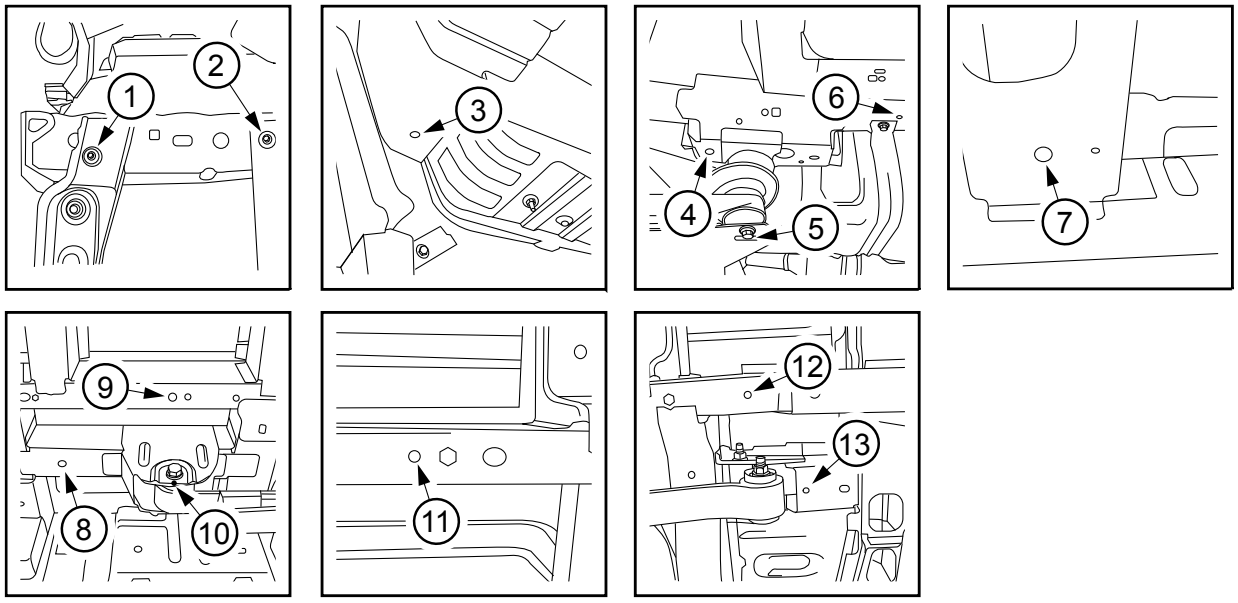
2. Body frame dimensions for Kombi/Bus/Van with long wheel base and rear-wheel drive

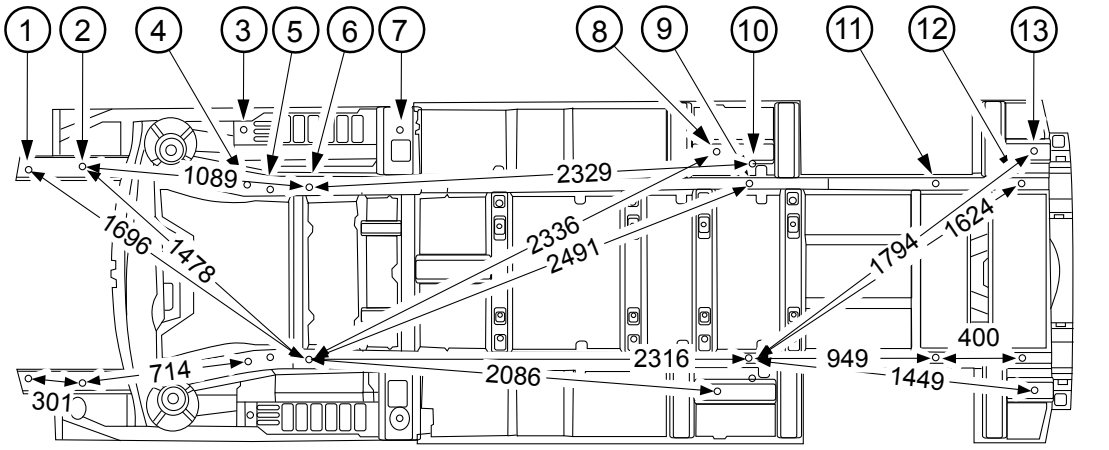
- A tolerance of ± 3 mm applies to all dimensions given. All detailed illustrations correspond to the left-hand side of the vehicle.

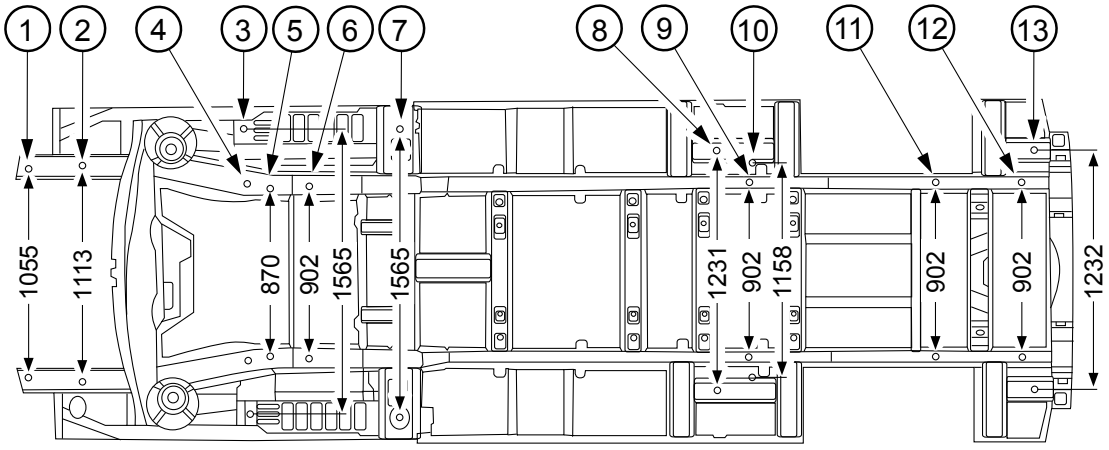
GENERAL PROCEDURES

- All dimensions correspond to a direct line between measurement points. All dimensions can therefore be determined using a symmetrically-adjusted beam trammel.
- The measurement points were measured with assemblies installed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (direction of travel).

GENERAL PROCEDURES







E47889

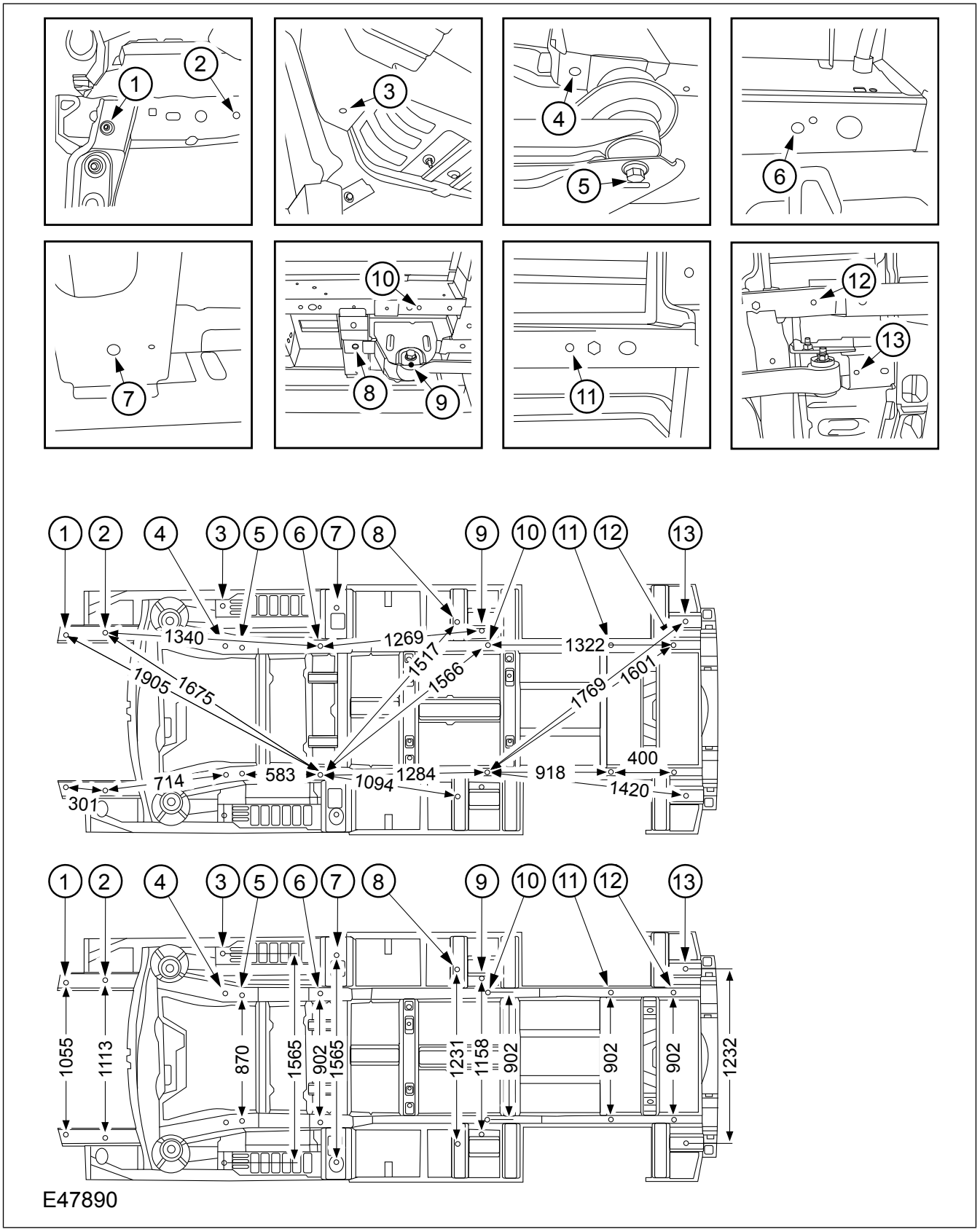
3. Body frame dimensions for Kombi/Bus/Van with short wheel base and front-wheel drive

- A tolerance of ± 3 mm applies to all dimensions given. All detailed illustrations correspond to the left-hand side of the vehicle.

GENERAL PROCEDURES

- All dimensions correspond to a direct line between measurement points. All dimensions can therefore be determined using a symmetrically-adjusted beam trammel.
- The measurement points were measured with assemblies installed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (direction of travel).

GENERAL PROCEDURES



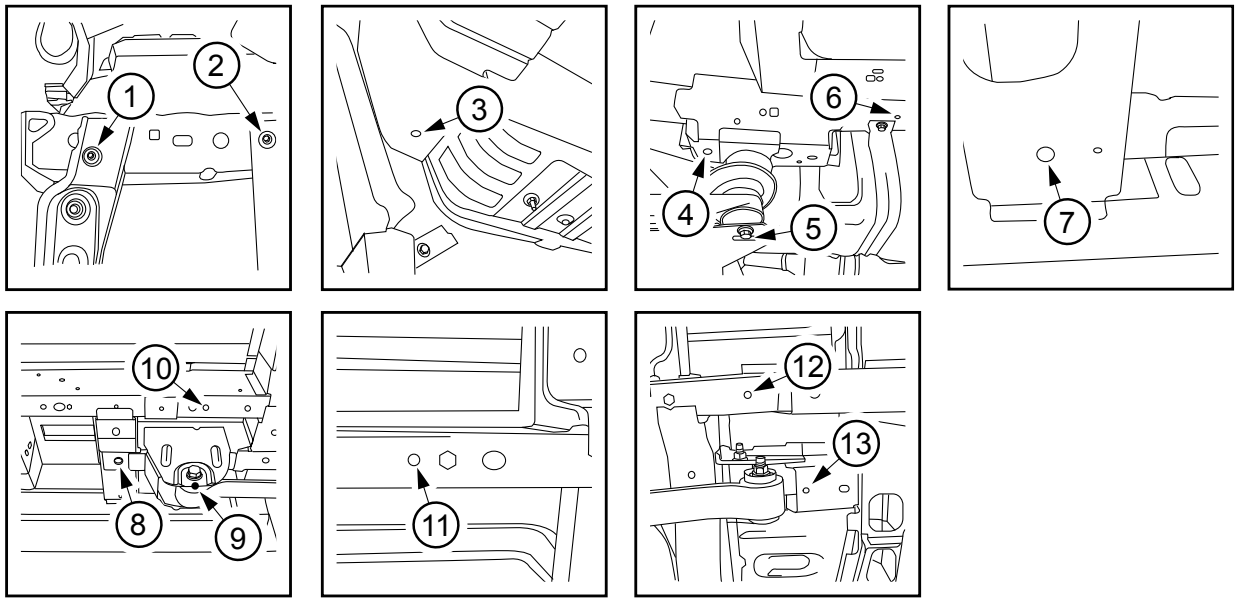
4. Body frame dimensions for Kombi/Bus/Van with short wheel base and rear-wheel drive

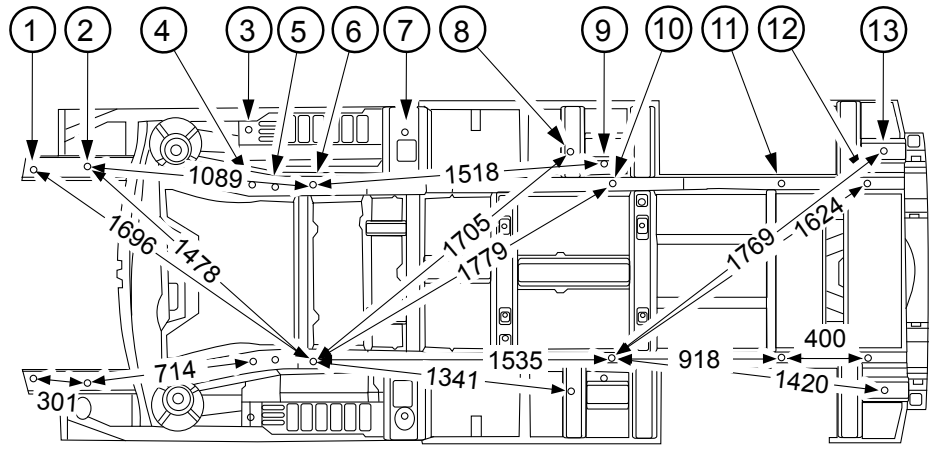
- A tolerance of ± 3 mm applies to all dimensions given. All detailed illustrations correspond to the left-hand side of the vehicle.

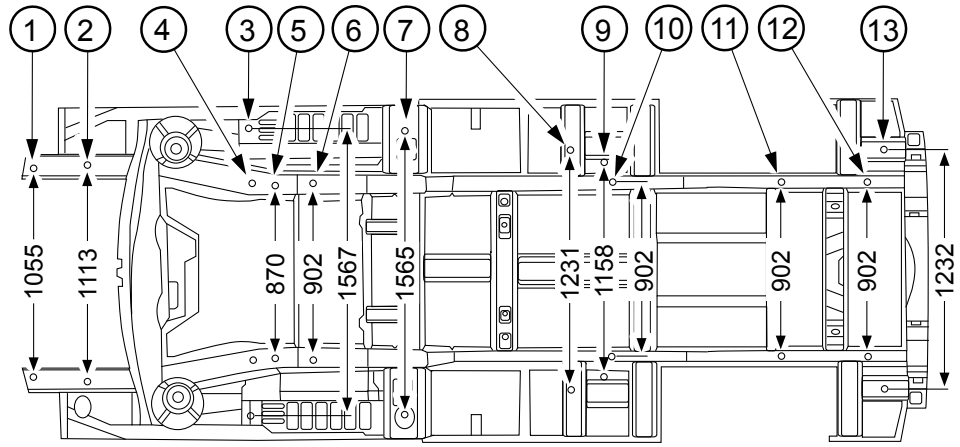
GENERAL PROCEDURES

- All dimensions correspond to a direct line between measurement points. All dimensions can therefore be determined using a symmetrically-adjusted beam trammel.
- The measurement points were measured with assemblies installed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (direction of travel).

GENERAL PROCEDURES







E47891

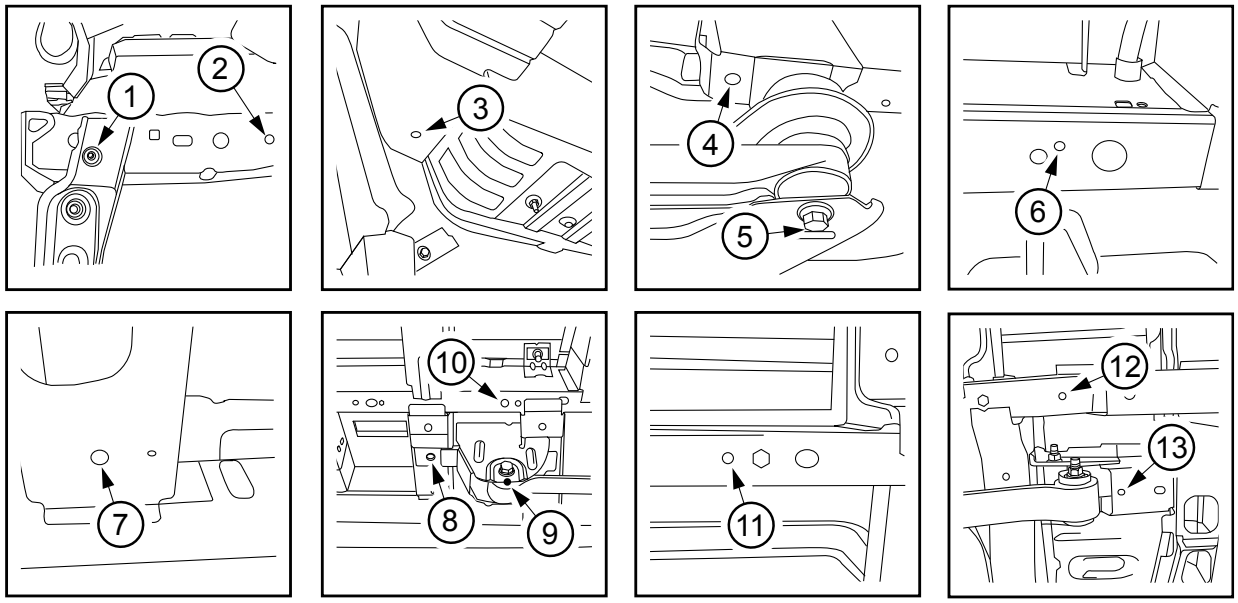
5. Body frame dimensions for Kombi/Bus/Van with medium wheel base and front-wheel drive

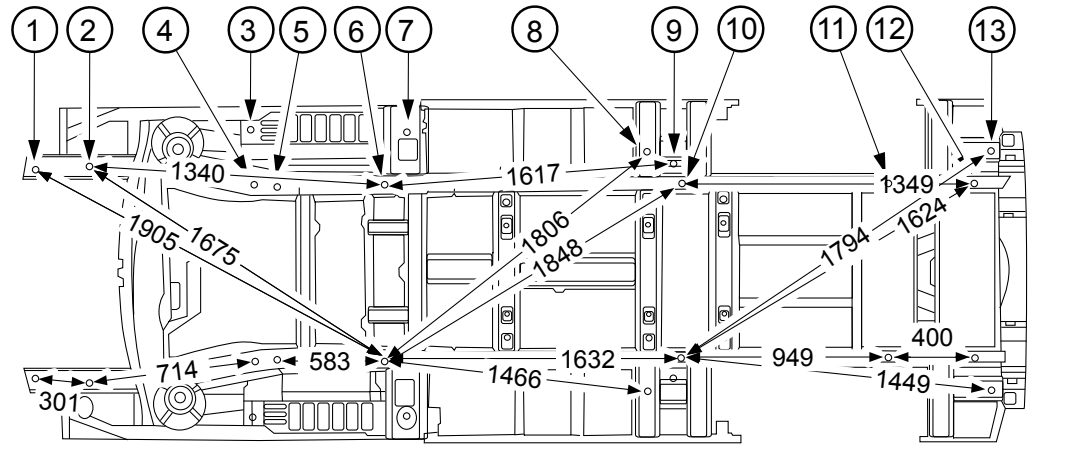
- A tolerance of ± 3 mm applies to all dimensions given. All detailed illustrations correspond to the left-hand side of the vehicle.

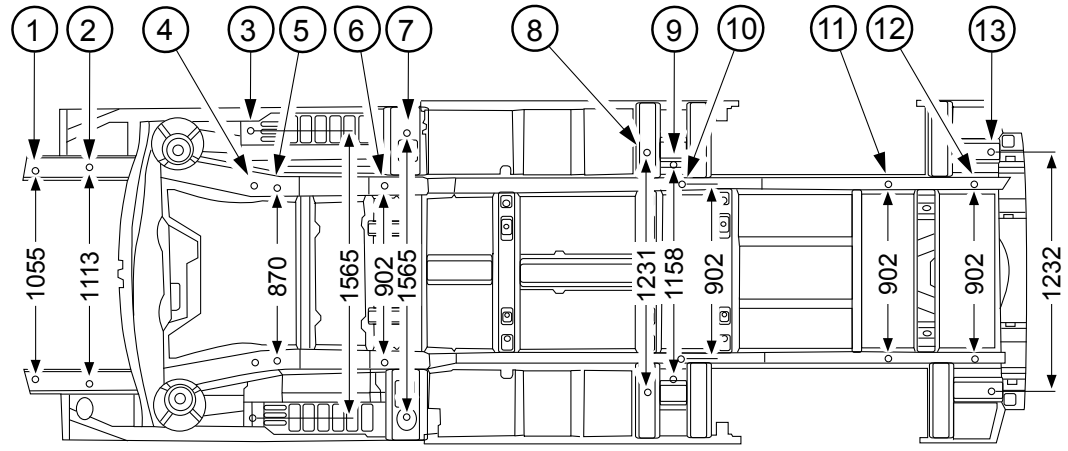
GENERAL PROCEDURES

- All dimensions correspond to a direct line between measurement points. All dimensions can therefore be determined using a symmetrically-adjusted beam trammel.
- The measurement points were measured with assemblies installed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (direction of travel).

GENERAL PROCEDURES







E47892

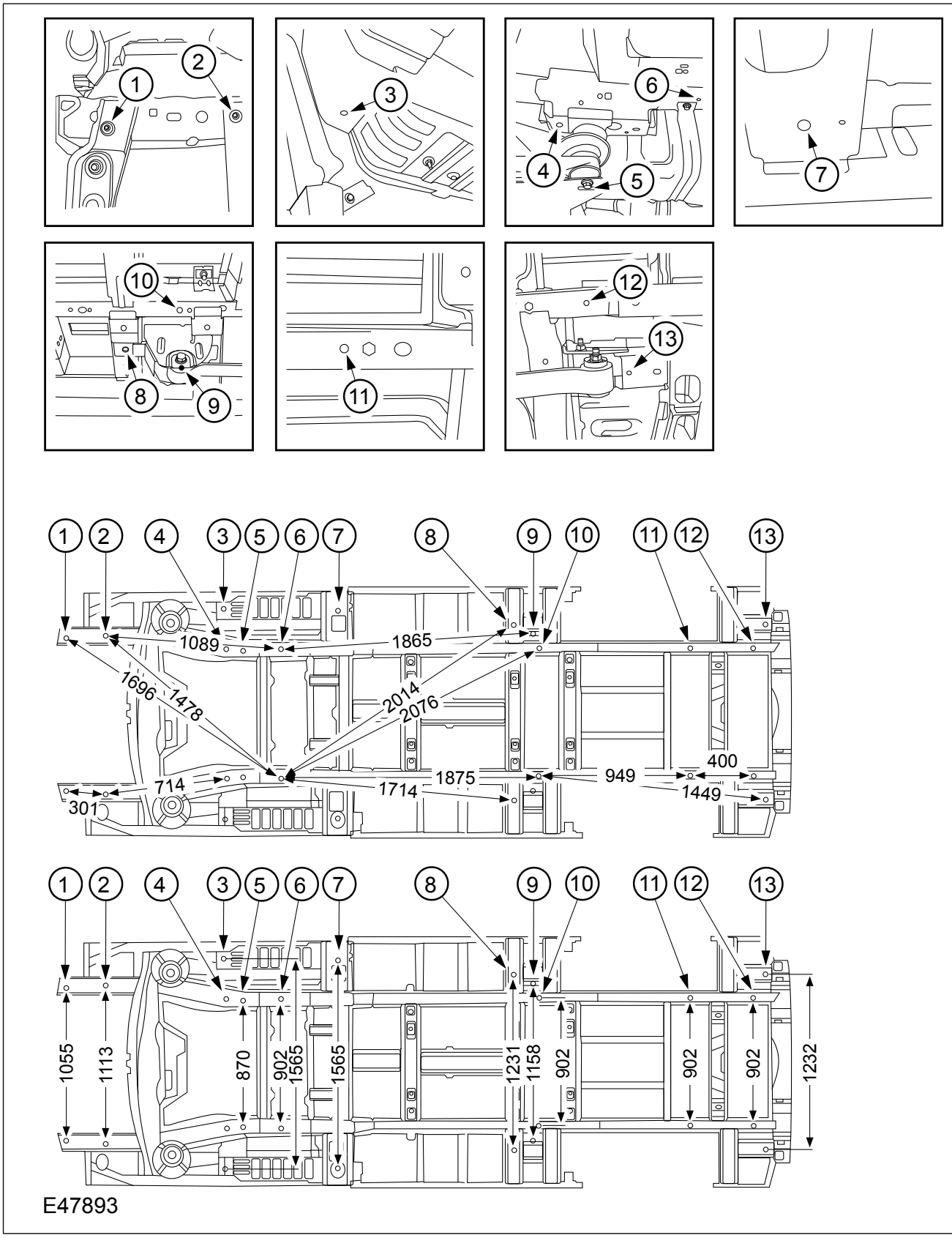
6. Body frame dimensions for Kombi/Bus/Van with medium wheel base and rear-wheel drive

- A tolerance of ± 3 mm applies to all dimensions given. All detailed illustrations correspond to the left-hand side of the vehicle.

GENERAL PROCEDURES

- All dimensions correspond to a direct line between measurement points. All dimensions can therefore be determined using a symmetrically-adjusted beam trammel.
- The measurement points were measured with assemblies installed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (direction of travel).

GENERAL PROCEDURES



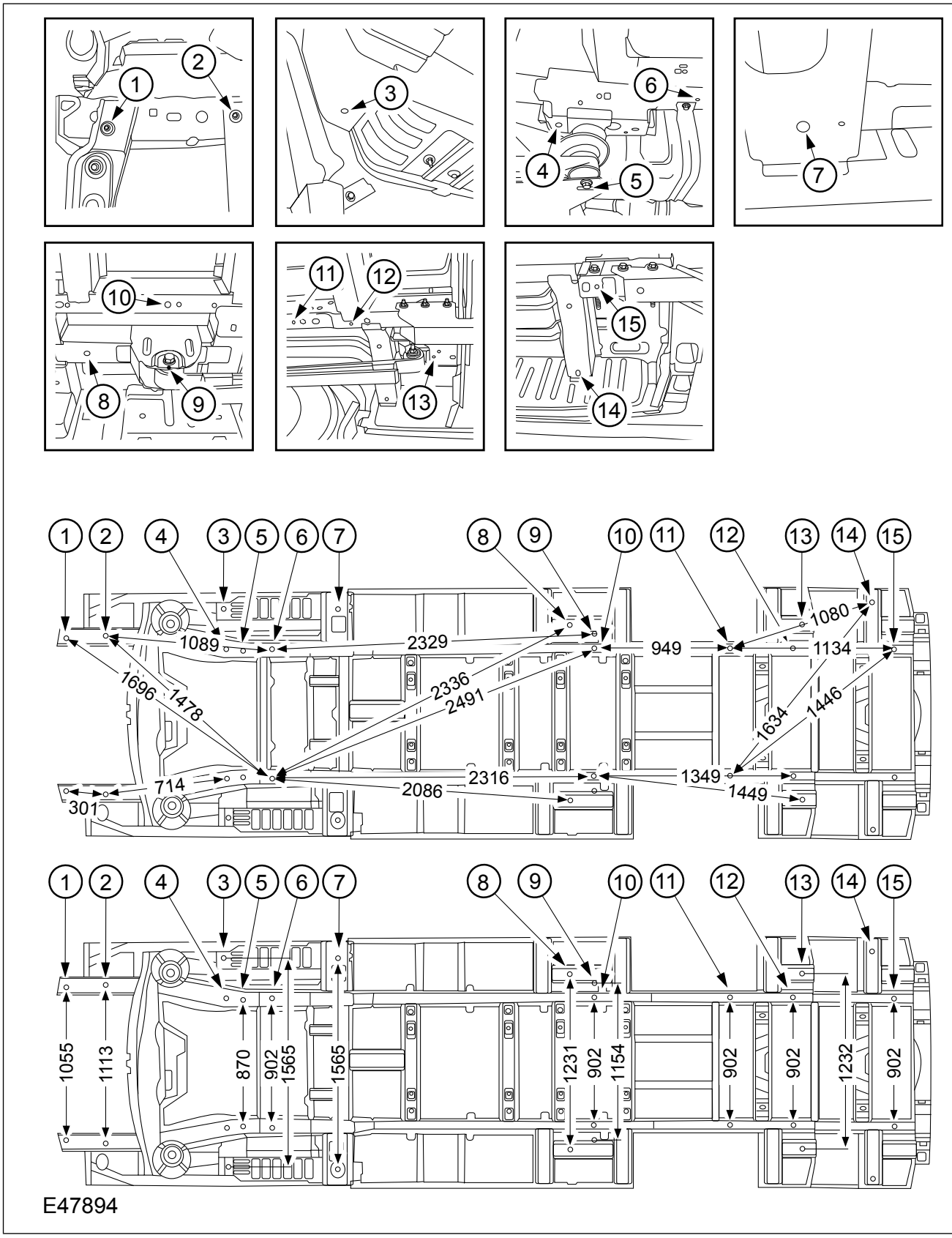
7. Body frame dimensions for Jumbo with rear-wheel drive

- A tolerance of ± 3 mm applies to all dimensions given. All detailed illustrations correspond to the left-hand side of the vehicle.

GENERAL PROCEDURES

- All dimensions correspond to a direct line between measurement points. All dimensions can therefore be determined using a symmetrically-adjusted beam trammel.
- The measurement points were measured with assemblies installed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (direction of travel).

GENERAL PROCEDURES



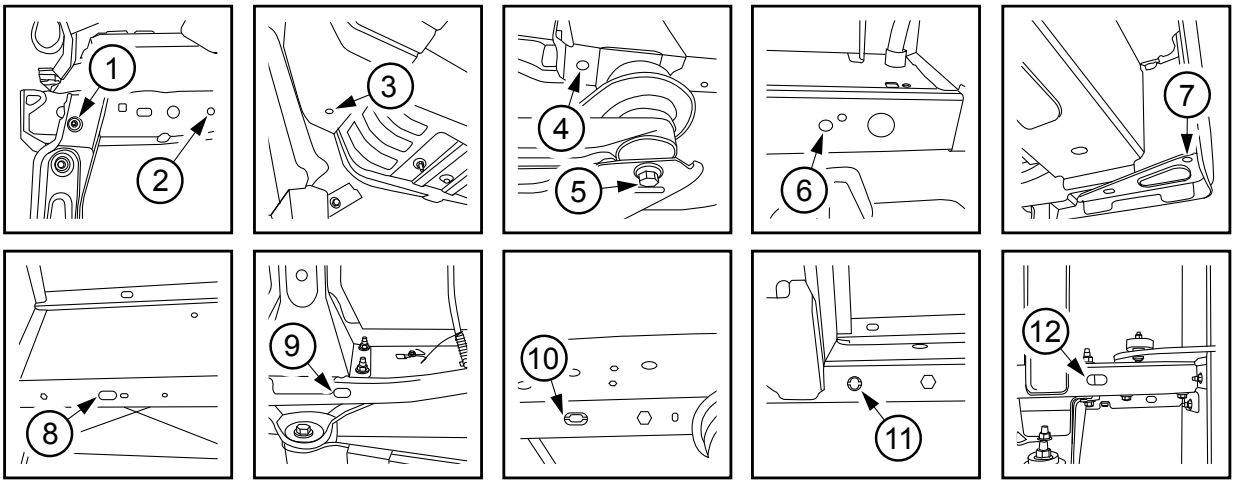
8. Body frame dimensions for single chassis cab with short wheel base and front-wheel drive

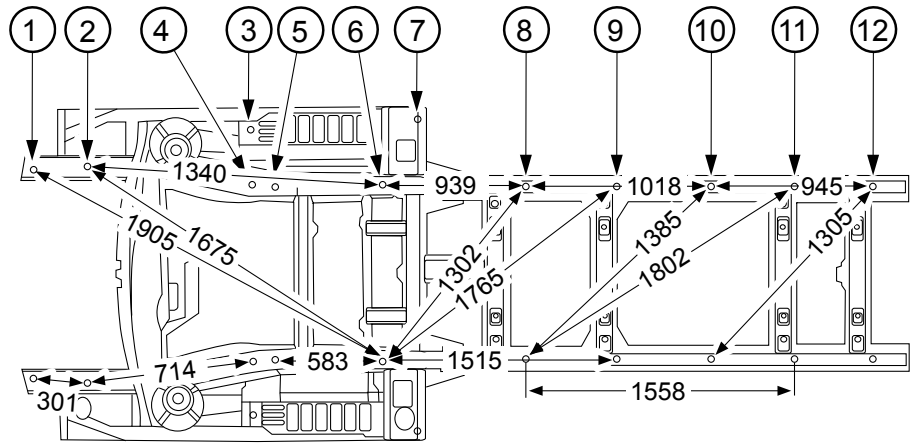
- A tolerance of ± 3 mm applies to all dimensions given. All detailed illustrations correspond to the left-hand side of the vehicle.

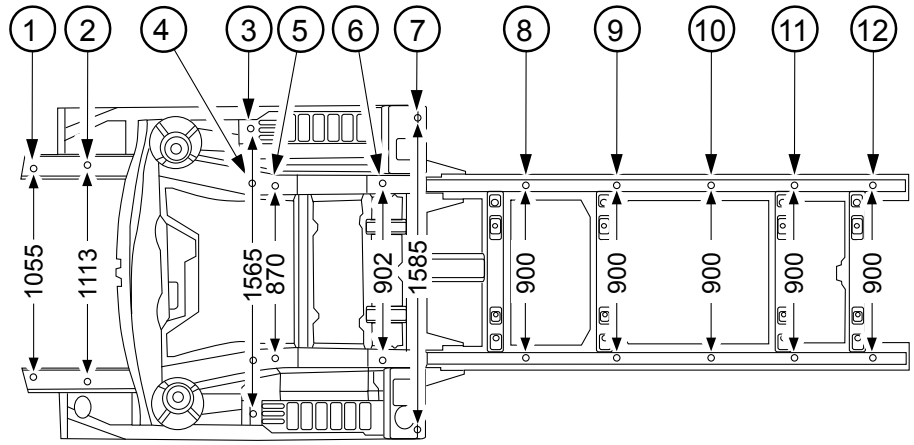
GENERAL PROCEDURES

- All dimensions correspond to a direct line between measurement points. All dimensions can therefore be determined using a symmetrically-adjusted beam trammel.
- The measurement points were measured with assemblies installed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (direction of travel).

GENERAL PROCEDURES







E47895

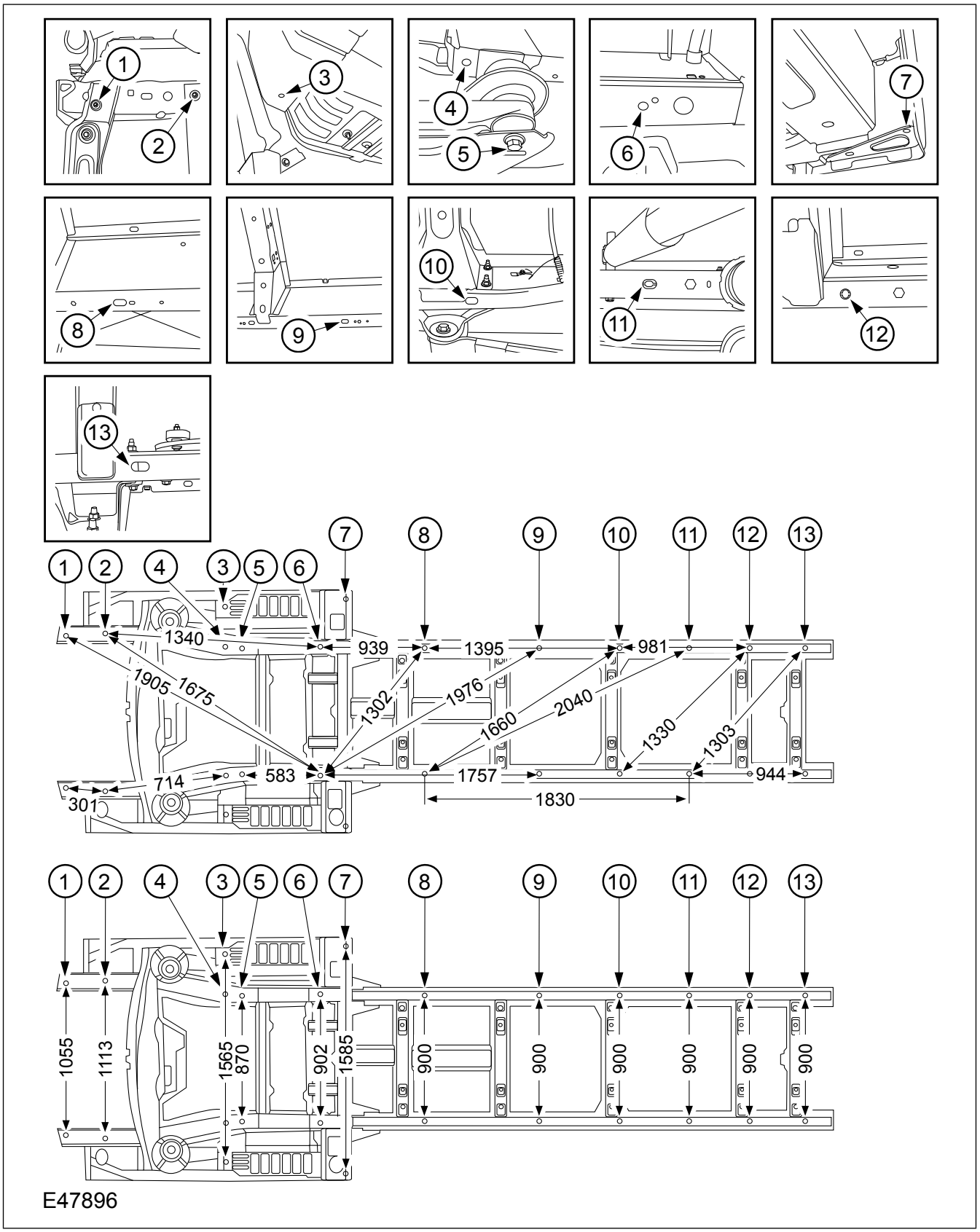
9. Body frame dimensions for single chassis cab with long wheel base and rear-wheel drive

- A tolerance of ± 3 mm applies to all dimensions given. All detailed illustrations correspond to the left-hand side of the vehicle.

GENERAL PROCEDURES

- All dimensions correspond to a direct line between measurement points. All dimensions can therefore be determined using a symmetrically-adjusted beam trammel.
- The measurement points were measured with assemblies installed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (direction of travel).

GENERAL PROCEDURES



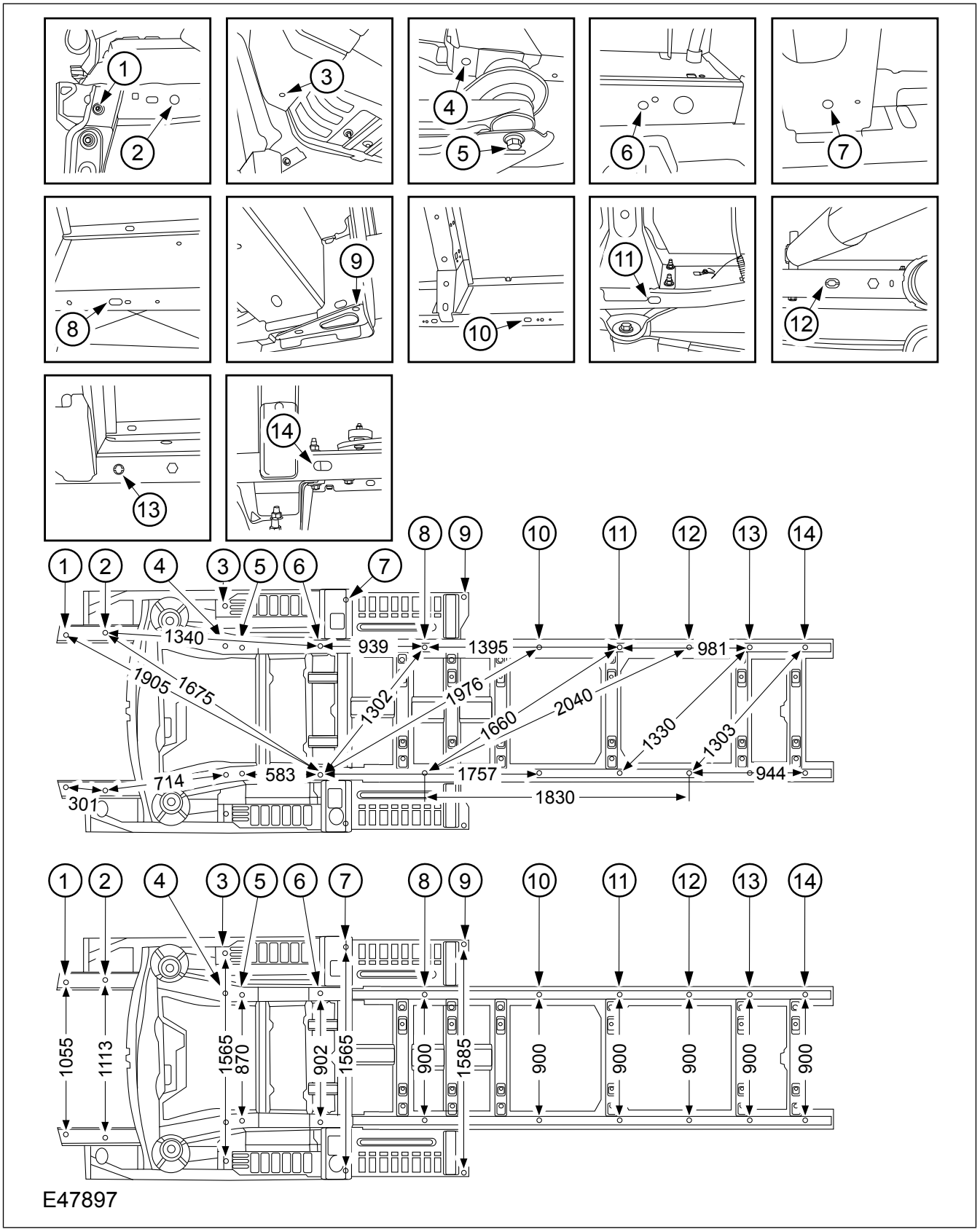
10. Body frame dimensions for double chassis cab with long wheel base and rear-wheel drive

- A tolerance of ± 3 mm applies to all dimensions given. All detailed illustrations correspond to the left-hand side of the vehicle.

GENERAL PROCEDURES

- All dimensions correspond to a direct line between measurement points. All dimensions can therefore be determined using a symmetrically-adjusted beam trammel.
- The measurement points were measured with assemblies installed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (direction of travel).

GENERAL PROCEDURES



E47897

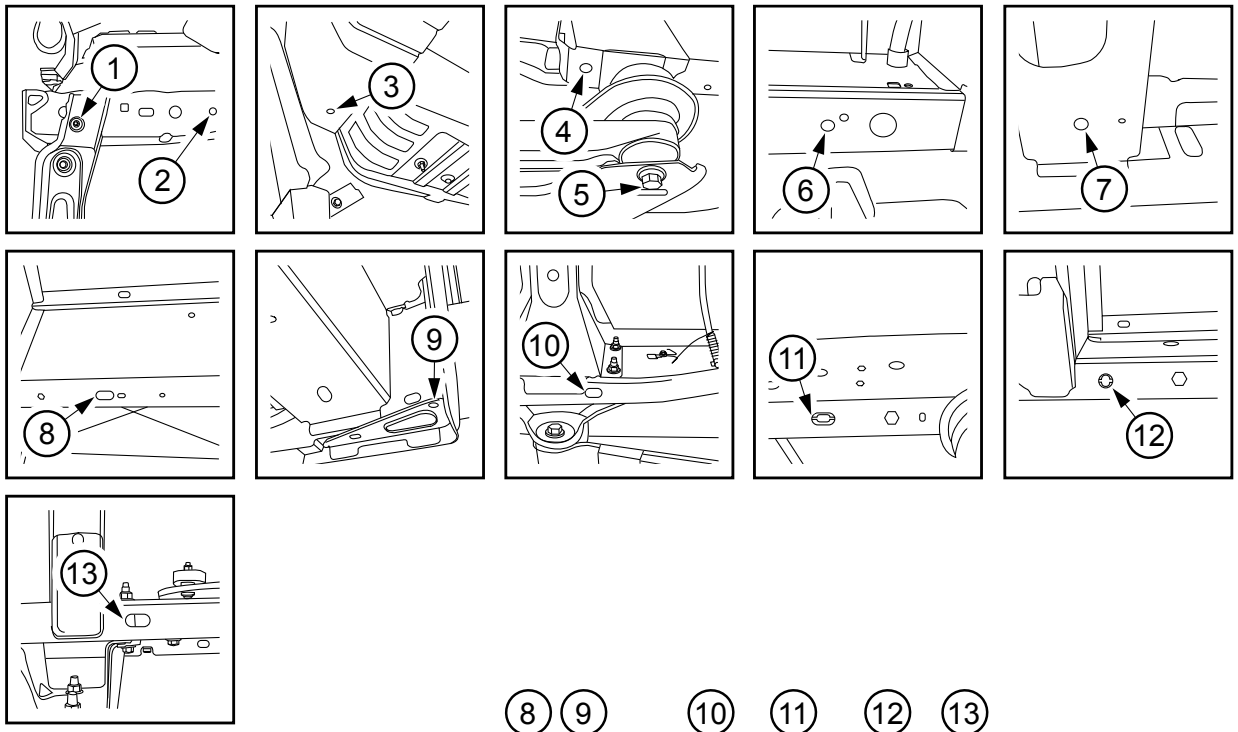
11. Body frame dimensions for double chassis cab with medium wheel base and front-wheel drive

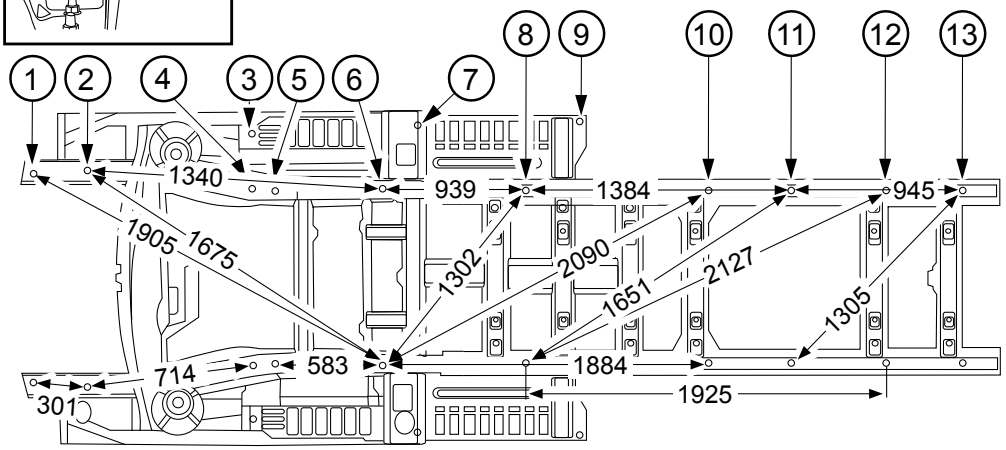
- A tolerance of ± 3 mm applies to all dimensions given. All detailed illustrations correspond to the left-hand side of the vehicle.

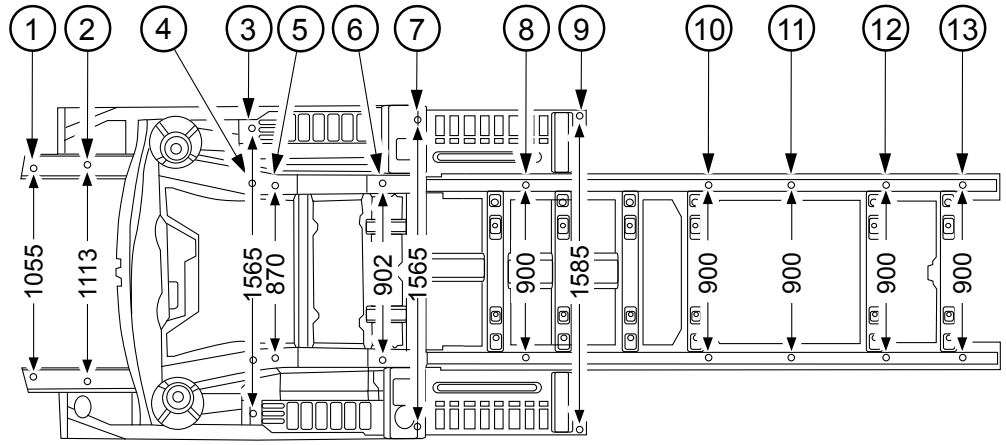
GENERAL PROCEDURES

- All dimensions correspond to a direct line between measurement points. All dimensions can therefore be determined using a symmetrically-adjusted beam trammel.
- The measurement points were measured with assemblies installed and with the exception of oval bodywork holes, refer to the centre of the hole.
- The measurement points for oval bodywork holes relate to the foremost position of the curve (direction of travel).

GENERAL PROCEDURES







E47898

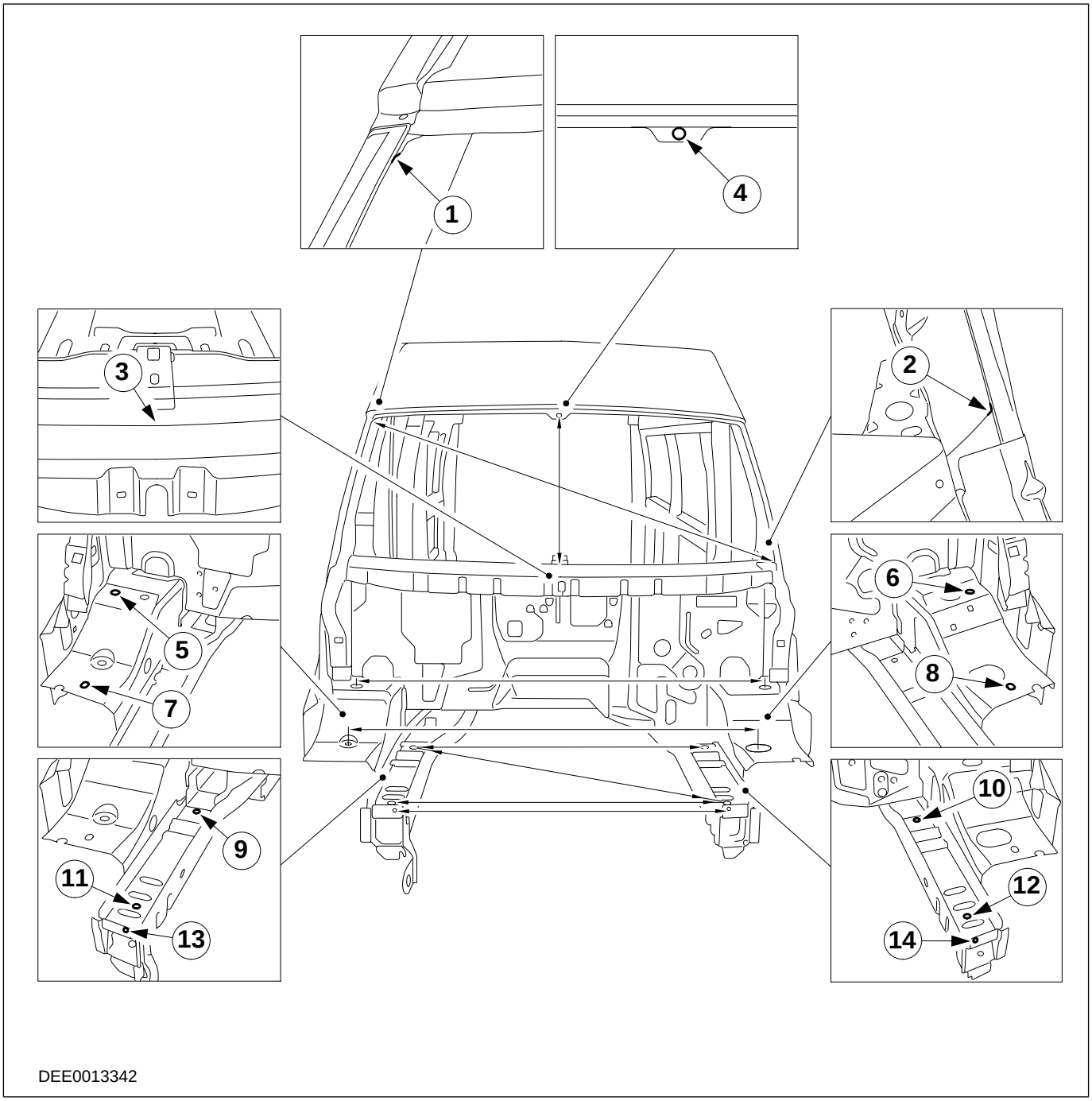
GENERAL PROCEDURES

Body Tolerance Check

1. **When re-alignment work is being carried out, or individual components are being exchanged, the given required values may be taken as guidelines (tolerance ± 3 mm).**
2. **NOTE:Testing the bodywork dimensions does not mean that the usual alignment work is not necessary.**

   This makes it possible to reduce the repeated installation and removal of attached components (e.g. doors, glazing, crossmembers etc.) in order to check that the bodywork measurements are correct.
3. **Body dimensions, front view. All dimensions have a tolerance of ± 3 mm. All dimensions were measured from the centre of the hole or the edge of the panel with a symmetrically adjusted beam trammel.**
   - 1 - 2 = 1826 mm; 3 - 4 = 822 mm; 5 - 6 = 1605 mm; 7 - 8 = 1485 mm; 9 - 10 = 1106 mm; 11 - 12 = 1106 mm; 9 - 12 = 1212 mm;13 - 14 = 1062 mm

GENERAL PROCEDURES

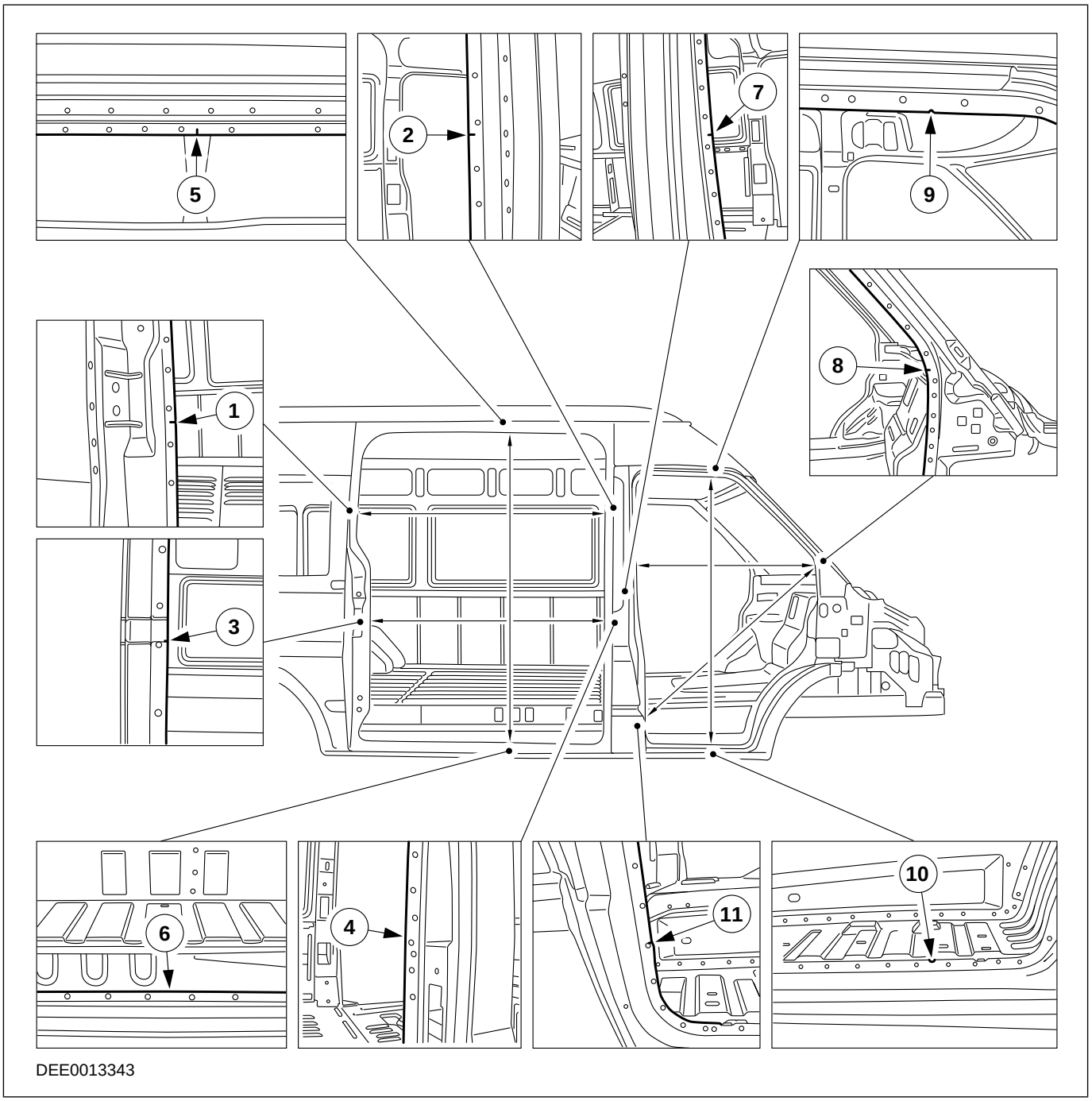


DEE0013342

4. Body dimensions, side view. All dimensions have a tolerance of ± 3 mm. All dimensions were measured from the centre of the hole or the edge of the panel with a symmetrically adjusted beam trammel.

- 15 - 16 = 1347 mm; 17 - 18 = 1281 mm; 19 - 20= 1710 mm (highroof only); 21 - 22 = 980 mm; 23 - 24 = 1450 mm; 22 - 25 = 1250 mm

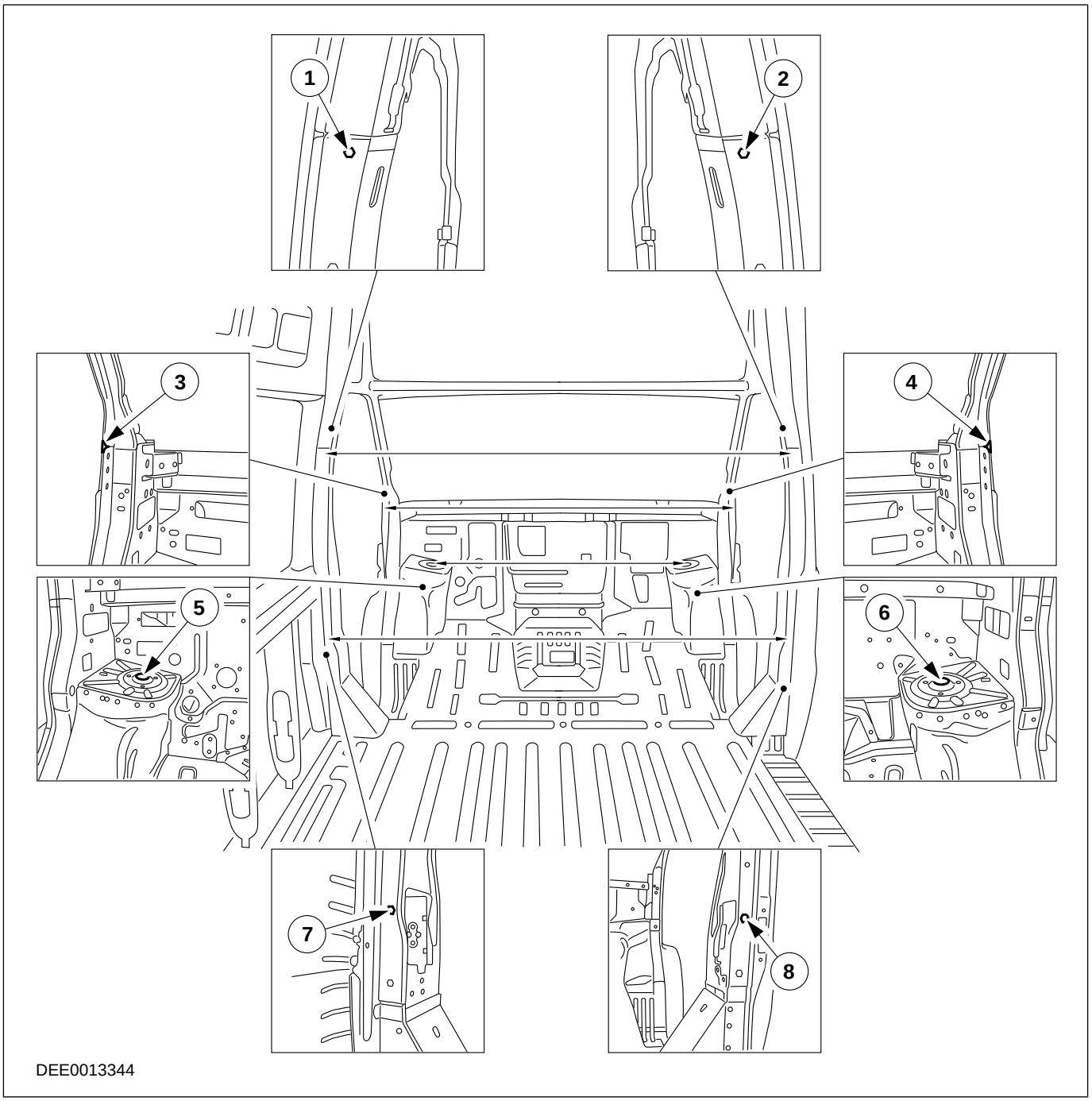
GENERAL PROCEDURES



5. Passenger compartment, body dimensions. All dimensions have a tolerance of ± 3 mm. All dimensions were measured from the centre of the hole or the edge of the panel with a symmetrically adjusted beam trammel.

- 26 - 27= 1675 mm; 28 - 29 = 1702 mm; 30 - 31 = 1285 mm; 32 - 33 = 1725 mm:

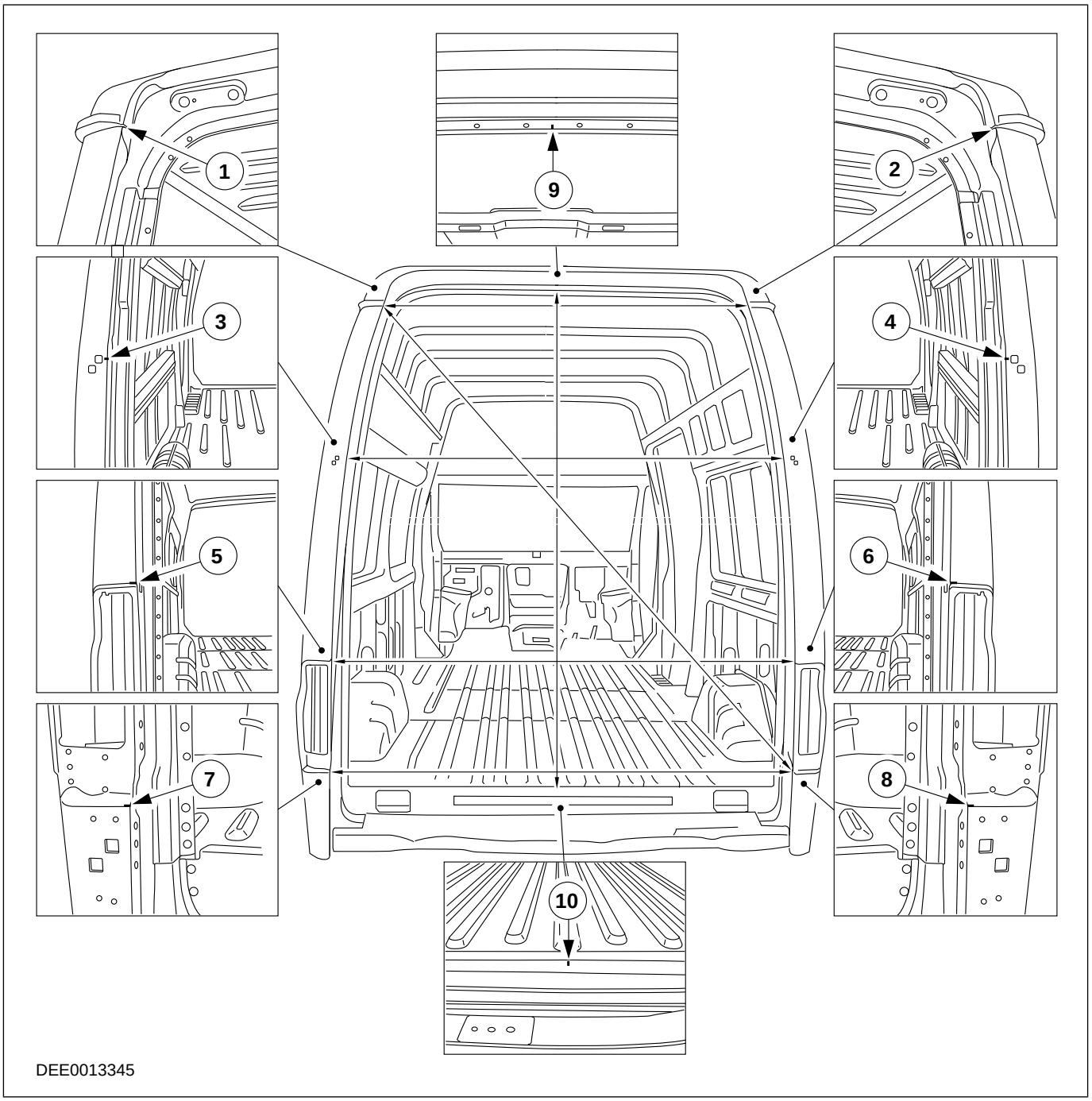
GENERAL PROCEDURES



6. Body dimensions, rear view. All dimensions have a tolerance of ± 3 mm. All dimensions were measured from the centre of the hole or the edge of the panel with a symmetrically adjusted beam trammel.

- 34 - 35 = 1452 mm; 36 - 37 = 1610 mm; 38 - 39 = 1645 mm; 40 - 41 = 1650 mm, 42 - 43 = 1574 mm; 34 - 41 = 2149 mm.

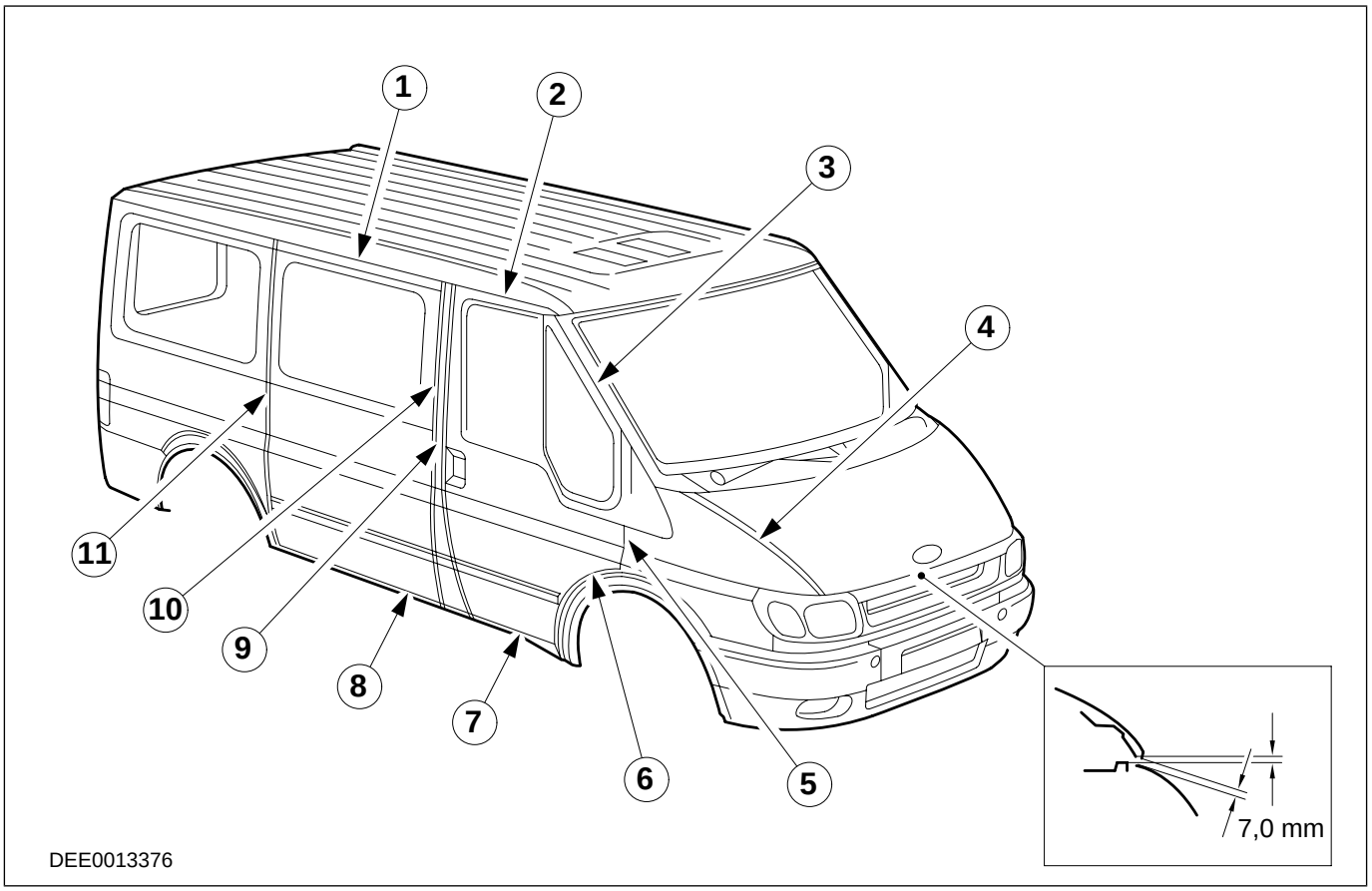
GENERAL PROCEDURES



7. The gap dimension given must be the same along the whole length of the gap.

- 1 = 6,0 mm ± 1,5 mm; 2 = 6,0 mm ±1,6 mm; 3 = 6,0 mm ± 3,5 mm; 4 = 4,0 mm ± 1,0 mm; 5 = 6,0 mm ± 1,6 mm; 6 = 6,5 mm ± 1,6 mm; 7 = 6,0 mm ± 1,6 mm; 8= 6,0 mm ± 1,6 mm; 9 = 6,0 mm ± 1,6 mm; 10 = 6,0 mm ±1,6 mm; 11 = 6,0 mm ± 1,6 mm

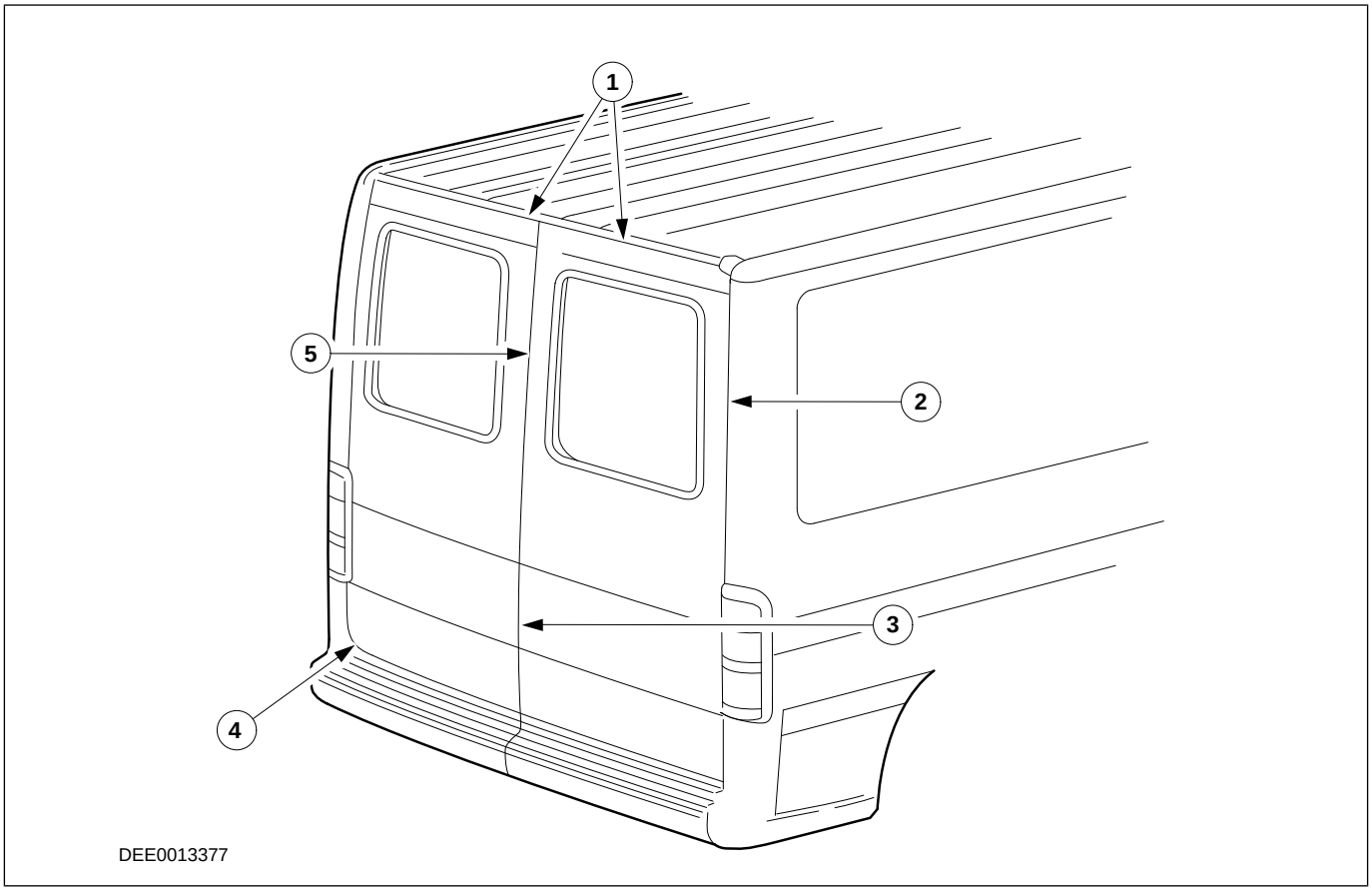
GENERAL PROCEDURES



8. The gap dimension given must be the same along the whole length of the gap.

- 12 = 9,0 mm ± 2,0 mm; 13 = 6,0 mm ±2,0 mm; 14 = 6,0 mm ± 1,0 mm; 15 = 13,0 mm ± 2,0 mm; 16 = 10,0mm ± 2,5 mm

GENERAL PROCEDURES



SECTION 501-27 Front End Sheet Metal Repairs

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

REMOVAL AND INSTALLATION

Fender Apron Panel..... 501-27-2
Fender Apron Panel Reinforcement..... (44 277 4) 501-27-3
Fender Apron Panel Inner Reinforcement..... 501-27-4
Front Side Member Section..... 501-27-5
Front Side Member and Fender Apron Panel LH..... 501-27-7

REMOVAL AND INSTALLATION

Fender Apron Panel

Materials	
Name	**Specification**
Apron panel	

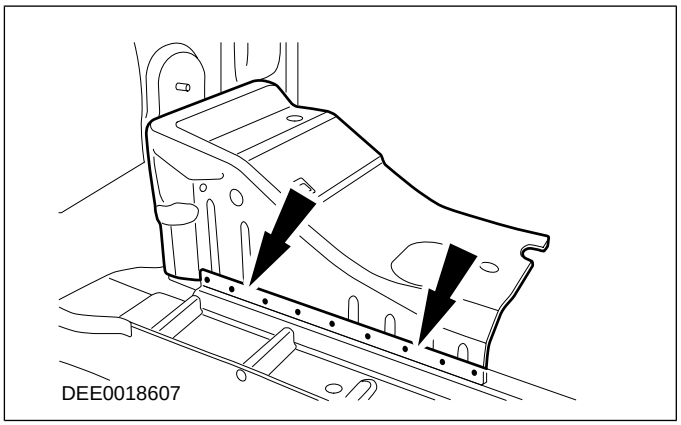
Removal

1. General notes

- Move floor coverings and cables from the working area.

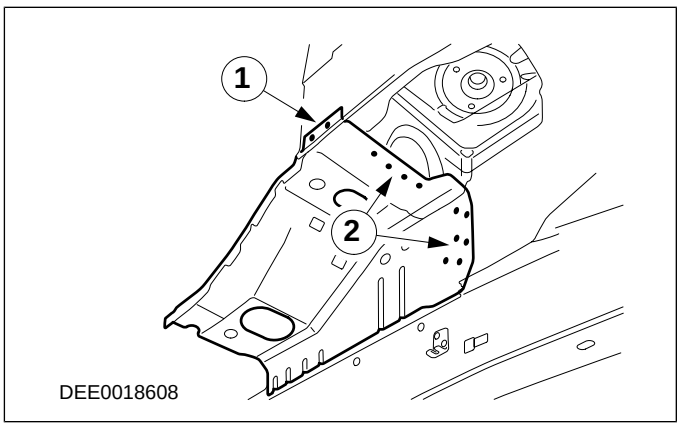
2. Apron panel

- Mill out the spot welds.



3. Apron panel

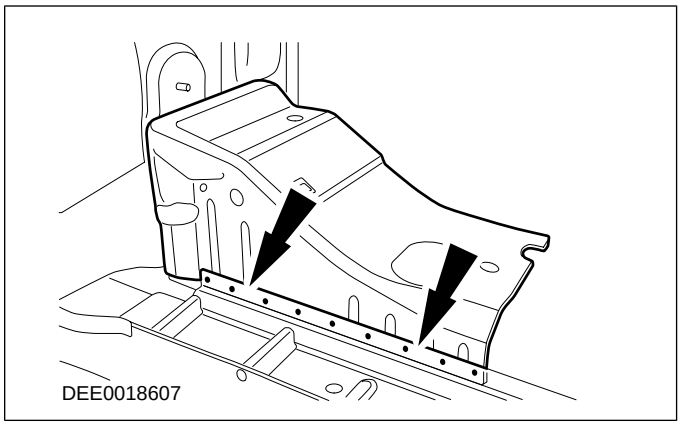
1. Mill out the spot welds from inside.
2. Mill out the spot welds.



Installation

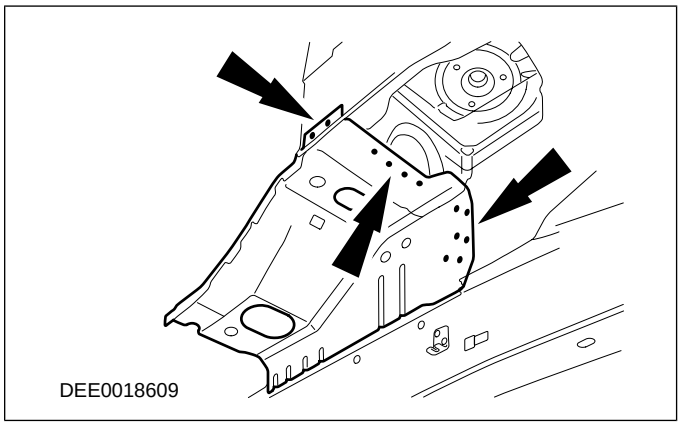
1. Apron panel

- Puddle weld.



2. Apron panel

- Puddle weld.



REMOVAL AND INSTALLATION

Fender Apron Panel Reinforcement (44 277 4)

Materials	
Name	**Specification**
Fender panel reinforcement	

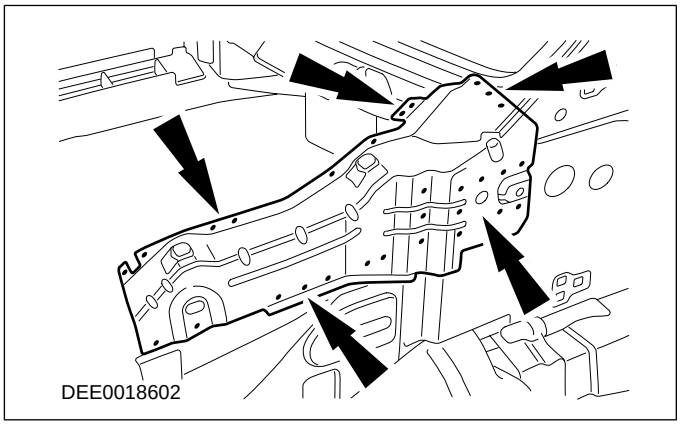
Removal

1. General notes

- Necessary removal work: windscreen, hood, hood hinges

2. Fender panel reinforcement

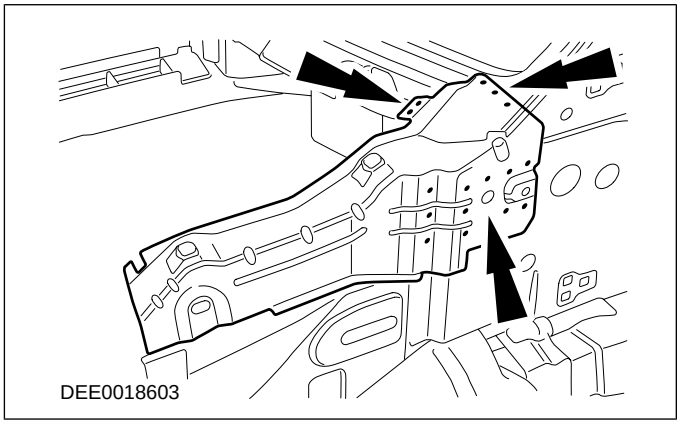
- Mill out the spot welds.



Installation

1. Apron panel reinforcement

- Puddle weld.



REMOVAL AND INSTALLATION

Fender Apron Panel Inner Reinforcement

Materials	
Name	**Specification**
Inner apron panel reinforcement	

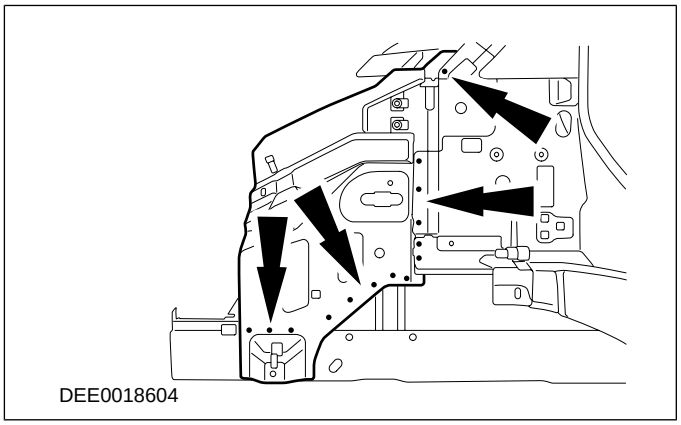
Removal

1. General notes

- Necessary removal work: windscreen, fender, hood, hood hinge

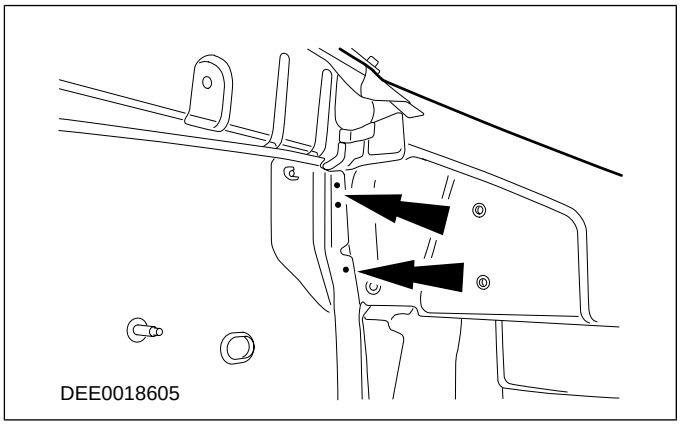
2. Inner apron panel reinforcement

- Mill out the spot welds.

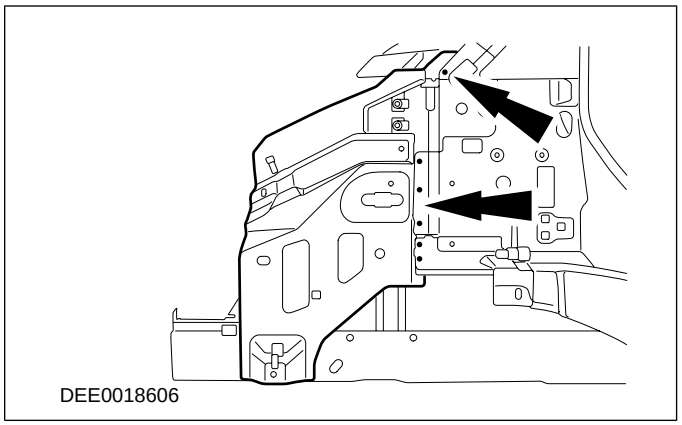

DEE0018604

3. Inner apron panel reinforcement

- Mill out the spot welds.

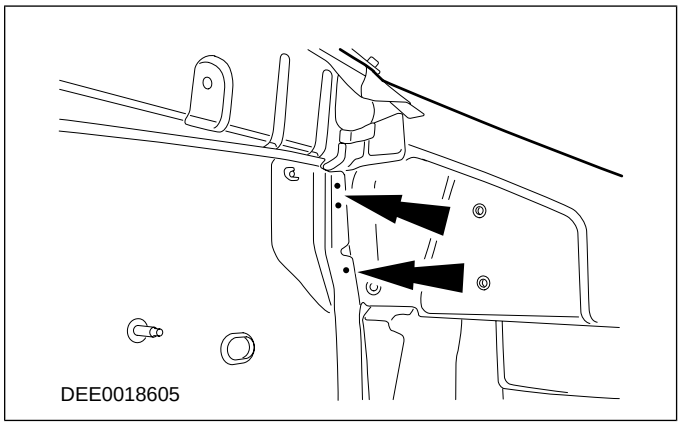

DEE0018605

- Puddle weld.


DEE0018606

2. Inner apron panel reinforcement

- Puddle weld.


DEE0018605

Installation

1. Inner apron panel reinforcement

REMOVAL AND INSTALLATION

Front Side Member Section

General Equipment

Measurement or alignment angle system

Materials	
Name	**Specification**
Side member section	
Towing bracket	
Side member closing panel	

Removal

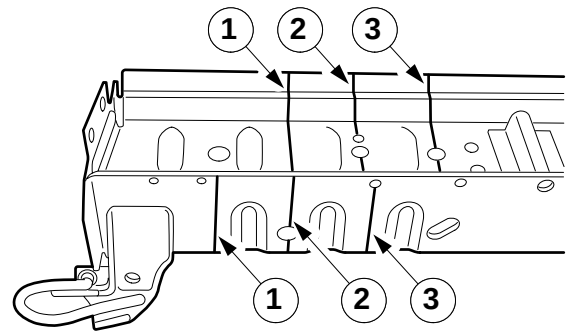
1. General information

- Necessary removal work: Fender

2. NOTE:3 cut locations are possible, depending on the extent of the damage. The minimum cut line offset should be 70 mm. If there is damage behind the third cut line variant, the whole side member must be replaced (442831).

Side member

1. Cut variant 1
2. Cut variant 2
3. Cut variant 3

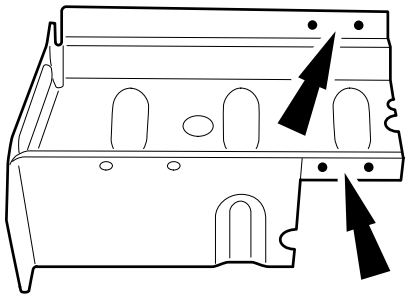


DEE0018610

Installation

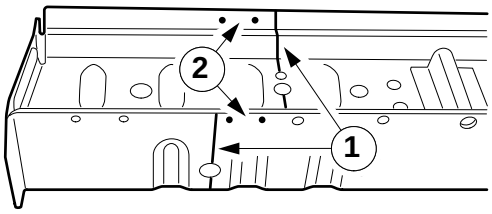
1. Prepare the new part.

- Make holes for puddle welding.


DEE0018614

2. Side member

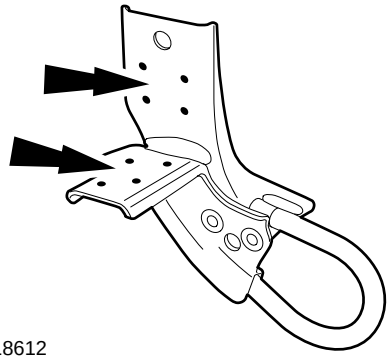
1. Attach the new part by means of several tack welds. Then produce continuous MIG weld seams with gaps.
2. Puddle weld.



DEE0018611

3. Towing bracket

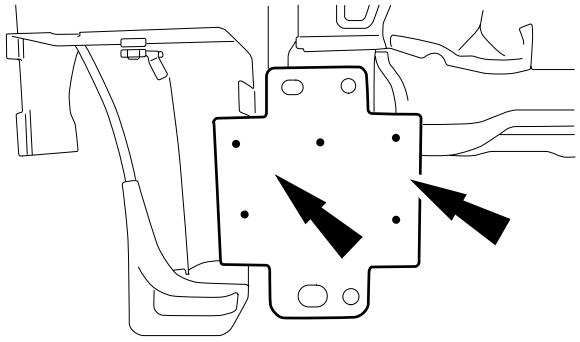
- Make holes for puddle welding.
- Fix the towing eye in position and puddle weld.


DEE0018612

4. Side member closing panel

REMOVAL AND INSTALLATION

- Electric resistance spot welding.



DEE0018613

REMOVAL AND INSTALLATION

Front Side Member and Fender Apron Panel LH

General Equipment

Measurement or alignment angle system

Materials

Name	Specification
Side member	
Side member closing panel	

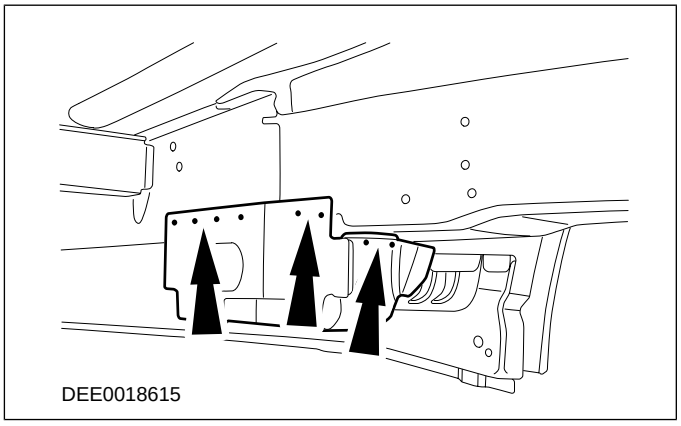
Removal

1. General notes

- Necessary removal work: apron panel, apron panel reinforcement, fender, bumper, cross member

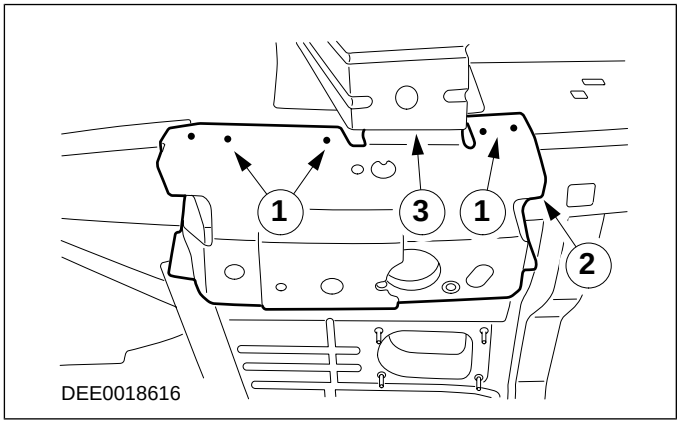
2. Mounting

- Mill out the spot welds.


DEE0018615

3. Mounting

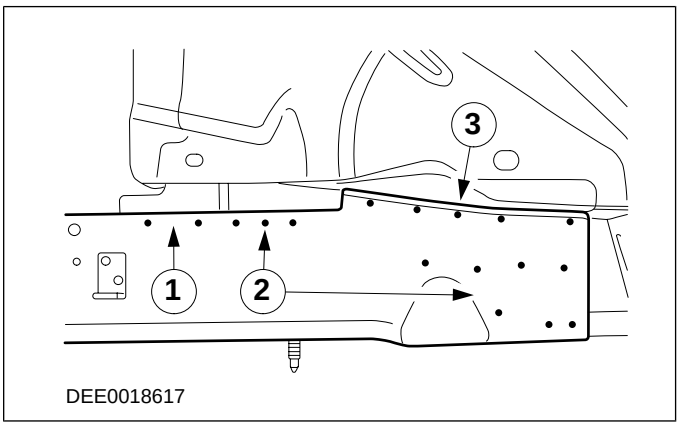
1. Mill out the spot welds.
2. Mill out the hidden spot welds.
3. Cut point.



DEE0018616

4. Side member

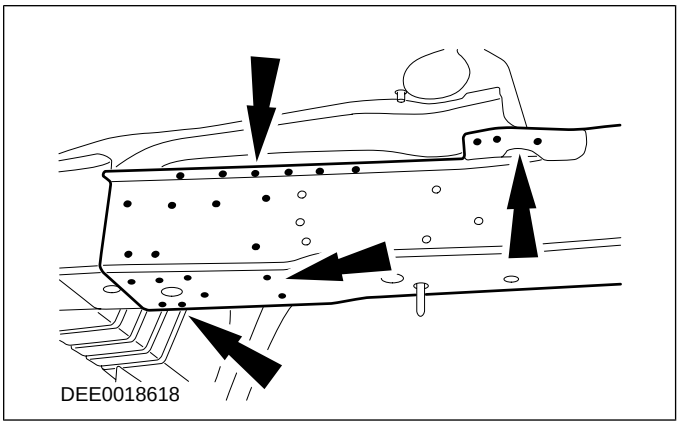
1. Mill out the spot welds (two panel thicknesses).
2. Mill out the spot welds.
3. Mill out the spot welds from below.



DEE0018617

5. Side member

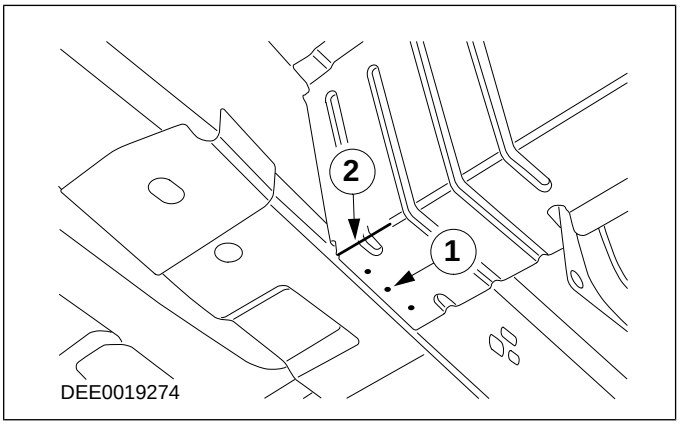
- Mill out the spot welds.


DEE0018618

Installation

1. Prepare the old part

1. Mill out the spot welds and remove the flange remnants.
2. Cut point.

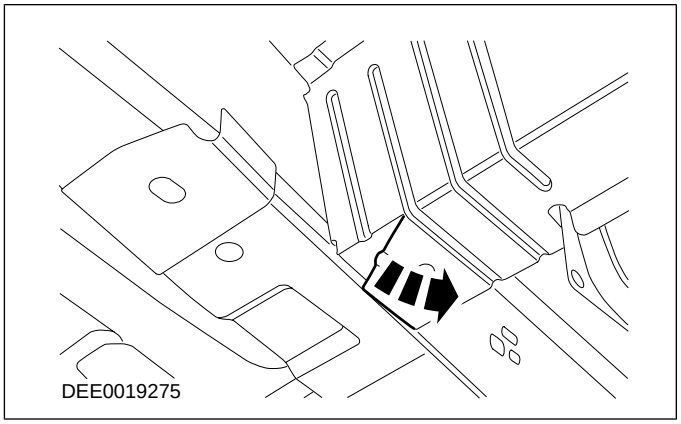


DEE0019274

REMOVAL AND INSTALLATION

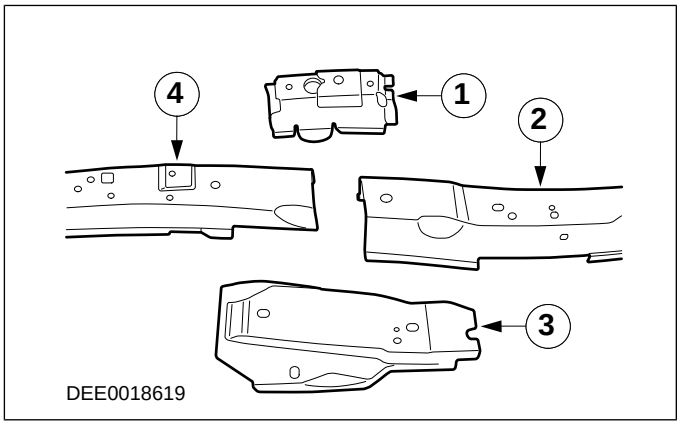
2. Prepare the old part

- Bend up the old part.



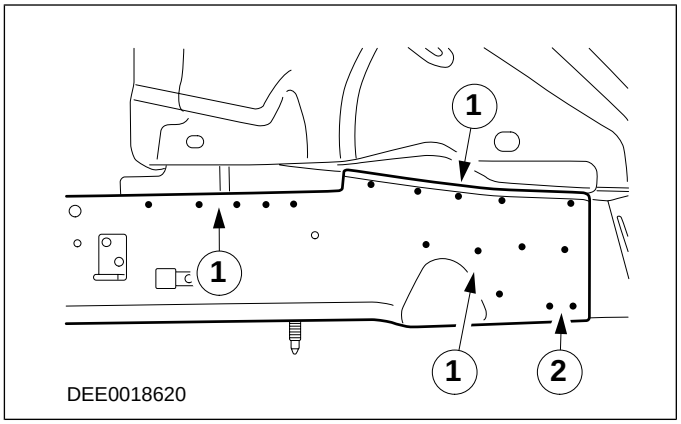
3. Prepare the new part. Mill out the spot welds at the original joining locations.

1. Mounting.
2. Front part of side member.
3. Covering plate.
4. Rear part of side member.



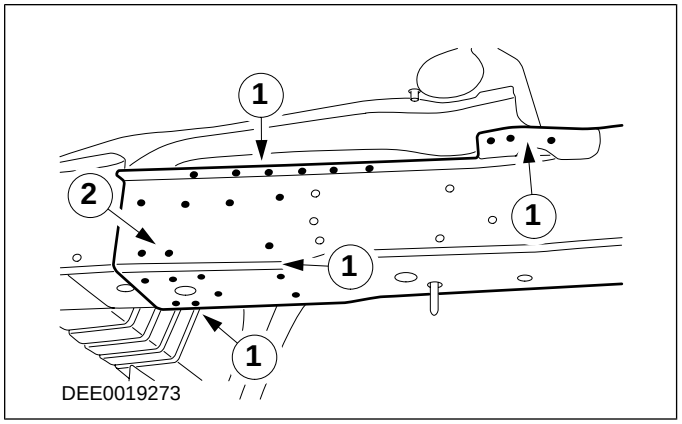
4. Side member

1. Puddle weld.
2. Puddle welding is only done after the mounting is installed.



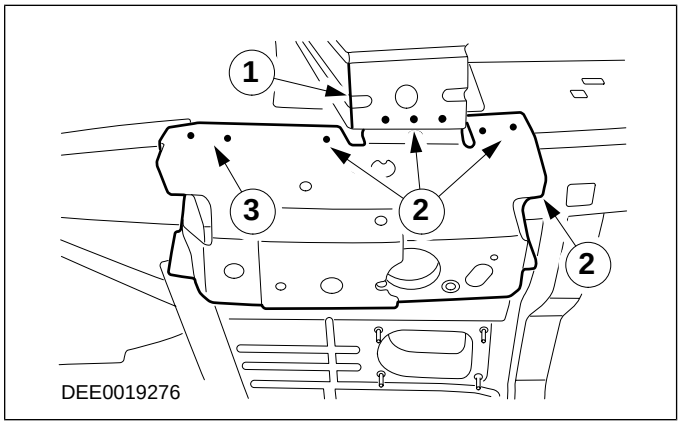
5. Side member

1. Puddle weld.
2. Puddle welding is only done after the mounting is installed.



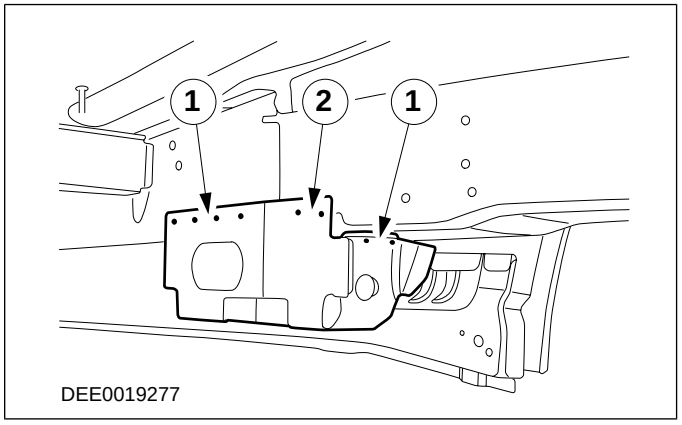
6. Mounting

1. Insert the mounting, bend back the old part and produce a continuous MIG weld.
2. Puddle weld.
3. Puddle weld (2 panel thicknesses).



7. Mounting

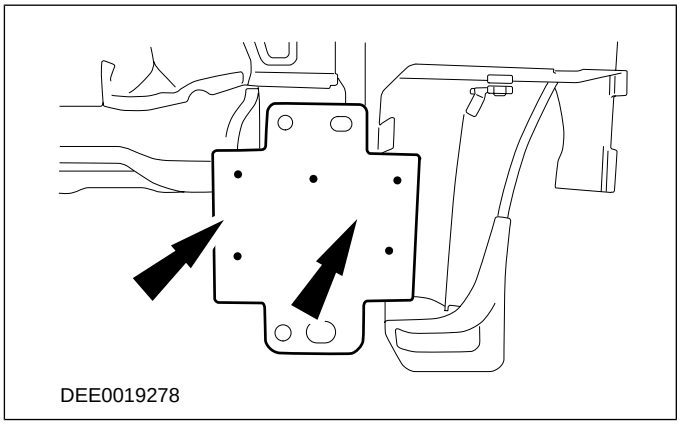
1. Puddle weld.
2. Puddle weld (2 panel thicknesses).



8. Side member closing panel

REMOVAL AND INSTALLATION

- Electric resistance spot welding.


DEE0019278

SECTION 501-29 Side Panel Sheet Metal Repairs

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 501-29-2

REMOVAL AND INSTALLATION

A-Pillar Outer Panel Section and Reinforcement..... 501-29-3
Sliding Door Step Outer Panel..... 501-29-5
Front Door Step..... 501-29-6
Side Panel Lower Section..... 501-29-10
Side Panel..... 501-29-12

SPECIFICATIONS

Lubricants, sealants and adhesives

	Specifications
Clinched flange protection	ESK-M4G245-A
2-pack metal adhesive	WSK-M4G200 A/B

REMOVAL AND INSTALLATION

A-Pillar Outer Panel Section and Reinforcement

Materials	
Name	**Specification**
A-pillar outer panel	
Reinforcement	
Wheelhouse reinforcement	

Removal

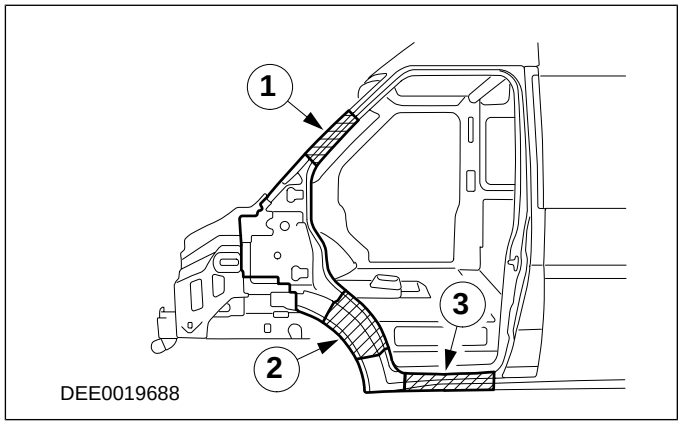
1. General notes

- Necessary removal work: apron panel reinforcement, fender, door, door hinges

2. NOTE:There are several possible ways to carry out the repair. Deciding where the relevant cuts are to be made and the job steps necessary for the repair depends on the extent of the damage. When making the separating cuts, care must be taken not to damage underlying panels.

A-pillar outer panel

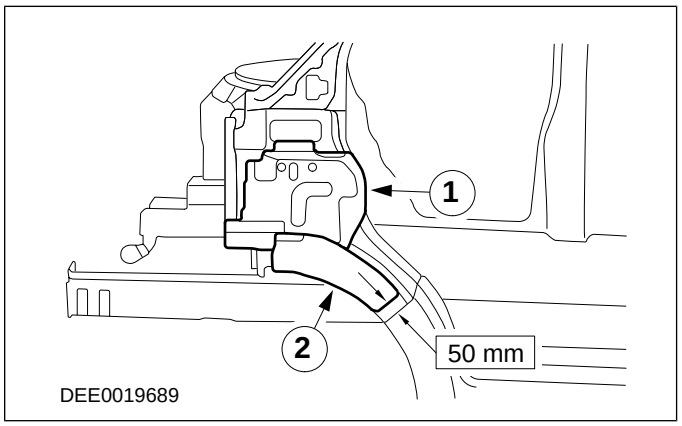
1. Cutting area for the A-pillar.
2. Cutting area for the wheelhouse.
3. Cutting area for the sill outer panel.



3. NOTE:When cutting in the area of the wheelhouse, the wheelhouse reinforcement below should be cut offset by 50 mm.

Section - Wheelhouse Reinforcement - Renew

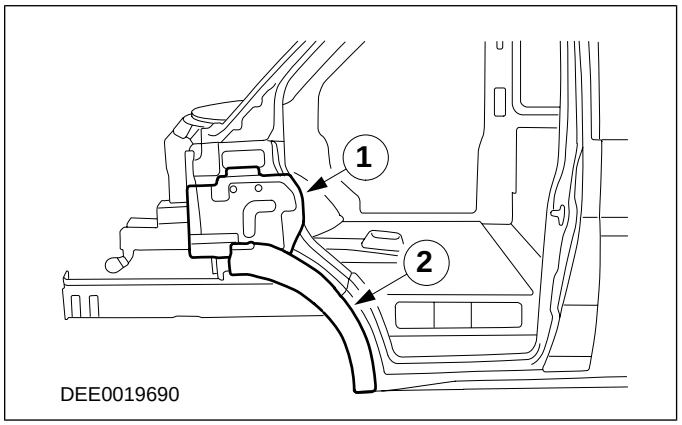
1. Reinforcement.
2. Section - Wheelhouse Reinforcement - Renew.



4. NOTE:When making the cut in the area of the sill outer panel, the whole wheelhouse reinforcement must be renewed.

Whole wheelhouse reinforcement

1. Reinforcement.
2. Wheelhouse reinforcement.



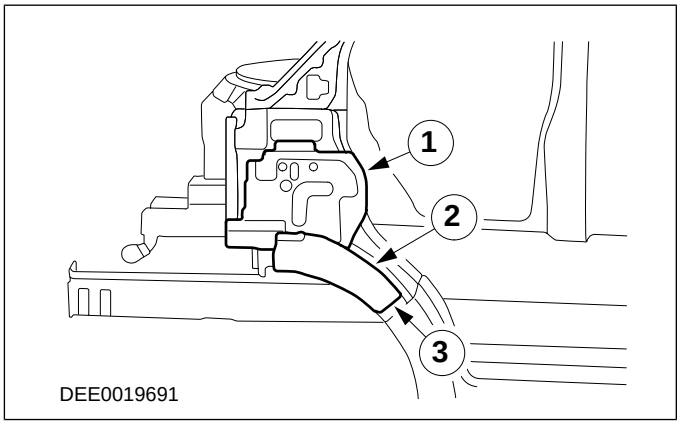
Installation

1. Section - Wheelhouse Reinforcement - Renew

1. Reinforcement.
2. Section - Wheelhouse Reinforcement - Renew.

REMOVAL AND INSTALLATION

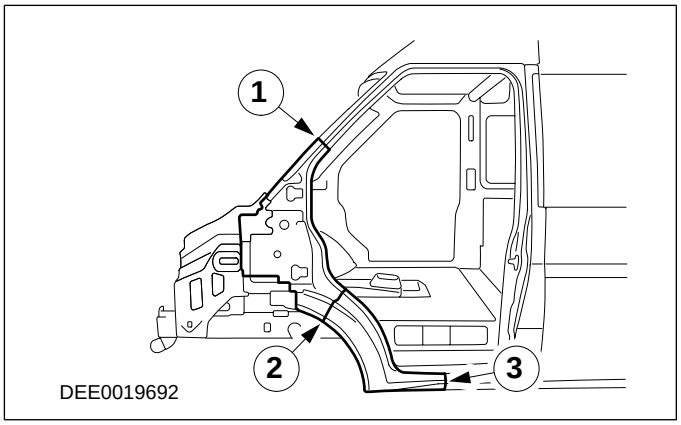
3. Continuous MIG seam weld.



2. NOTE:The join to the old part is to be suitably remade depending on the repair method.

A-pillar outer panel

1. Continuous MIG weld in the A-pillar area.
2. Continuous MIG weld in the wheelhouse area.
3. Continuous MIG weld in the sill outer panel area.



REMOVAL AND INSTALLATION

Sliding Door Step Outer Panel

Materials	
Name	**Specification**
Sill outer panel	

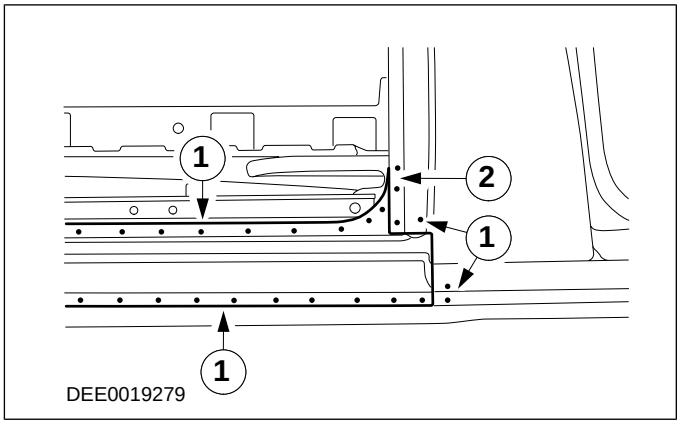
Removal

1. General Instructions

- Necessary removal work: door sealing rubber

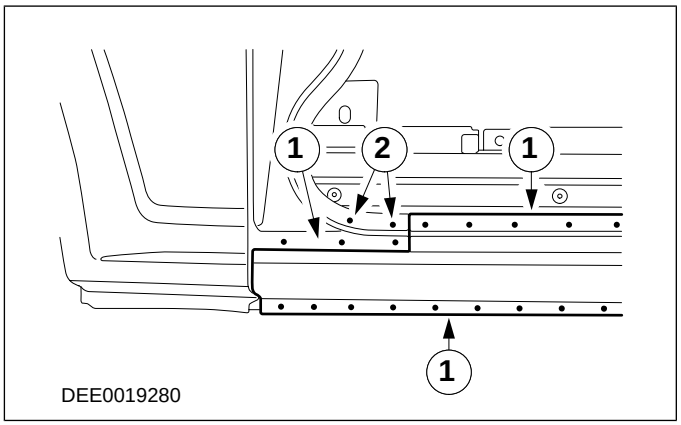
2. Sill outer panel

1. Mill out the spot welds.
2. Mill out the spot welds (2 panel thicknesses).



3. Sill outer panel

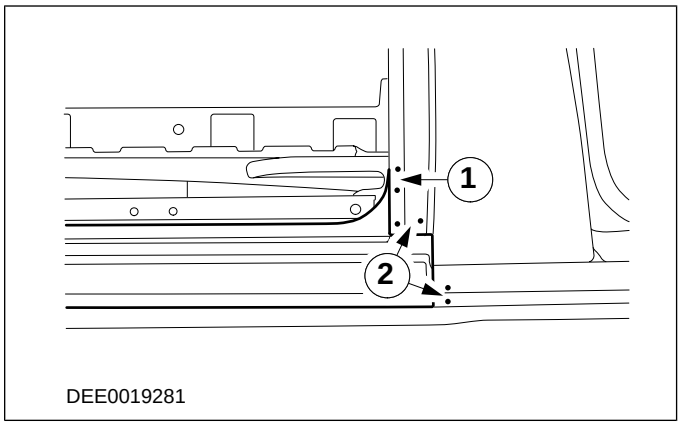
1. Mill out the spot welds.
2. Mill out the spot welds (2 panel thicknesses).



Installation

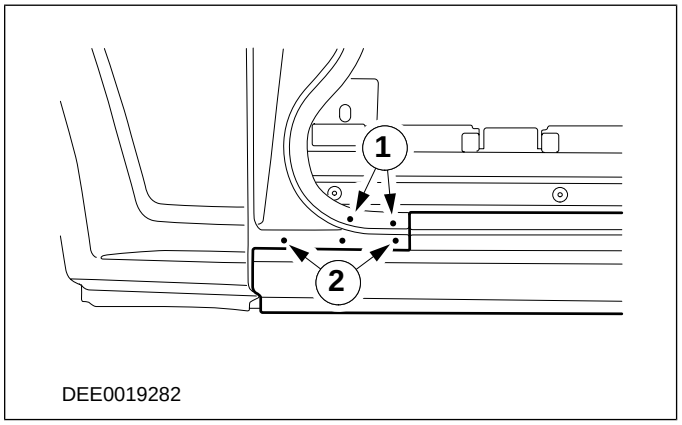
1. Sill outer panel

1. Puddle weld (two panel thicknesses).
2. Puddle weld.



2. Sill outer panel

1. Puddle weld (two panel thicknesses).
2. Puddle weld.



REMOVAL AND INSTALLATION

Front Door Step

Materials	
Name	Specification
Front door scuff plate	

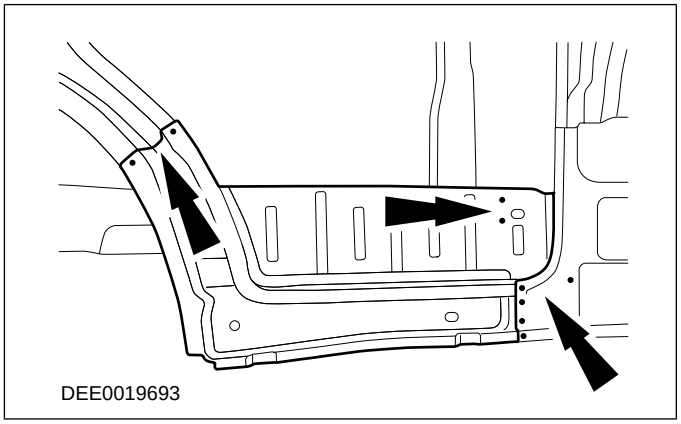
Removal

1. General notes

- Necessary removal work: Outer skin in repair area, tank flap, door, door sealing rubber
- Move back the floor covering and the wiring away from the working area.

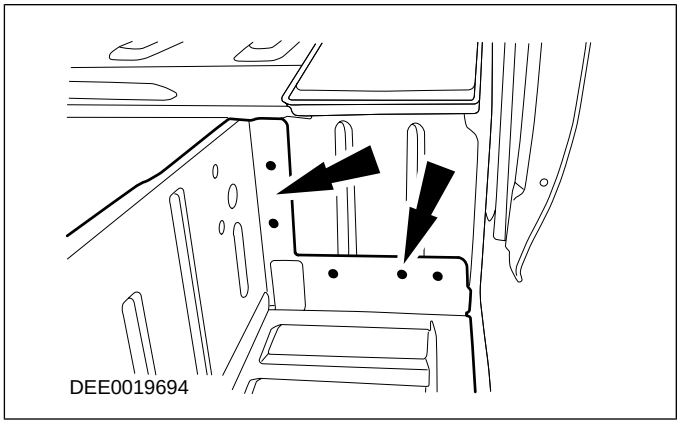
2. Front door scuff plate

- Mill out the spot welds.



3. Front door scuff plate

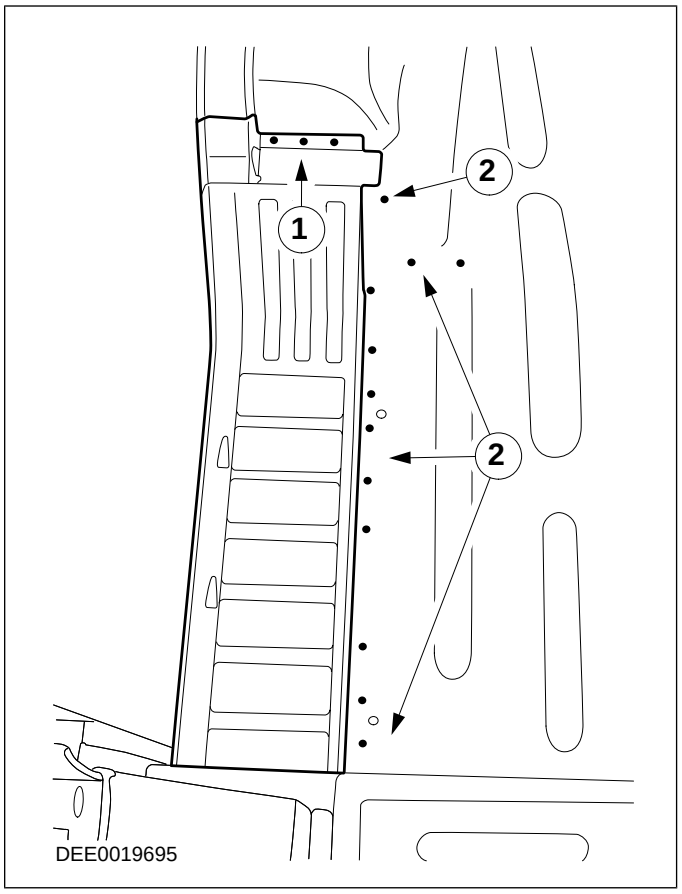
- Mill out the spot welds.



4. Front door scuff plate

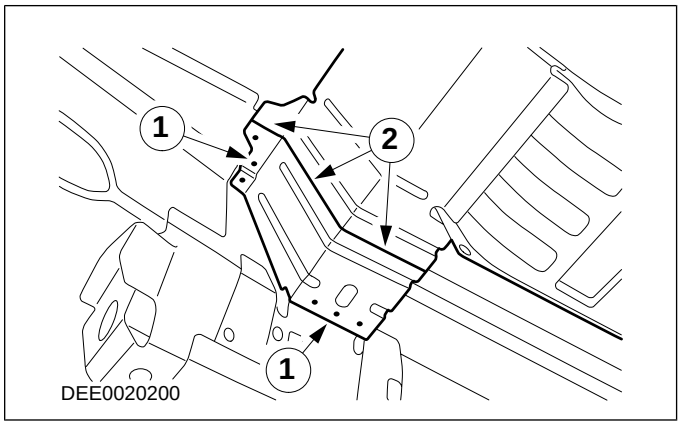
1. Mill out the spot welds (two panel thicknesses).

2. Mill out the spot welds.



5. Front door scuff plate

1. Mill out the spot welds.
2. Rough separating cut.

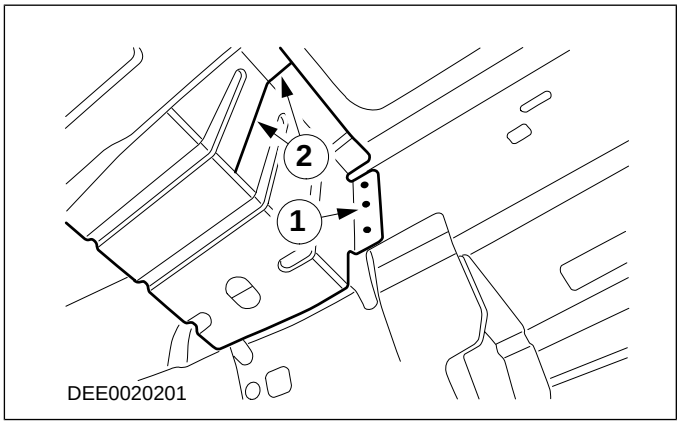


6. Front door scuff plate

1. Mill out the spot welds.

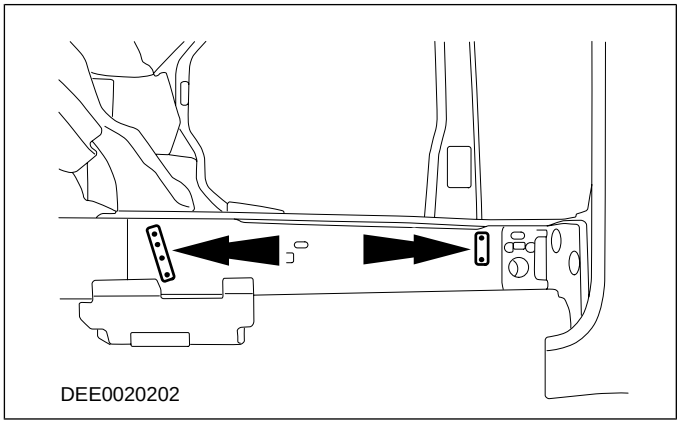
REMOVAL AND INSTALLATION

2. Rough separating cut.



7. Front door scuff plate

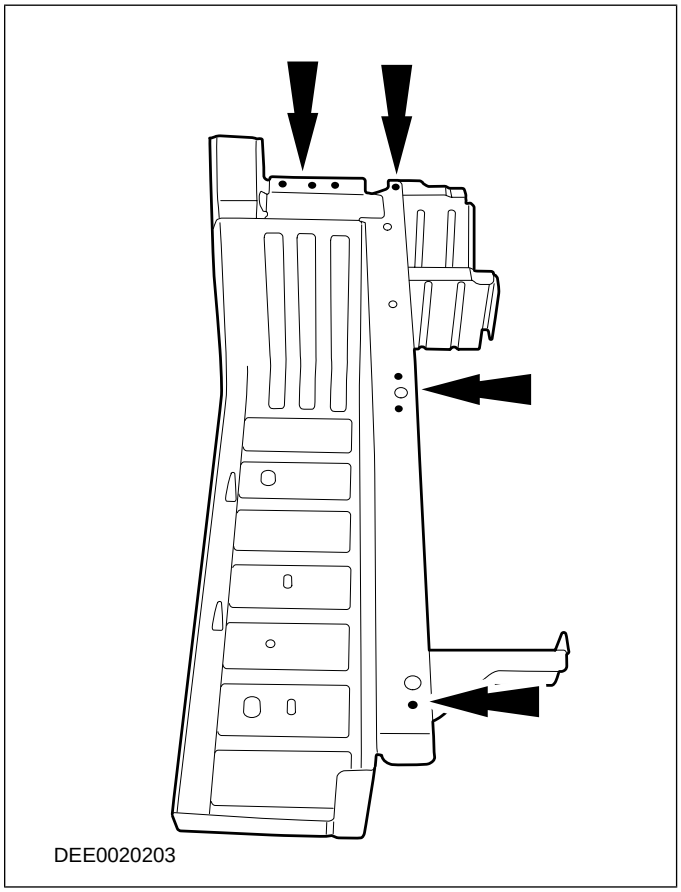
- Mill out the spot welds and remove the flange remnant.



Installation

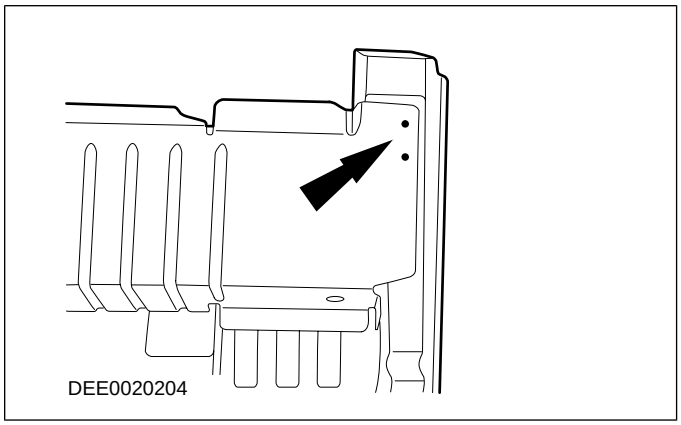
1. Prepare the new part

- Add the missing spot welds.



2. Prepare the new part

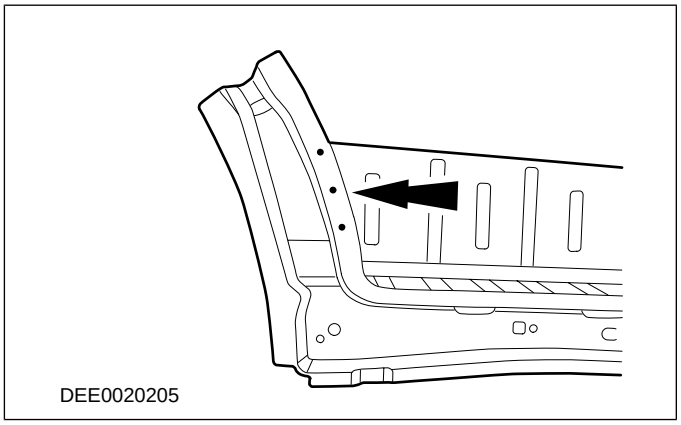
- Add the missing spot welds.



3. Prepare the new part

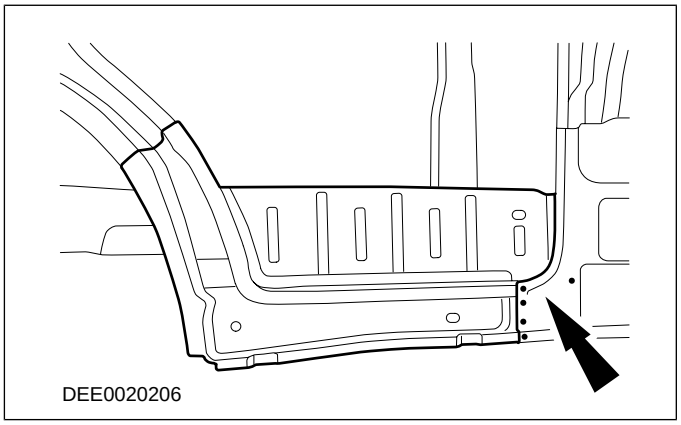
REMOVAL AND INSTALLATION

- Add the missing spot welds.



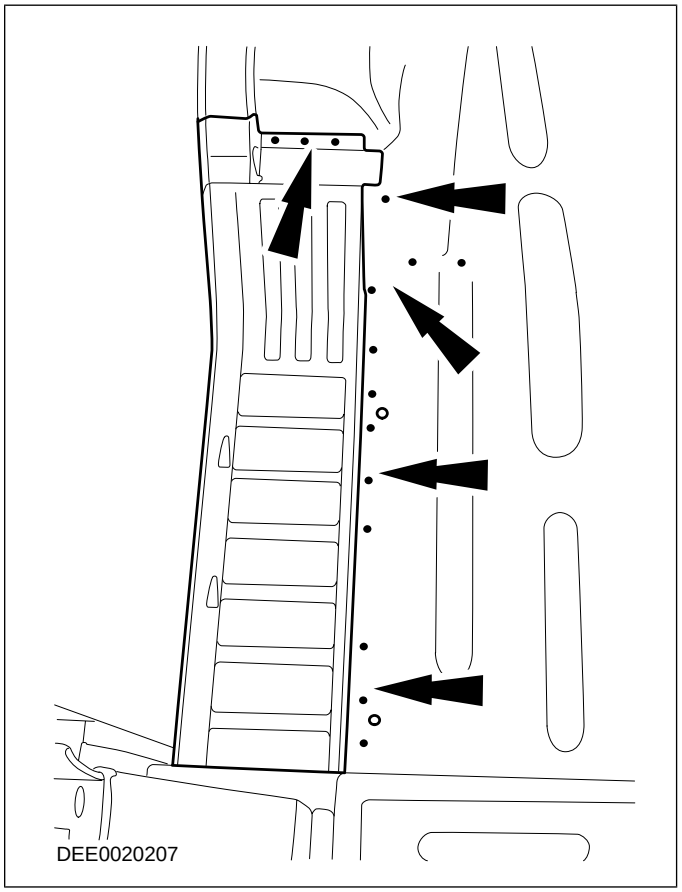
4. Front door scuff plate

- Puddle weld.



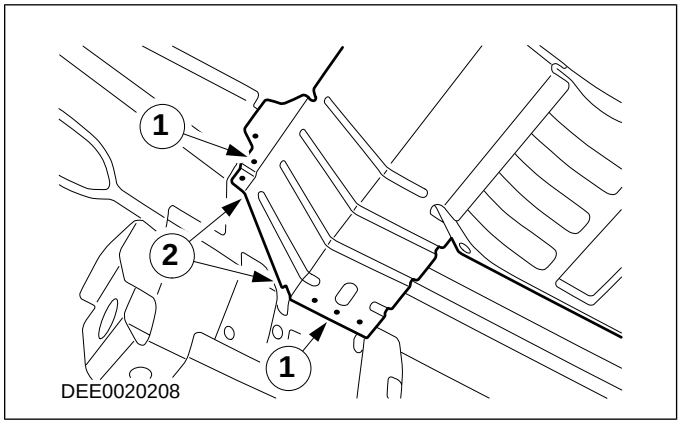
5. Front door scuff plate

- Puddle weld.



6. Front door scuff plate

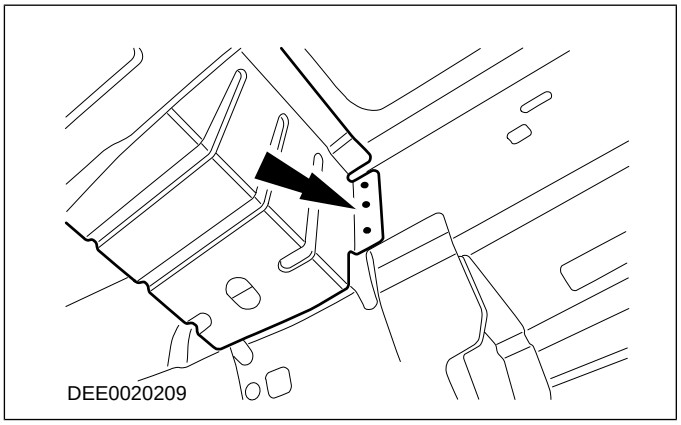
1. Puddle weld.
2. Intermittent MIG seam weld.



7. Front door scuff plate

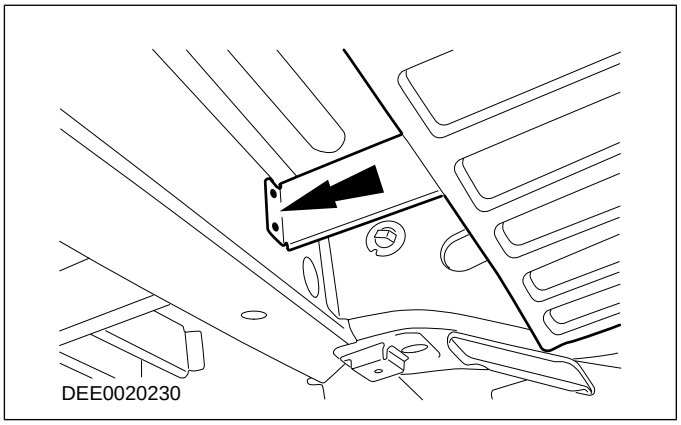
REMOVAL AND INSTALLATION

- Puddle weld.



8. Front door scuff plate

- Puddle weld.



REMOVAL AND INSTALLATION

Side Panel Lower Section

Materials	
Name	**Specification**
Quarter panel section	

Removal

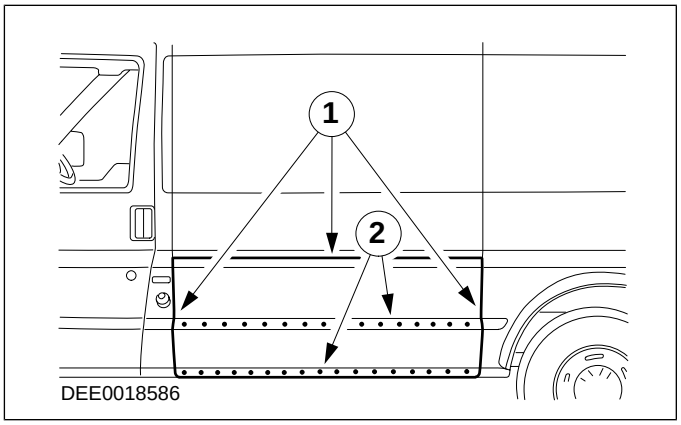
1. General notes

- Necessary removal work: fuel filler flap, inner trim, move cables away from the working area.
- Warm the area where it is glued to the inner side panel to remove the side panel.

2. ⚠CAUTION:Make the cut along the sealing seam on the B-pillar or C-pillar. Do not damage the reinforcing panel located behind it.

Quarter panel

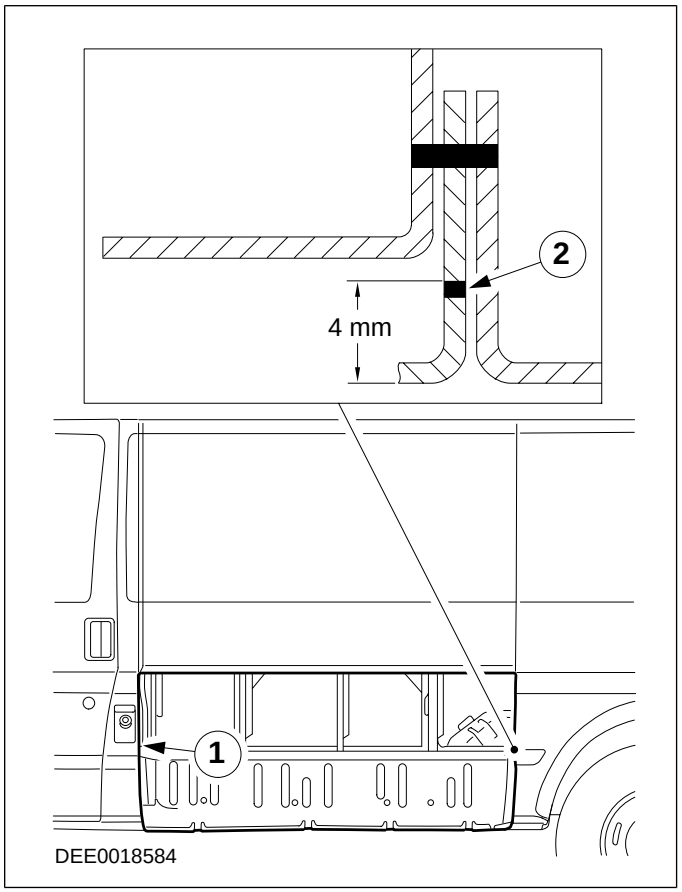
1. Cut points.
2. Mill out the spot welds.



3. Quarter panel

1. Mill out the spot welds and remove the flange remnants.

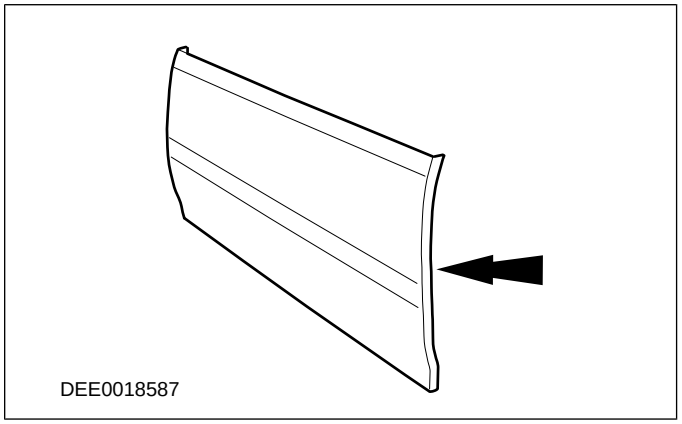
2. Separating cut on the C-pillar flange remnant. In doing so do not damage the neighbouring side panel.



Installation

1. Prepare the new part.

- Cut 14 mm from the flange to join to the C-pillar (matching the previous step).

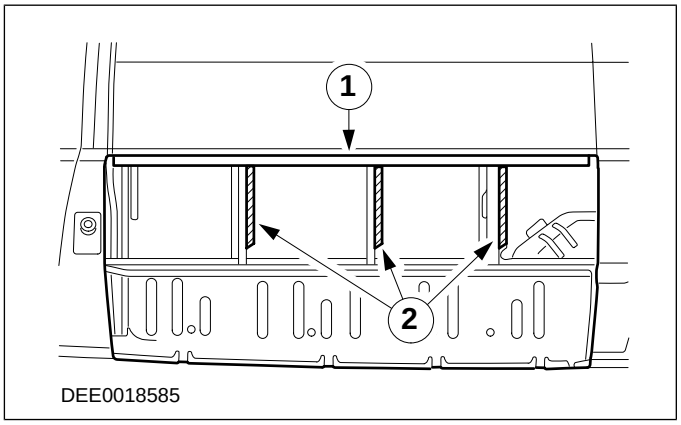


2. Quarter panel

1. Spot weld a backing strip in place (cut one from the remainder of the new part).

REMOVAL AND INSTALLATION

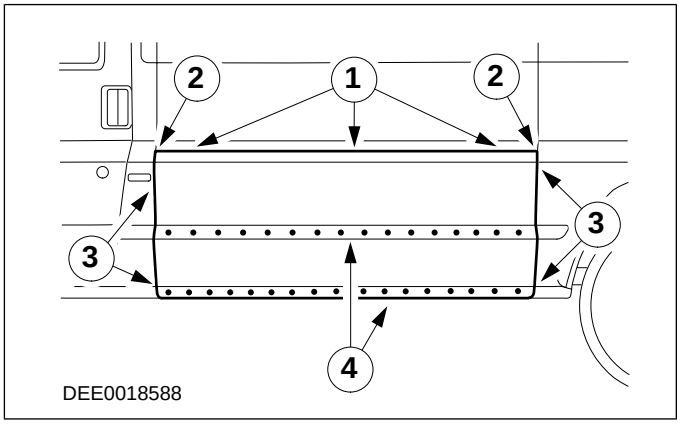
2. Apply clinched flange protection.



3. **CAUTION:Heat distortion may occur during welding.**

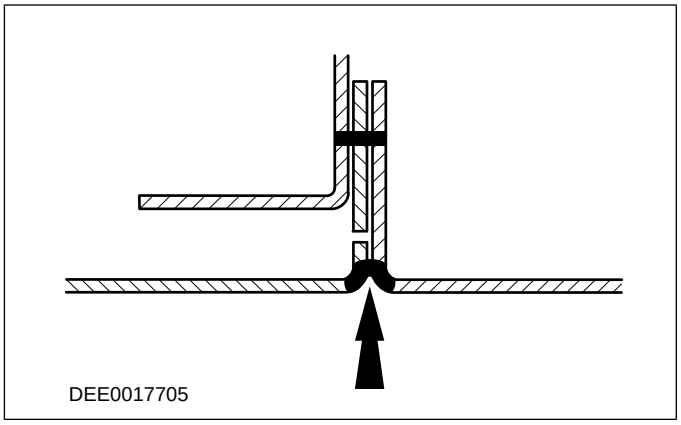
Side panel

1. Intermittent MIG seam weld.
2. Continuous MIG seam weld.
3. Continuous MIG weld (bead length 5 mm, distance between each 30 mm).
4. Puddle weld.



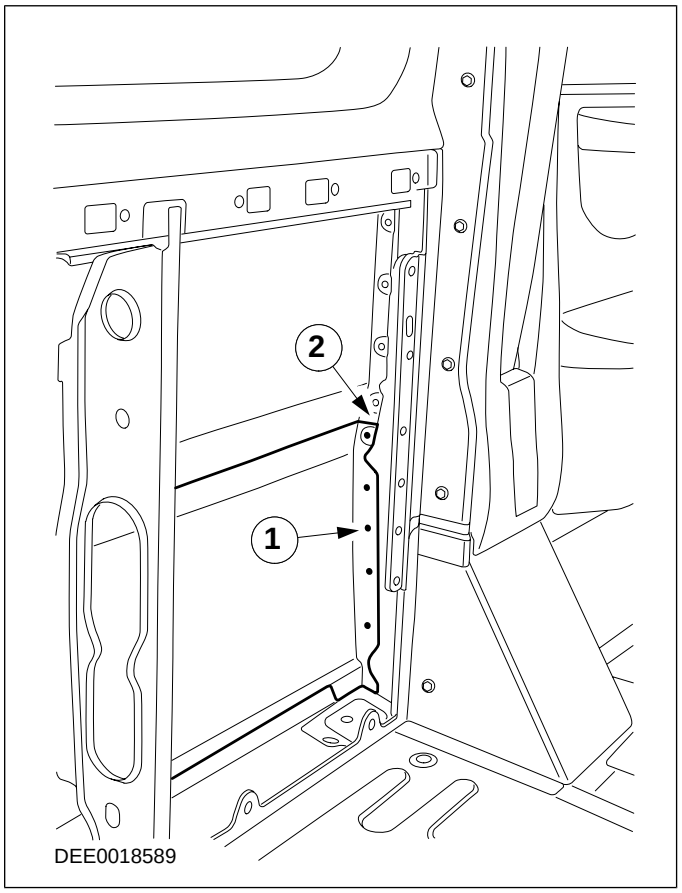
4. **Quarter panel**

- Hollow grind the intermittent MIG welds at the B- and C-pillars.



5. **Quarter panel**

1. Puddle weld.
2. Continuous MIG seam weld.



6. **Quarter panel**

- The corrosion protection at the joint to the B- and C-pillars must be very carefully carried out.
- Seam sealing to the B- and C-pillars is only done after paint application.

REMOVAL AND INSTALLATION

Side Panel

Materials	
Name	**Specification**
Quarter panel	

Removal

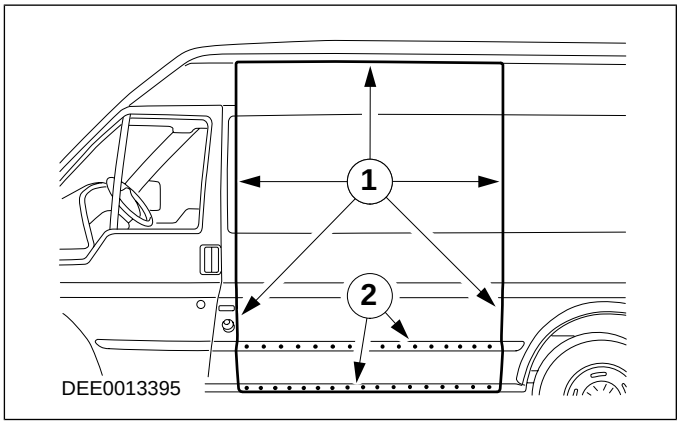
1. General notes

- Depending on the damage, partial replacement at the side panel is also possible (445160).
- Necessary removal work: fuel filler flap; move inner trim and cables away from the working area.
- Warm the area where it is glued to the inner side panel to remove the side panel.

2. ⚠CAUTION:Make the cut at the B- and C-pillars along the sealing seam. Do not damage the reinforcing panel located behind it.

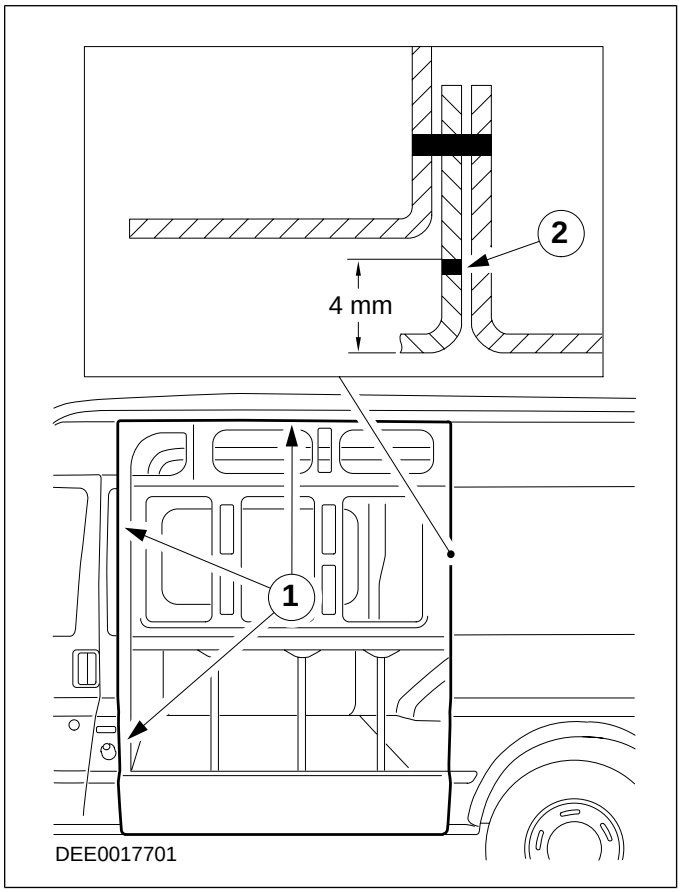
Side panel

1. Cut points.
2. Mill out the spot welds.



3. Quarter panel

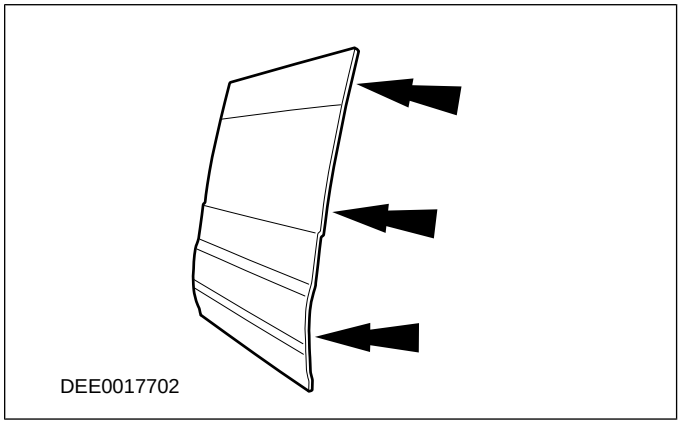
1. Mill out the spot welds and remove the flange remnants in the roof and B-pillar areas.
2. Separating cut on the C-pillar flange remnant. In doing so do not damage the neighbouring side panel.



Installation

1. Prepare the new part.

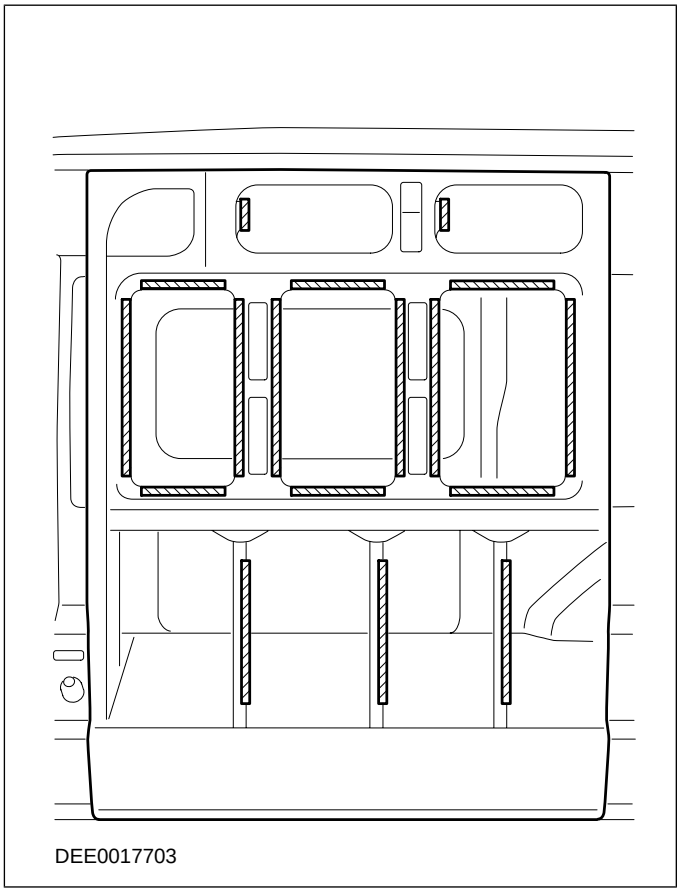
- Cut 14mm from the flange to join to the window pillar (matching the previous step).



2. Inner side panel and reinforcement

REMOVAL AND INSTALLATION

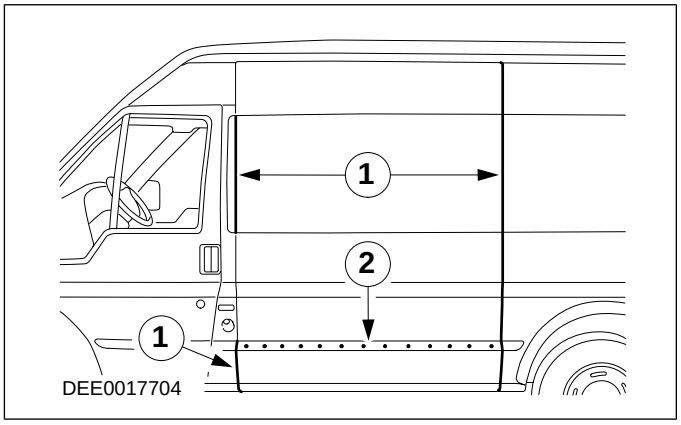
- Apply clinched flange protection.



3. ⚠**CAUTION:Heat distortion may occur during welding.**

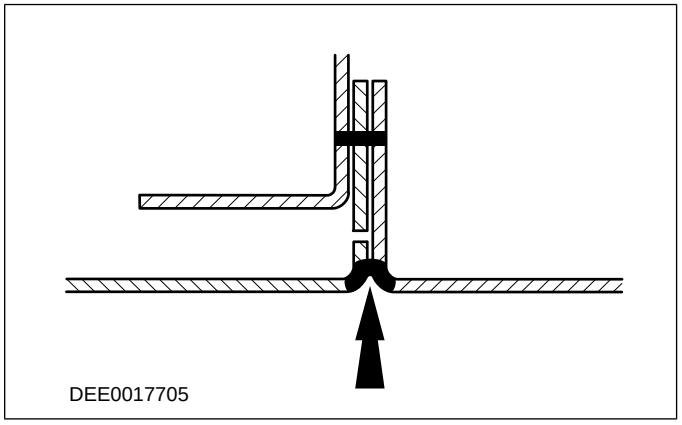
   Side panel

   1. Continuous MIG weld (bead length 5 mm, distance between each 30 mm).
   2. Puddle weld.



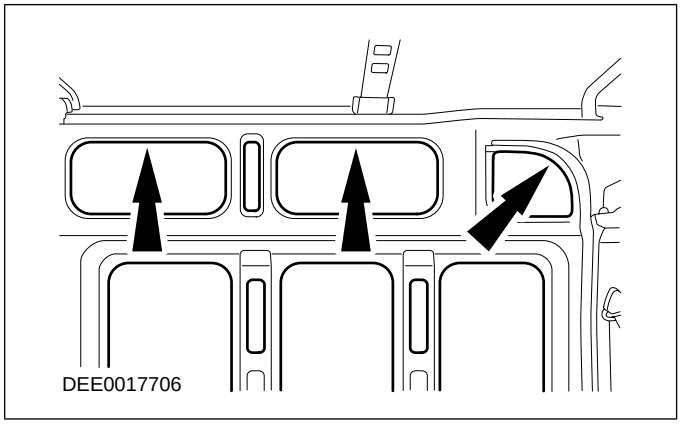
4. **Side panel**

- Grind the continuous MIG welds hollow in the region of the B- and C-pillars.



5. **Side panel**

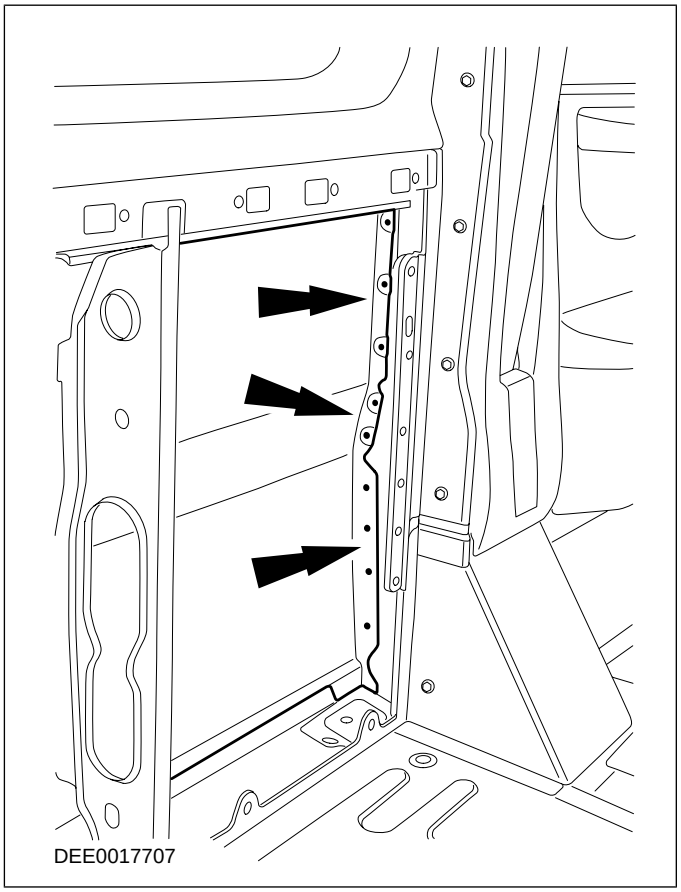
- Puddle weld.



6. **Quarter panel**

REMOVAL AND INSTALLATION

- Puddle weld.



7. Quarter panel

- The corrosion protection at the joint to the B- and C-pillars must be very carefully carried out.
- Seam sealing to the B- and C-pillars is only done after paint application.

SECTION 501-30 Rear End Sheet Metal Repairs

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 501-30-2

REMOVAL AND INSTALLATION

Quarter/Side Panel Rear Section LH..... 501-30-3
Lower Quarter Panel Section..... 501-30-6
Lower Side Panel Rear Section..... 501-30-8
Rear Inner Wheelhouse Half..... 501-30-10
Rear Outer Wheelhouse Half..... 501-30-11
Box Corner..... 501-30-13
Box Corner Section..... 501-30-20
Back Panel and Crossmember..... 501-30-25
Rear Side Member Section..... 501-30-28

SPECIFICATIONS

Parts	Specification
Clinched flange protection	ESK-M4G245-A
2-pack metal adhesive	WSK-M4G200 A/B

REMOVAL AND INSTALLATION

Quarter/Side Panel Rear Section LH

Materials	
Name	**Specification**
Side panel	

Removal

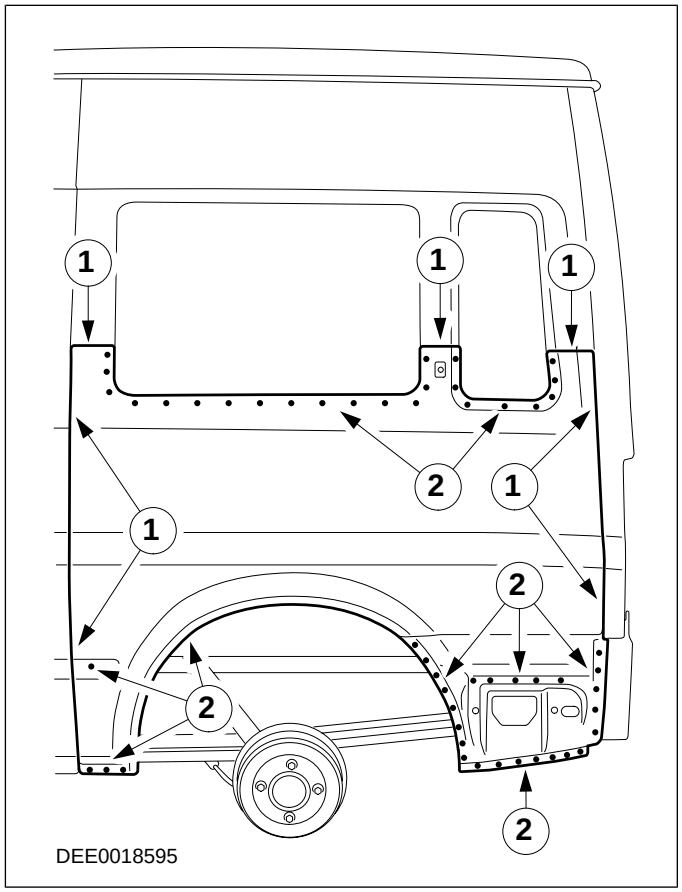
1. General Instructions

- Required disassembly: side windows, inner trims, tail light, re-route cables away from working area.
- Warm the area where it is glued to the inner side panel to remove the side panel.

2. ⚠CAUTION:Make the cut along the sealing seam on the C-pillar or D-pillar. Do not damage the reinforcing panel located behind it.

Side panel

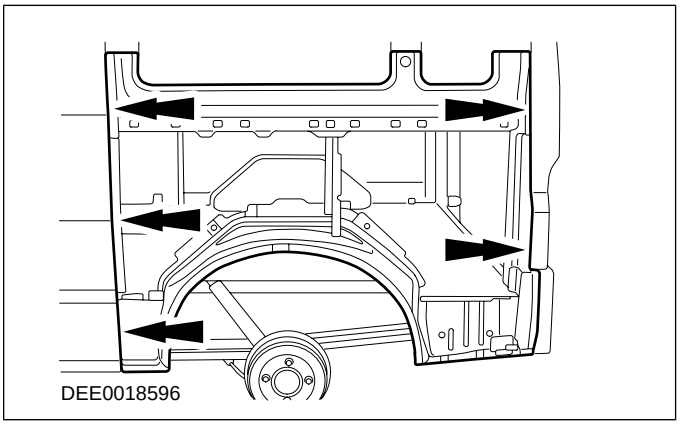
1. Separating cut.
2. Mill out the spot welds.



DEE0018595

3. Side panel

- Mill out the spot welds and remove the flange remnant.

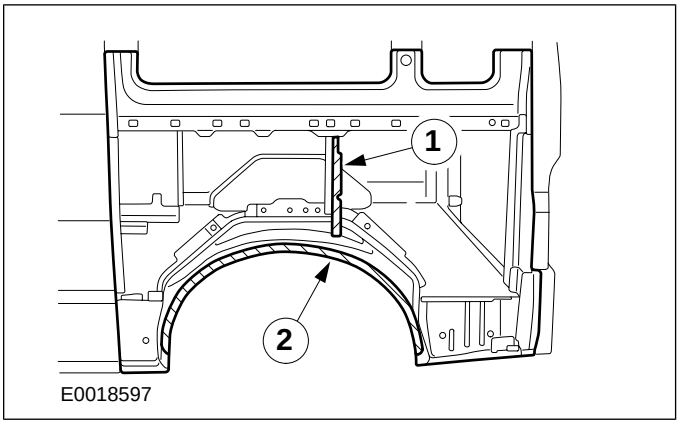

DEE0018596

Installation

1. NOTE:Always apply clinched flange protection and 2-pack metal adhesive just before installing the new part.

Side panel

1. Apply clinched flange protection.
2. Apply 2-pack metal adhesive



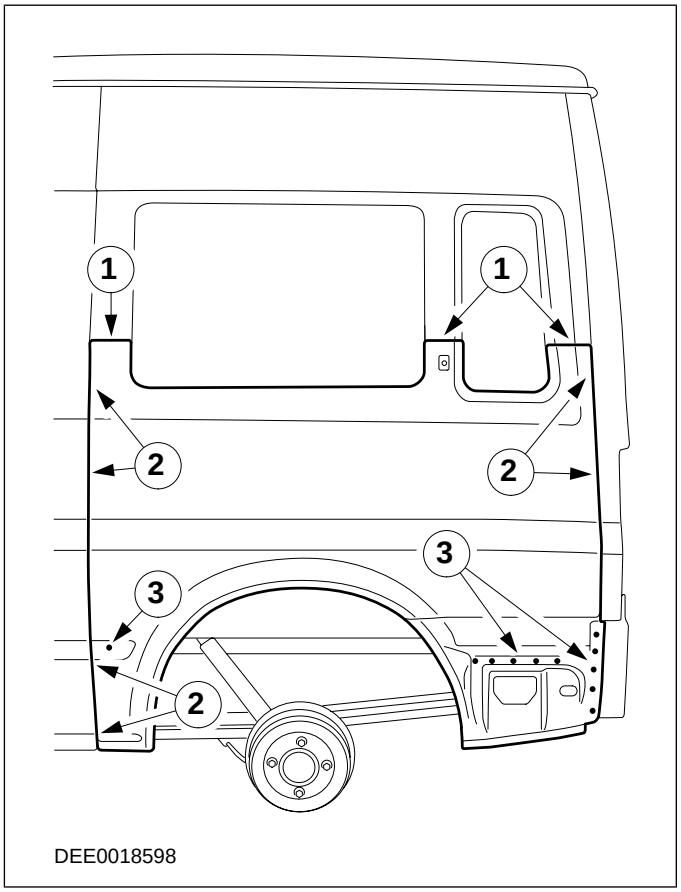
E0018597

2. Side panel

1. Continuous seam MIG welding
2. Continuous MIG weld (bead length 5 mm, distance between each 30 mm).

REMOVAL AND INSTALLATION

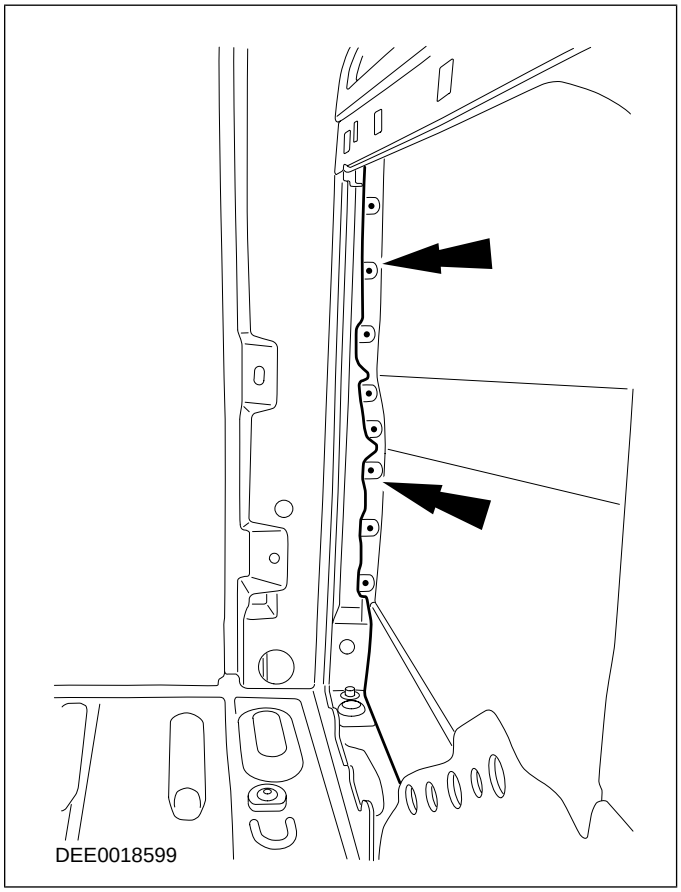
3. Puddle weld.



DEE0018598

3. Side panel

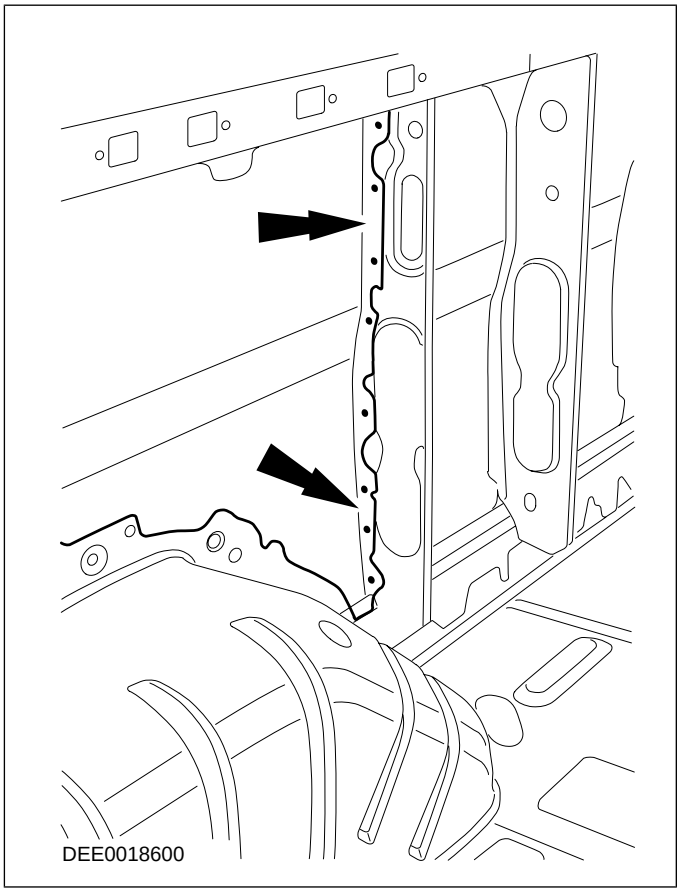
- Puddle weld.


DEE0018599

4. Side panel

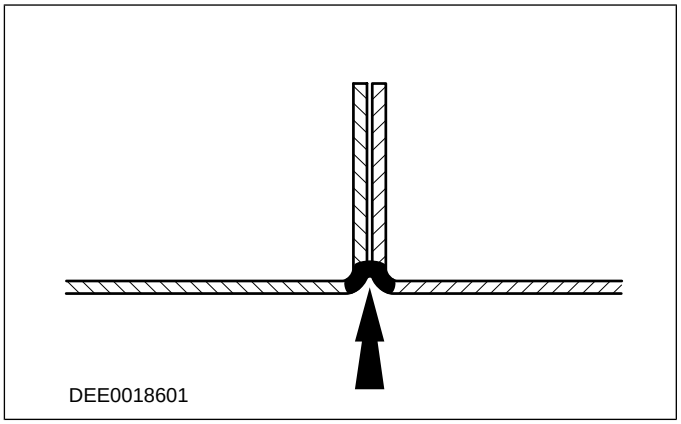
REMOVAL AND INSTALLATION

- Puddle weld.



5. Side panel

- Grind the continuous MIG welds hollow in the region of the C- and D-pillars.



6. Side panel

- The corrosion protection at the joint to the C-pillar and at the D-pillar must be very carefully carried out.
- Seam sealing to the C- and D-pillars is only done after paint application.

REMOVAL AND INSTALLATION

Lower Quarter Panel Section

Materials	
Name	Specification
Side panel section	

Removal

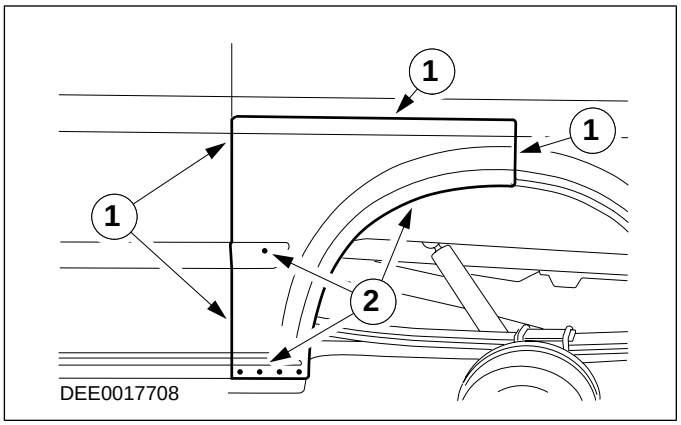
1. General Instructions

- Required disassembly: interior trims and move the wiring back away from the working area.
- Warm the glued area of the wheel house halves to remove the side panel.

2. ⚠CAUTION:Cut the B-pillar along the sealing seam. Do not damage the reinforcing panel located behind it.

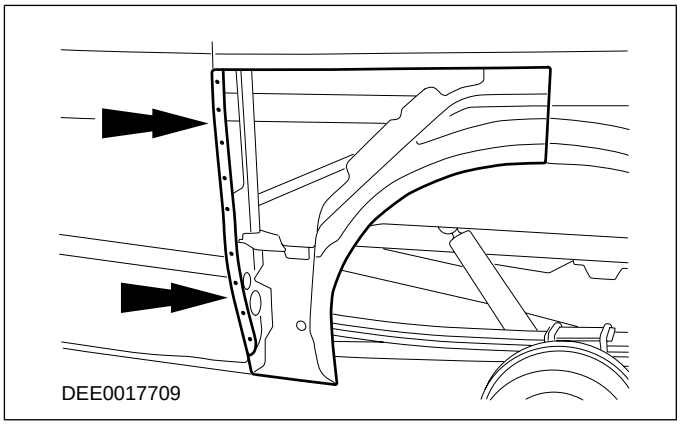
Side panel

1. Separating cut.
2. Mill out the spot welds.



3. Side panel

- Mill out the spot welds and remove the flange remnants.

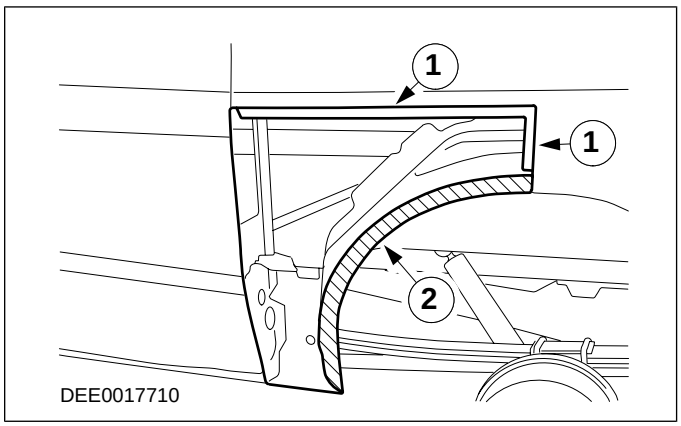


Installation

1. NOTE:Always apply 2-pack metal adhesive just before installing the new part.

Side panel

1. Spot weld a backing strip in place (cut one from the remainder of the new part).
2. Apply 2-pack metal adhesive.

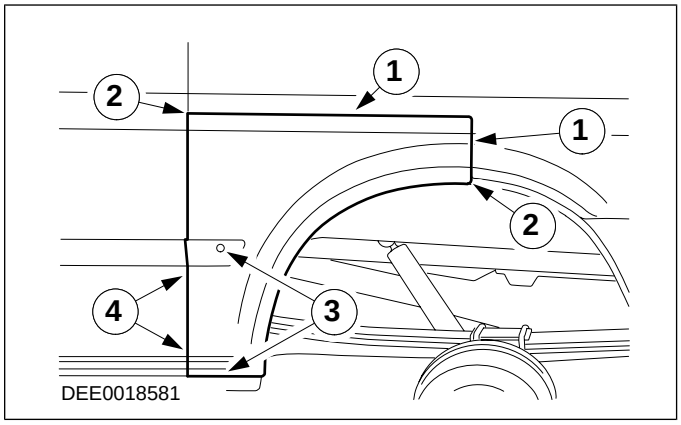


2. ⚠CAUTION:.

- Carry over the original positions of the spot welds in the C-pillar area exactly onto the new part.
- Heat distortion may occur during welding.

Side panel

1. Intermittent seam MIG welding.
2. Continuous seam MIG welding.
3. Puddle weld.
4. Continuous MIG weld (bead length 5 mm, distance between each 30 mm).

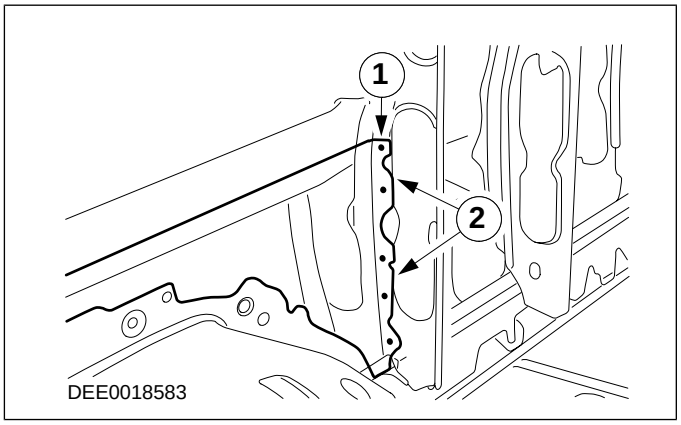


3. Side panel

1. Continuous seam MIG welding.

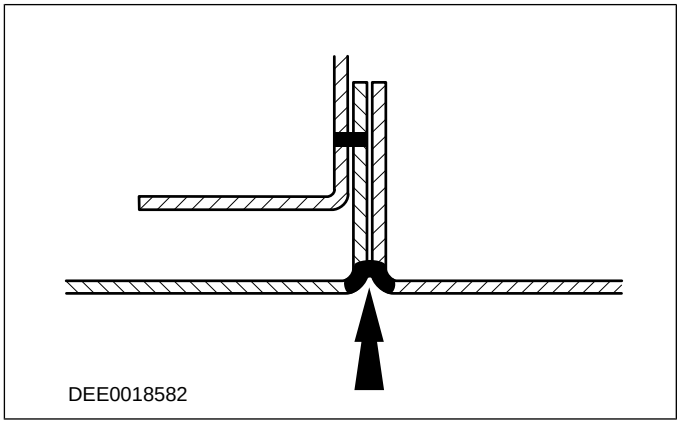
REMOVAL AND INSTALLATION

2. Puddle weld.



4. Side panel

- Hollow grind the intermittent MIG welds at the C-pillar.



5. Side panel

- The corrosion protection at the joint to the C-pillar must be very carefully carried out.
- Seam sealing to the C-pillar is only done after paint application.

REMOVAL AND INSTALLATION

Lower Side Panel Rear Section

Materials	
Name	Specification
Side panel section	

Removal

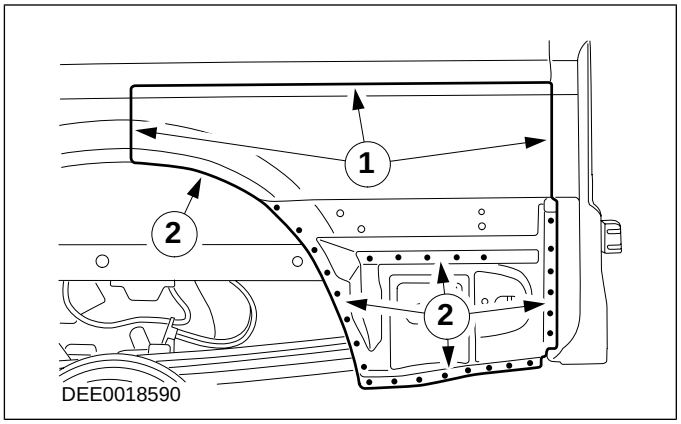
1. General Instructions

- Required disassembly: inner trims, bumper corner, tail light, re-route cables away from working area.
- Warm the glued area of the wheel house halves to remove the side panel.

2. ⚠CAUTION:Cut the D-pillar along the sealing seam. Do not damage the reinforcing panel located behind it.

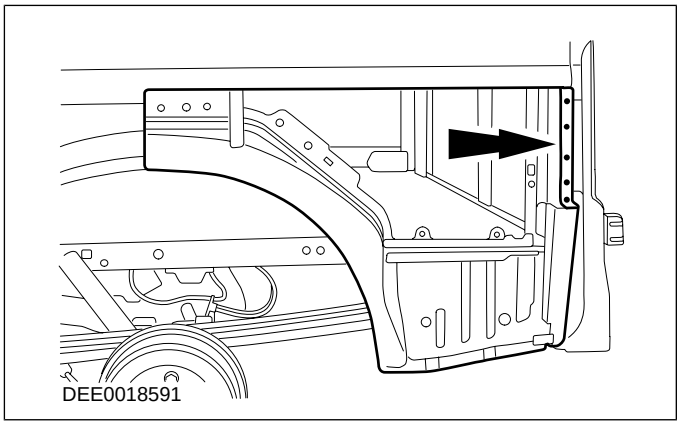
Side panel

1. Separating cut.
2. Mill out the spot welds.



3. Side panel

- Mill out the spot welds and remove the flange remnants.

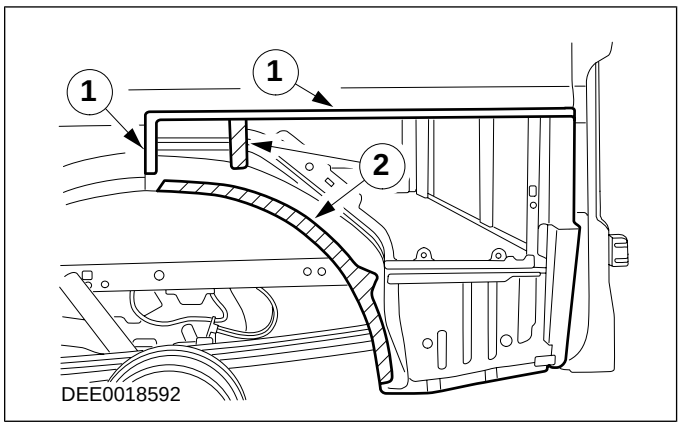


Installation

1. NOTE:Always apply 2-pack metal adhesive just before installing the new part.

Side panel

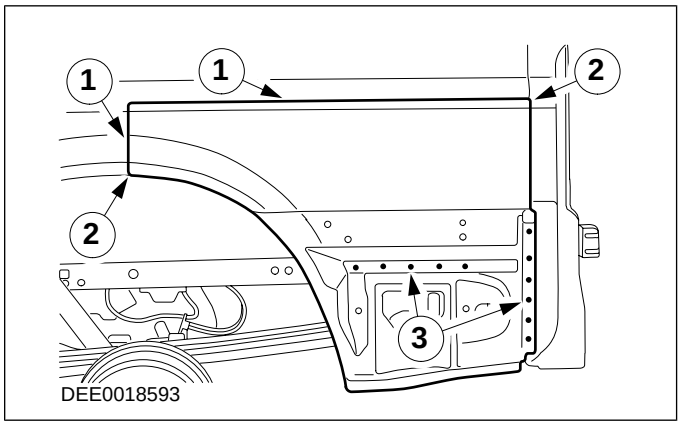
1. Spot weld a backing strip in place (cut one from the remainder of the new part).
2. Apply 2-pack metal adhesive.



2. ⚠CAUTION:Heat distortion may occur during welding.

Side panel

1. Intermittent seam MIG welding.
2. Continuous seam MIG welding.
3. Puddle weld.

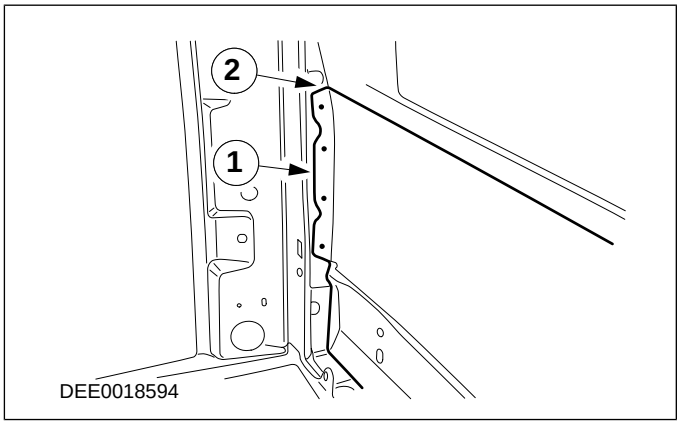


3. Side panel

1. Puddle weld.

REMOVAL AND INSTALLATION

2. Continuous seam MIG welding.



4. Side panel

- The corrosion protection at the joint to the D-pillar must be very carefully carried out.
- Seam sealing to the D-pillar is only done after paint application.

REMOVAL AND INSTALLATION

Rear Inner Wheelhouse Half

Materials	
Name	**Specification**
Inner half wheelhouse	

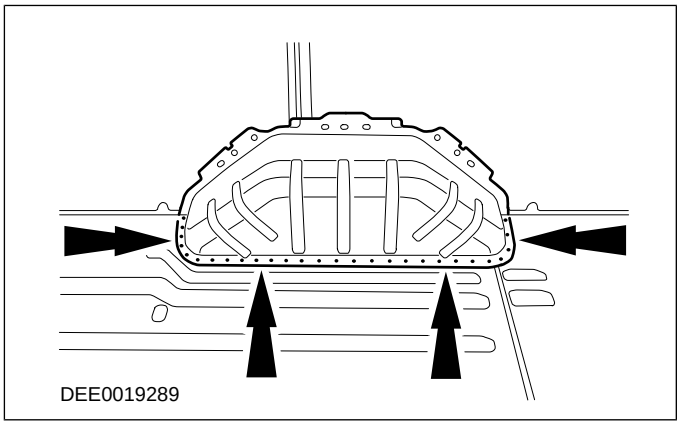
Removal

1. General notes

- The outer half of the wheelhouse must already be removed before repair work is started.

2. Inner half wheelhouse

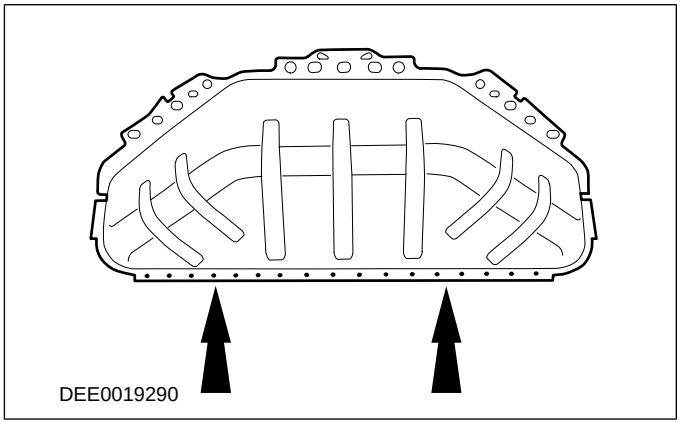
- Mill out the spot welds.



Installation

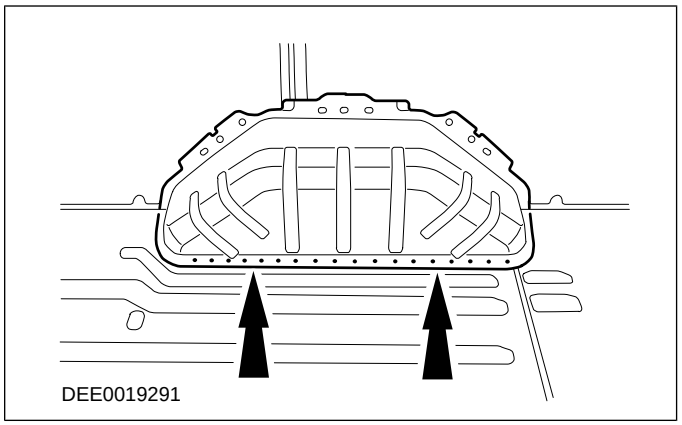
1. Prepare the new part

- Make holes for puddle welding.



2. Inner half wheelhouse

- Puddle weld.



REMOVAL AND INSTALLATION

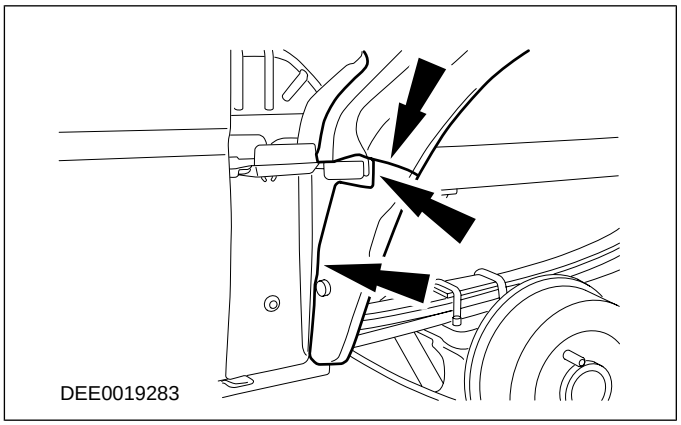
Rear Outer Wheelhouse Half

Materials	
Name	**Specification**
Wheelhouse outer half	

Removal

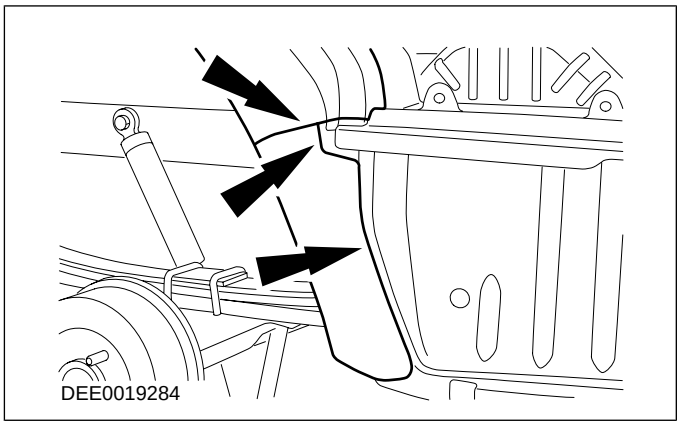
1. Wheelhouse outer half

- Cut point.



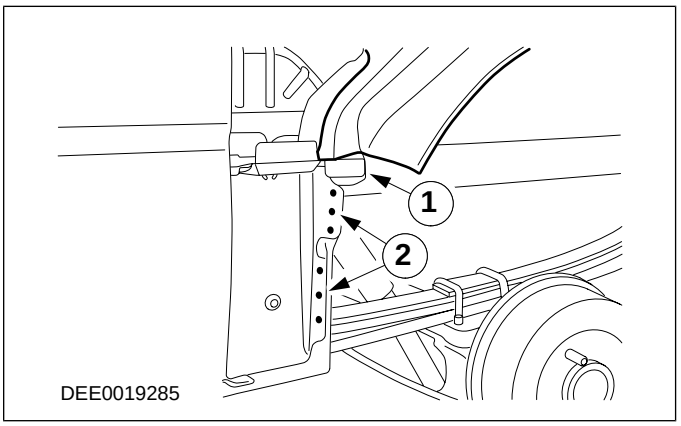
2. Wheelhouse outer half

- Cut point.



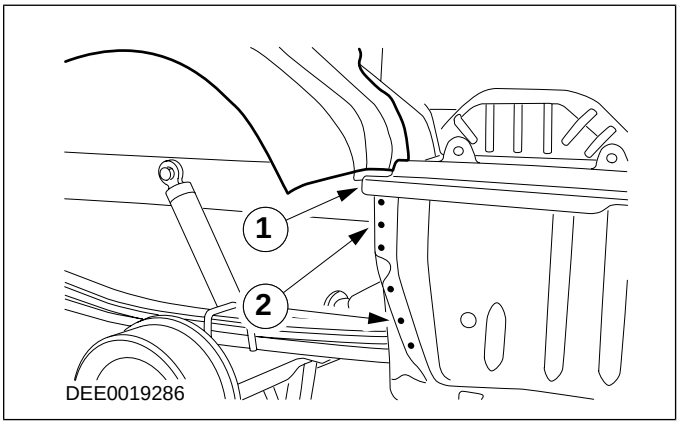
3. Wheelhouse outer half

1. Mill out the spot welds from the back and remove the flange remnants.
2. Mill out the spot welds and remove the flange remnants.



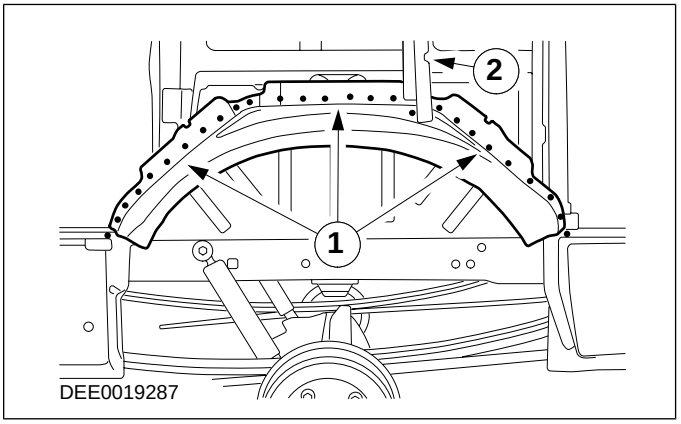
4. Wheelhouse outer half

1. Mill out the spot welds from the back and remove the flange remnants.
2. Mill out the spot welds and remove the flange remnants.



5. Wheelhouse outer half

1. Mill out the spot welds.
2. Bend the side panel reinforcement forwards.

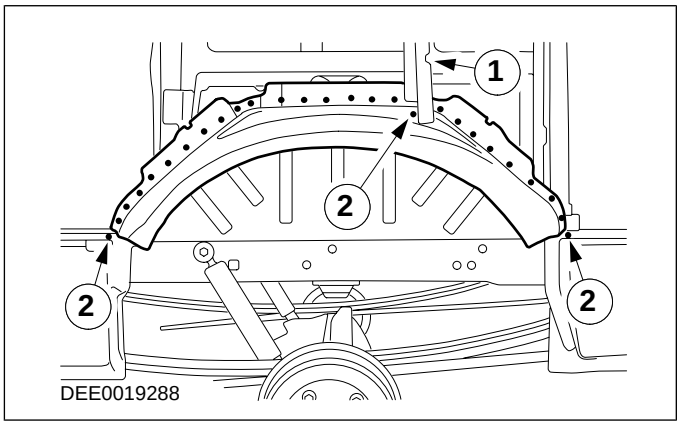


REMOVAL AND INSTALLATION

Installation

1. Wheelhouse outer half

1. Bend the side panel reinforcement back into position.
2. Puddle weld.



REMOVAL AND INSTALLATION

Box Corner

Materials	
Name	**Specification**
Box corner	

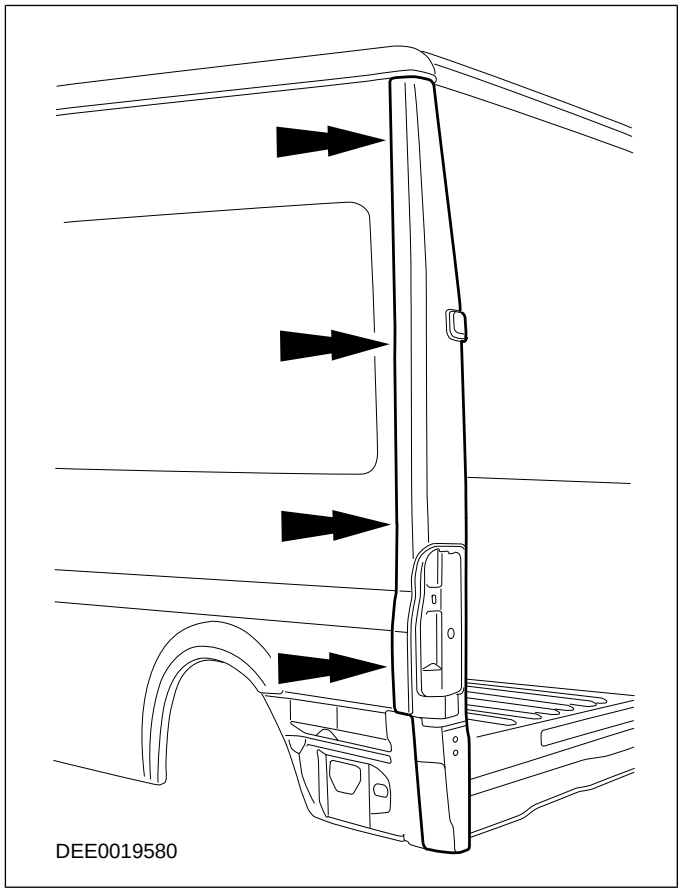
Removal

1. General notes

- Necessary removal work: inner trim, rear lamp, rear door, bumper, bumper corner, rear cross member

2. Box corner

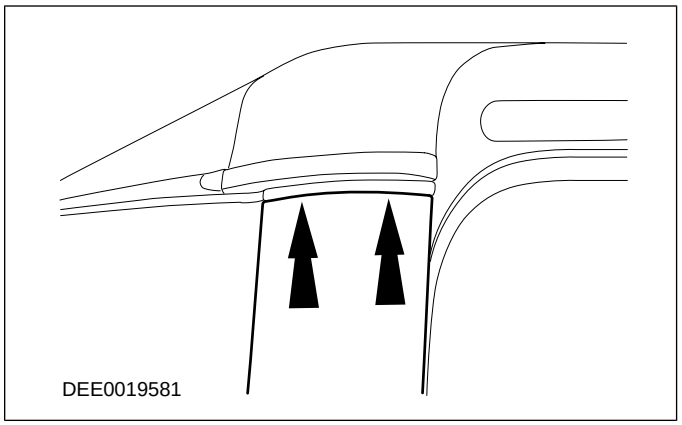
- Rough separating cut.



3. NOTE:The upper rough separating cut must be made approximately 10 mm below the drip rail. In doing so, make sure not to damage the drip rail.

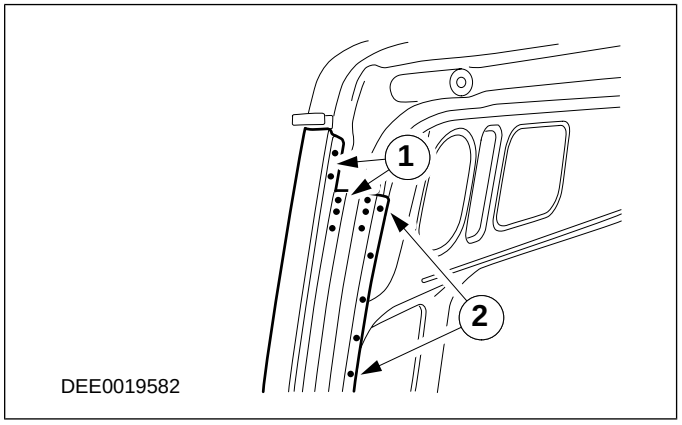
Box corner

- Rough separating cut.



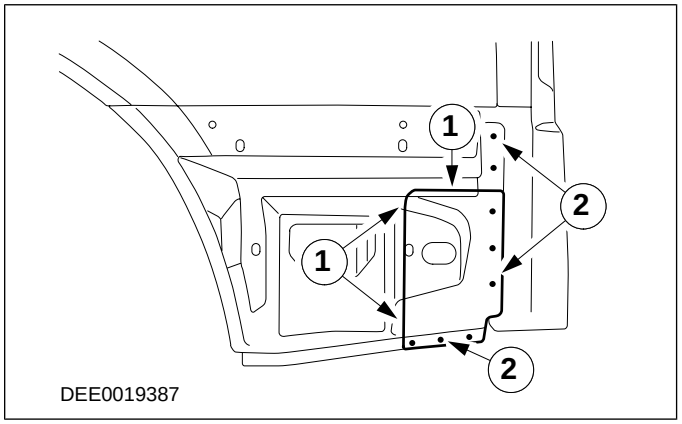
4. Box corner

1. Mill out the spot welds.
2. Mill out the spot welds along the whole length of the flange.



5. Neighbouring side panel

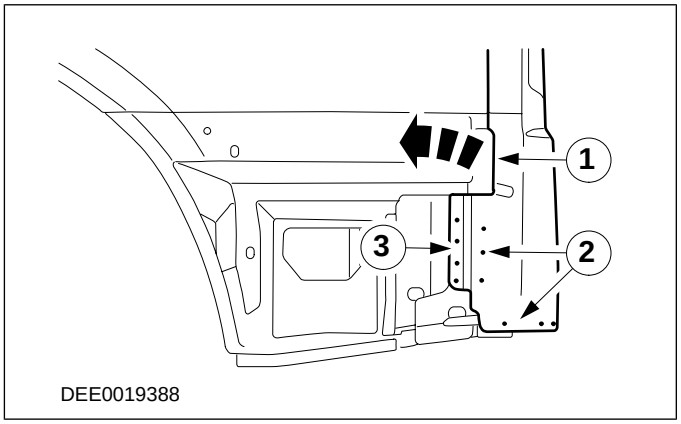
1. Rough separating cut.
2. Mill out the spot welds.



6. Box corner outer panel and neighbouring side panel

REMOVAL AND INSTALLATION

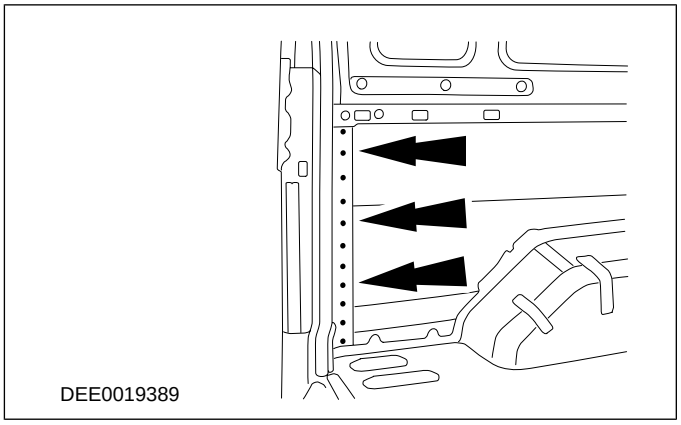
1. Bend the flange up and mill out the spot welds underneath.
2. Mill out the spot welds (free the outer panel).
3. Mill out the spot welds.



DEE0019388

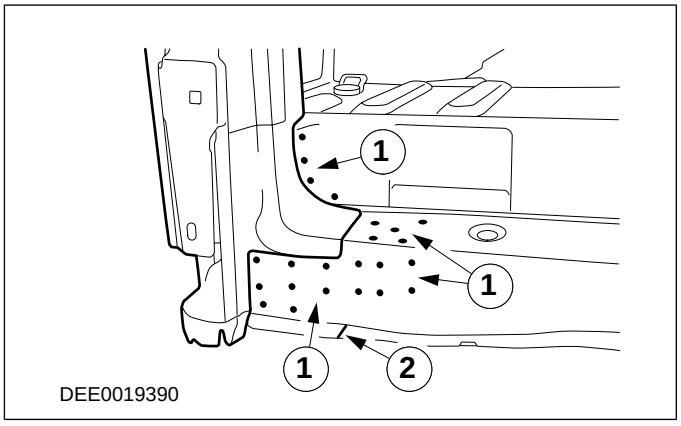
7. Box corner

- Mill out the spot welds.


DEE0019389

8. Box corner

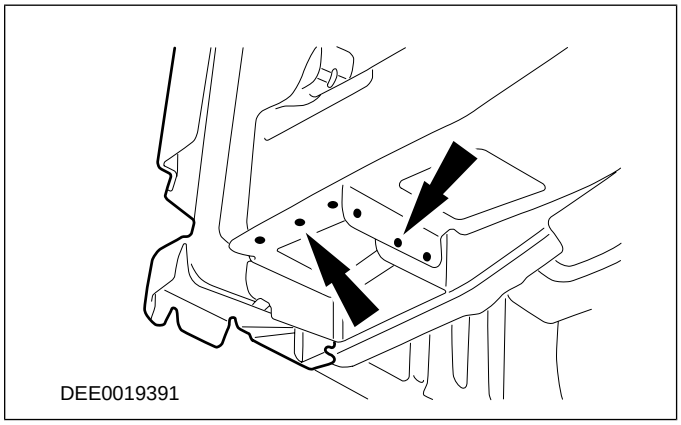
1. Mill out the spot welds.
2. Rough separating cut (one panel thickness).



DEE0019390

9. Box corner

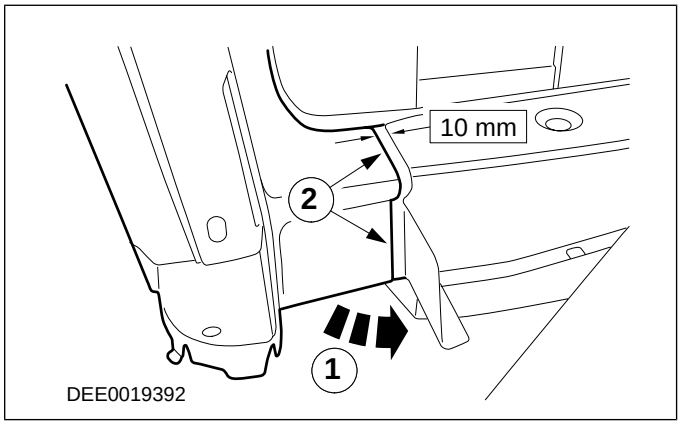
- Mill out the spot welds.


DEE0019391

10. NOTE:Depending on the extent of the damage and ease of access, after the following step the relevant reinforcements and gussets should be exposed.

Box corner

1. Bend up the flange by 90 degrees.
2. Rough separating cut. Maintain a distance of 10 mm between the closing panel with cross member and the cut line. Do not damage the reinforcement located behind. Remove the old box corner.



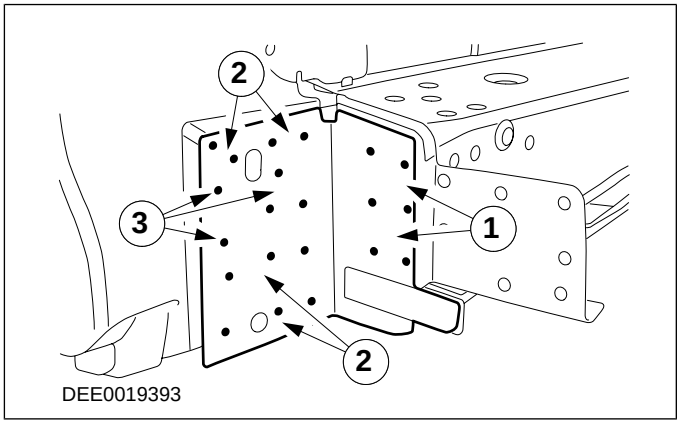
DEE0019392

11. Box corner

1. Drill out the spot welds (2 panel thicknesses).
2. Drill out the spot welds (three panel thicknesses).

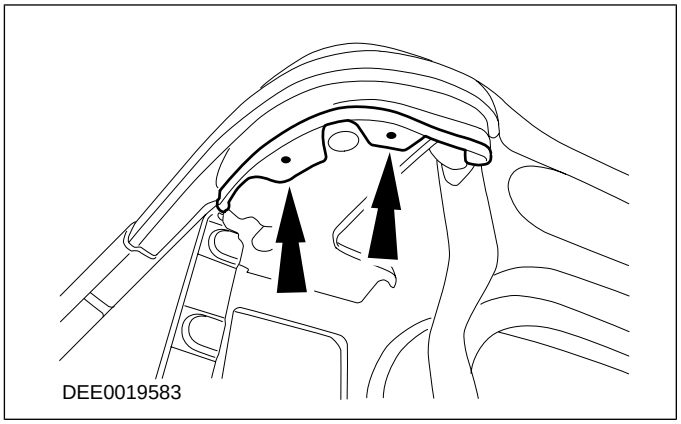
REMOVAL AND INSTALLATION

3. Mill out the spot welds and remove the flange remnants.



12. Box corner

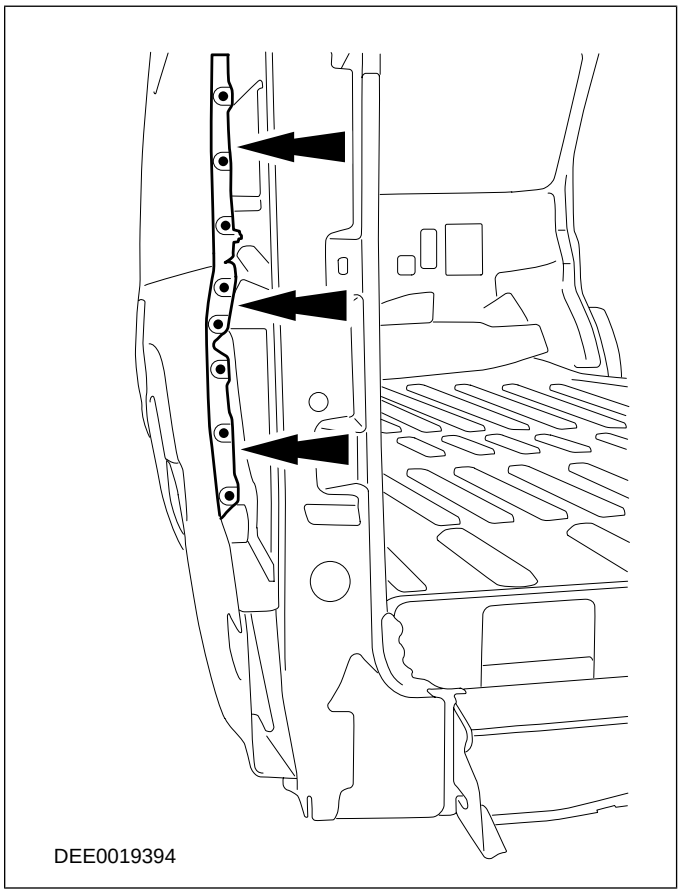
- Drill out the spot welds (2 panel thicknesses) and remove the flange remainder.



Installation

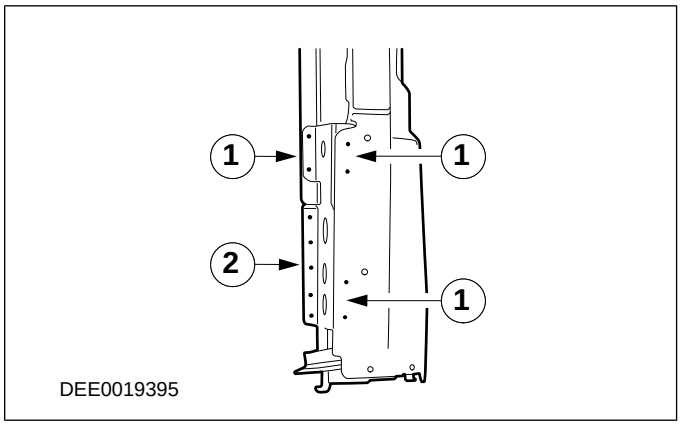
1. Prepare the neighbouring side panel

- Remove the flange remnant of the box corner outer panel along the whole length of the side panel. Make holes for puddle welding in the area marked.



2. Prepare the new part

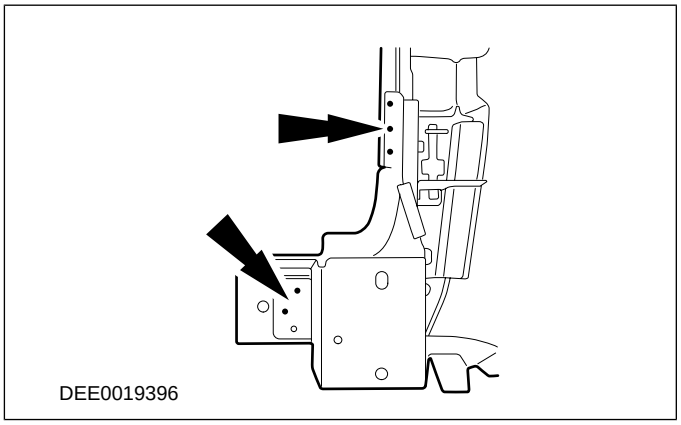
1. Add the missing spot welds.
2. Make holes for puddle welding.



3. Prepare the new part

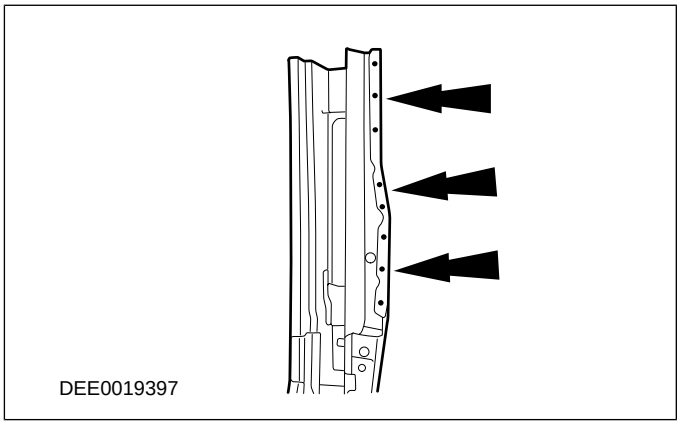
REMOVAL AND INSTALLATION

- Add the missing spot welds.



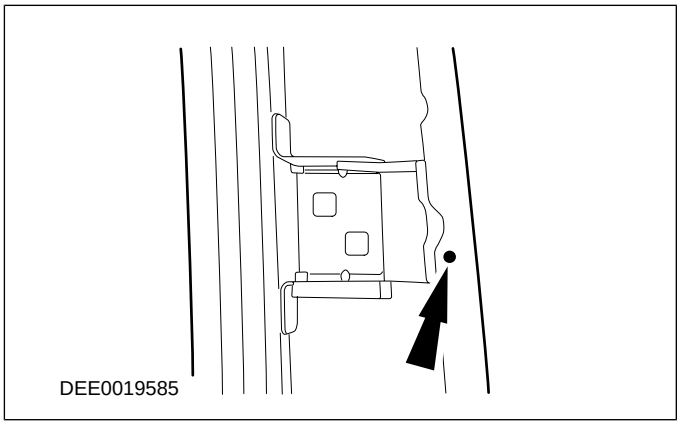
4. Prepare the new part

- Add the missing spot welds.



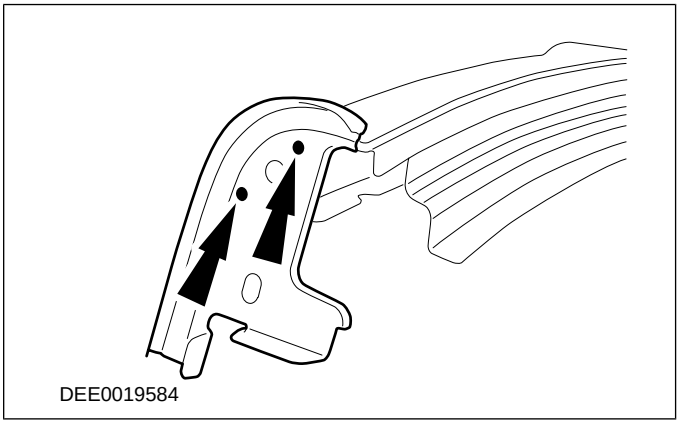
5. Prepare the new part

- Add the missing spot weld.



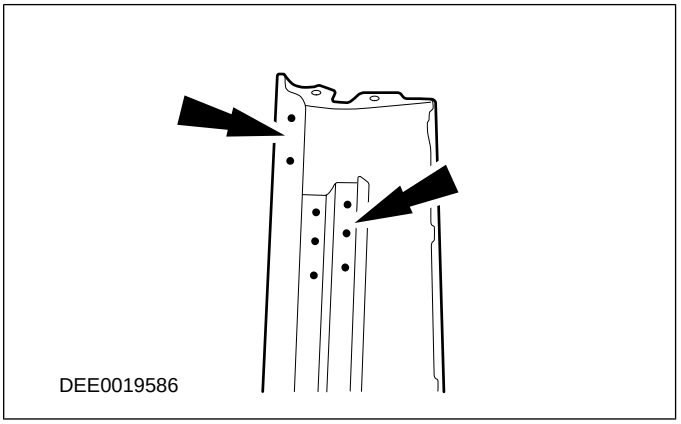
6. Prepare the new part

- Drill through the drip rail closing panel (two panel thicknesses).



7. Prepare the new part

- Make holes for puddle welding.

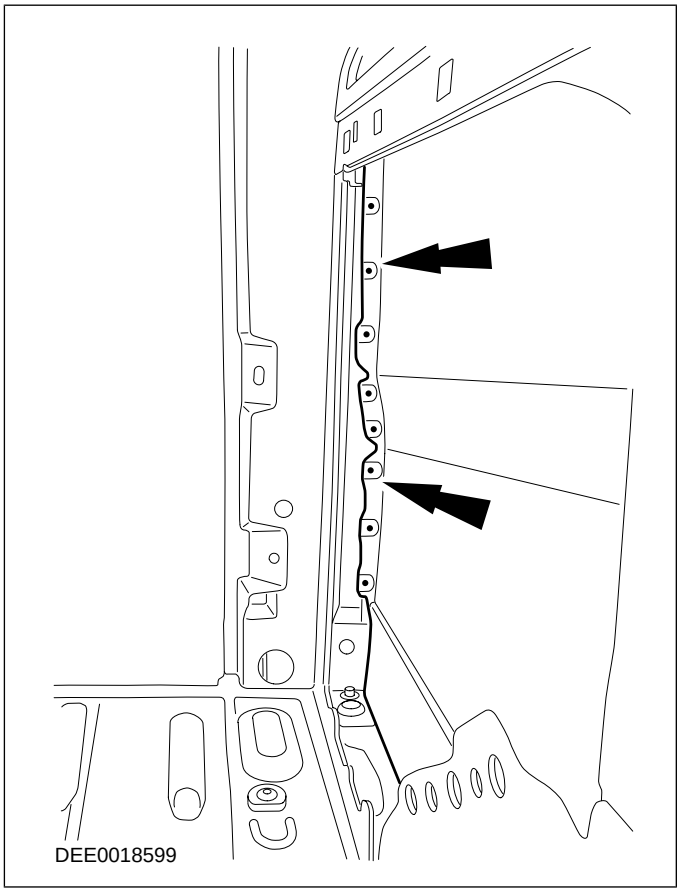


8. Align the box corner and secure it.

9. Neighbouring side panel

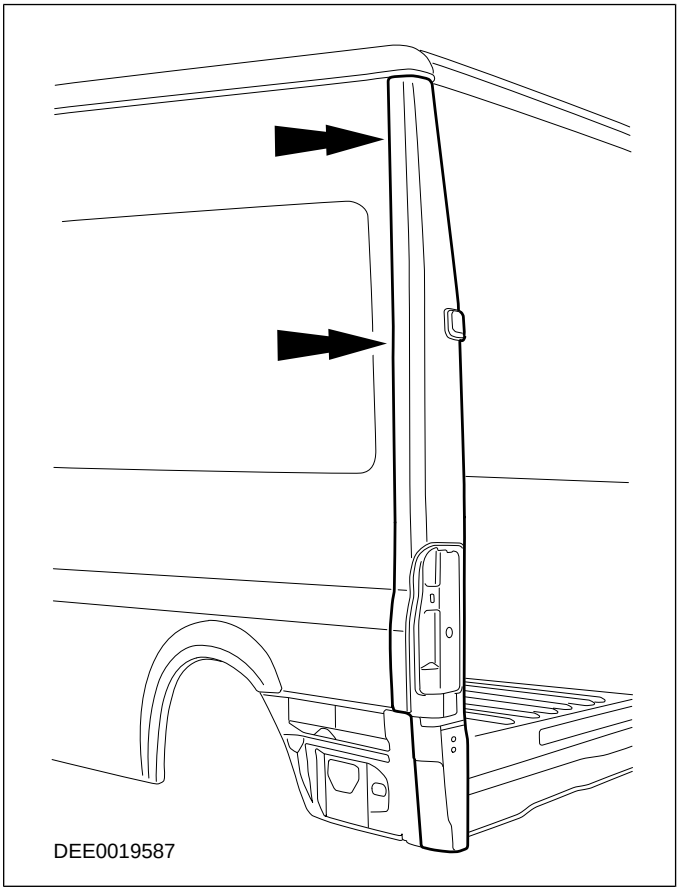
REMOVAL AND INSTALLATION

- Puddle weld.



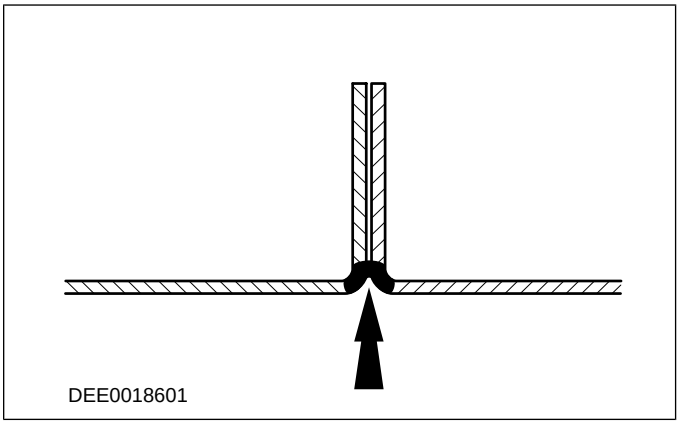
10. Box corner and neighbouring side panel

- Intermittent MIG weld (bead length 5 mm, distance between each 30 mm).



11. Box corner and neighbouring side panel

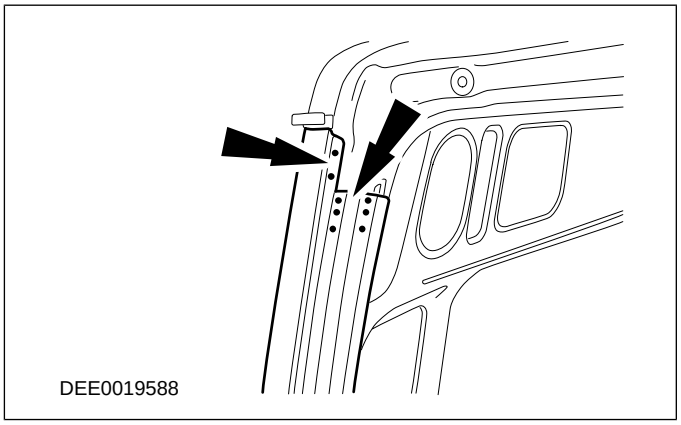
- Hollow grind the intermittent MIG weld seam.



12. Box corner

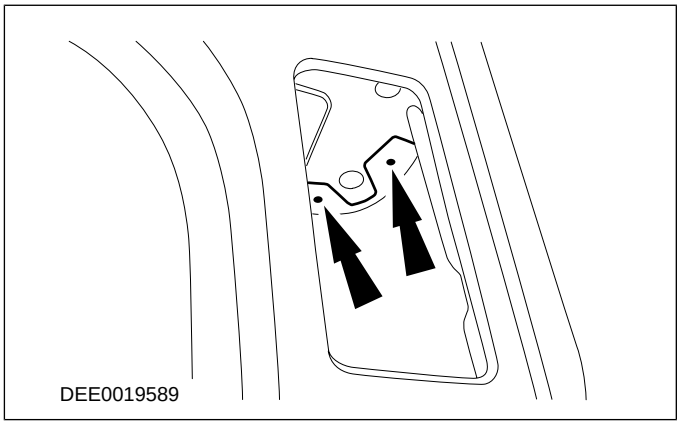
REMOVAL AND INSTALLATION

- Puddle weld.



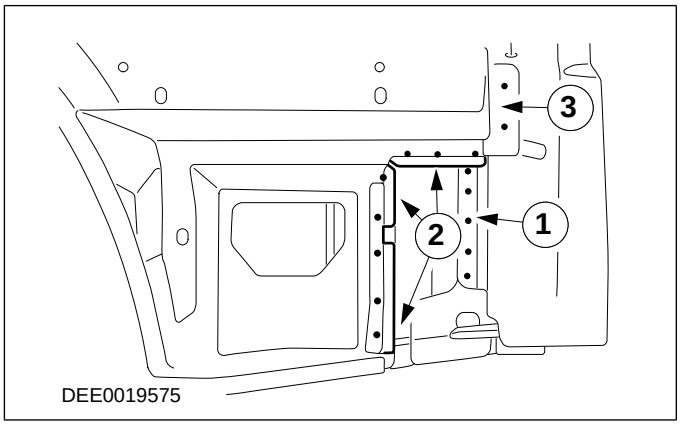
13. Box corner

- Puddle weld.



14. Box corner and neighbouring side panel

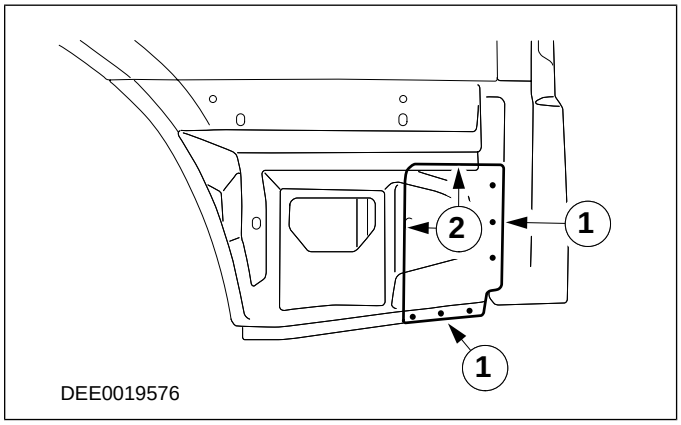
1. Puddle weld.
2. Spot weld a backing strip in place.
3. Lay the flange back down and puddle weld.



15. Neighbouring side panel

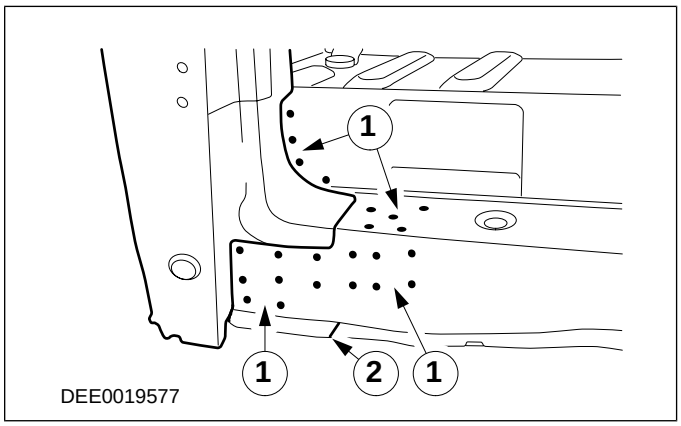
1. Puddle weld.

2. Intermittent MIG weld with gaps.



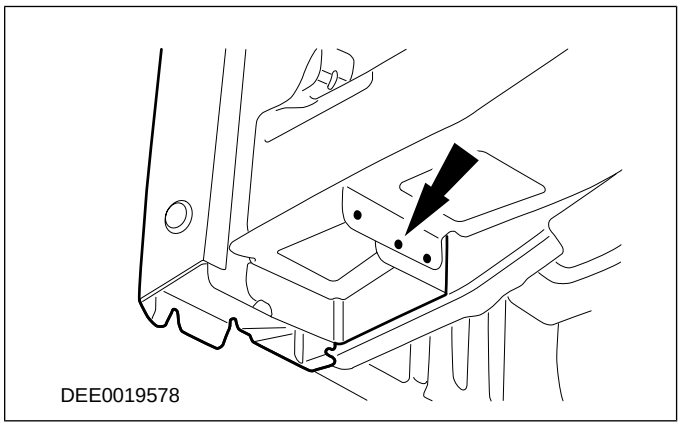
16. Box corner

1. Puddle weld.
2. Continuous MIG weld seam.



17. Box corner

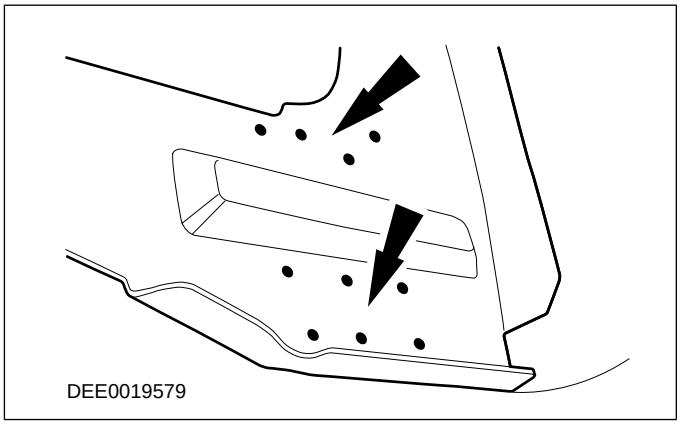
- Puddle weld.



18. Box corner

REMOVAL AND INSTALLATION

- Puddle weld (two sheet metal layers).



REMOVAL AND INSTALLATION

Box Corner Section

Materials	
Name	**Specification**
Box corner	

Removal

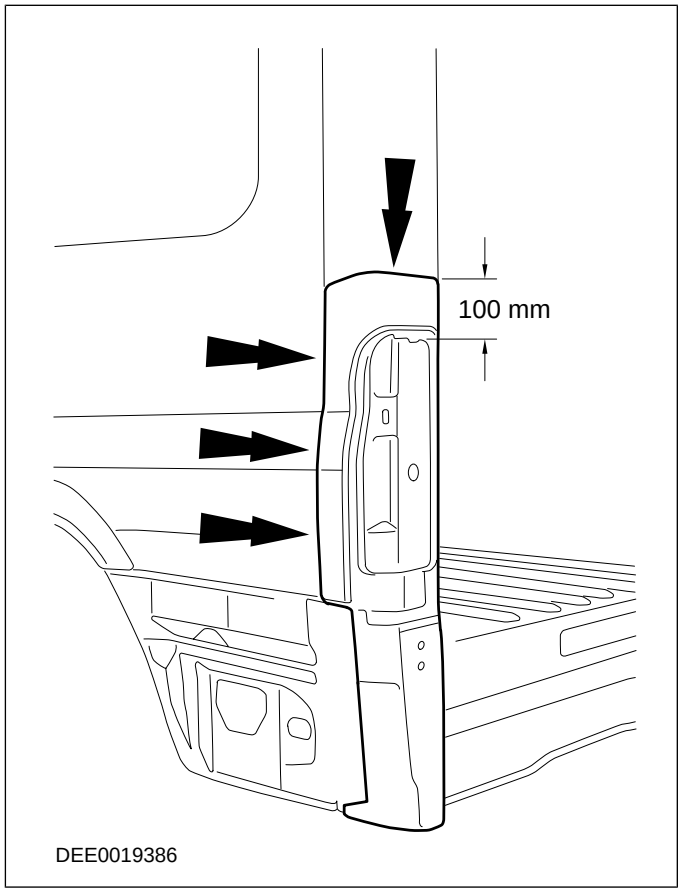
1. General notes

- Necessary removal work: inner trim, rear lamp, rear door, bumper, bumper corner, rear cross member

2. NOTE:The upper rough separating cut must be made exactly 100 mm above the rear lamp aperture. In doing so, make sure that the reinforcement panels behind are not damaged.

Box corner outer panel

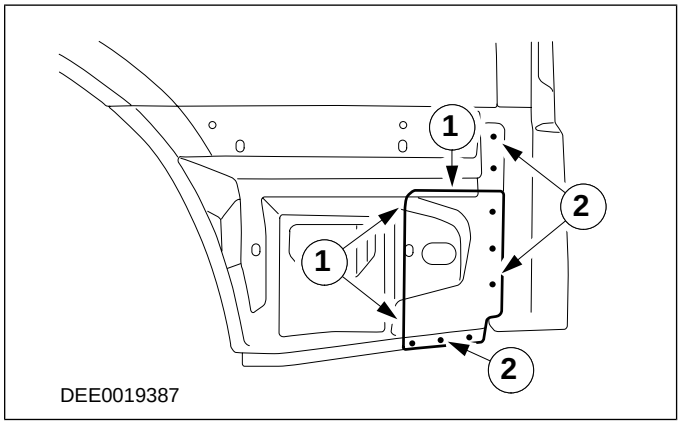
- Rough separating cut.



3. NOTE:To remove the box corner, a part of the neighbouring side panel must be removed.

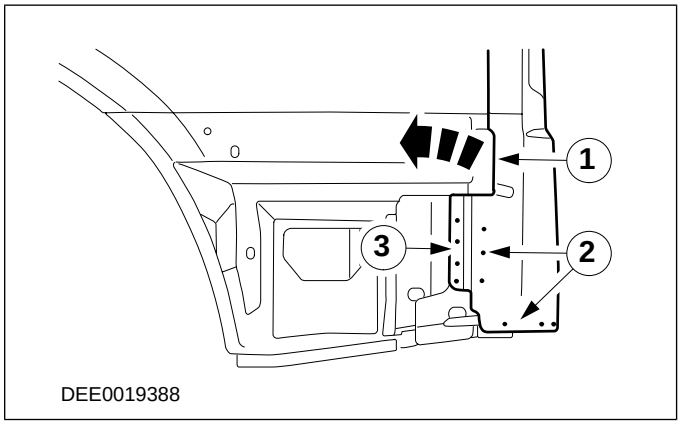
Neighbouring side panel

1. Rough separating cut.
2. Mill out the spot welds.



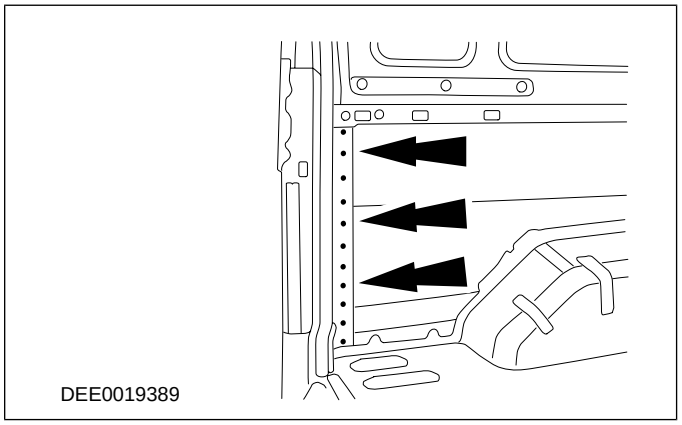
4. Box corner outer panel and neighbouring side panel

1. Bend the flange up and mill out the spot welds underneath.
2. Mill out the spot welds (free the outer panel).
3. Mill out the spot welds.



5. Box corner

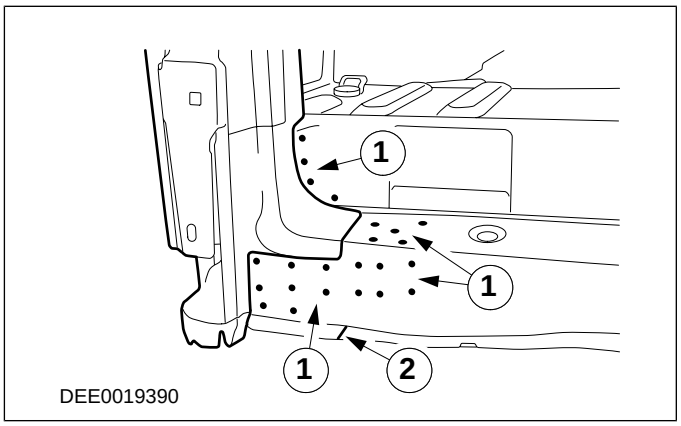
- Mill out the spot welds.



6. Box corner

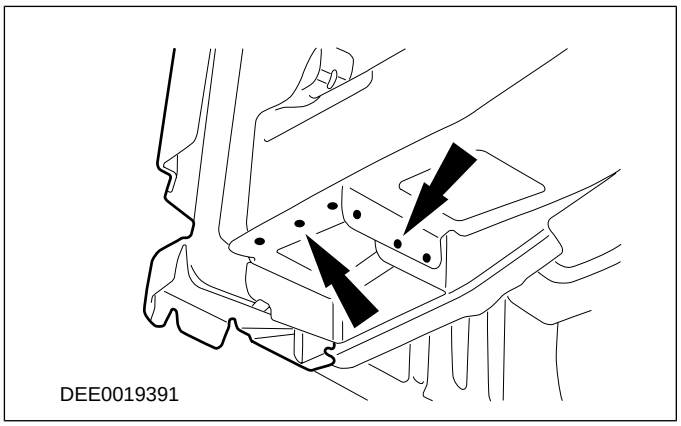
REMOVAL AND INSTALLATION

1. Mill out the spot welds.
2. Rough separating cut (one panel thickness).



7. Box corner

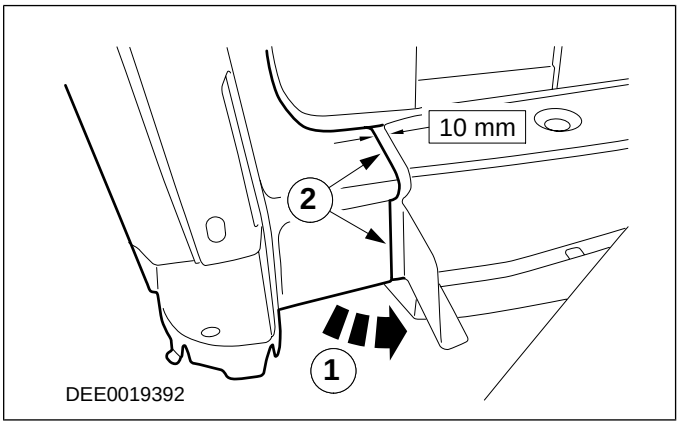
- Mill out the spot welds.



8. NOTE:Depending on the extent of the damage and ease of access, after the following step the relevant reinforcements and gussets should be exposed.

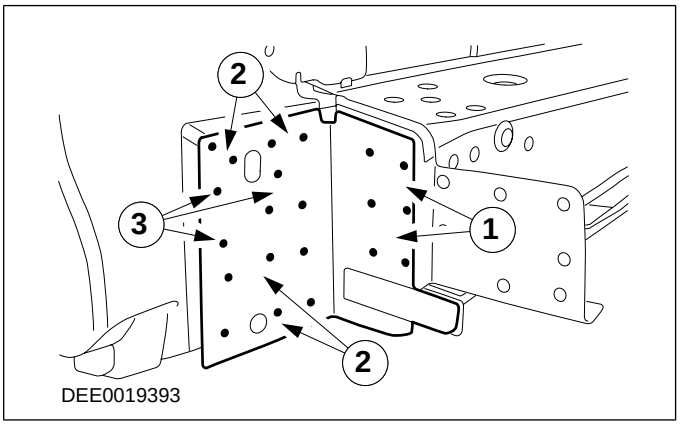
Box corner

1. Bend up the flange by 90 degrees.
2. Rough separating cut. Maintain a distance of 10 mm between the closing panel with cross member and the cut line. Do not damage the reinforcement located behind. Remove the old box corner.



9. Box corner

1. Drill out the spot welds (2 panel thicknesses).
2. Drill out the spot welds (three panel thicknesses).
3. Mill out the spot welds and remove the flange remnants.

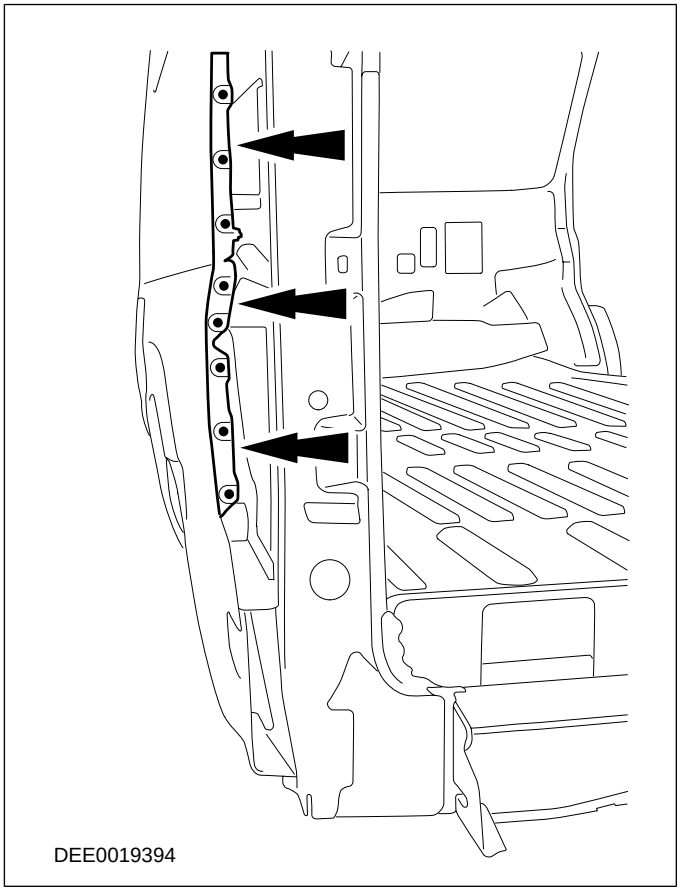


Installation

1. Prepare the neighbouring side panel

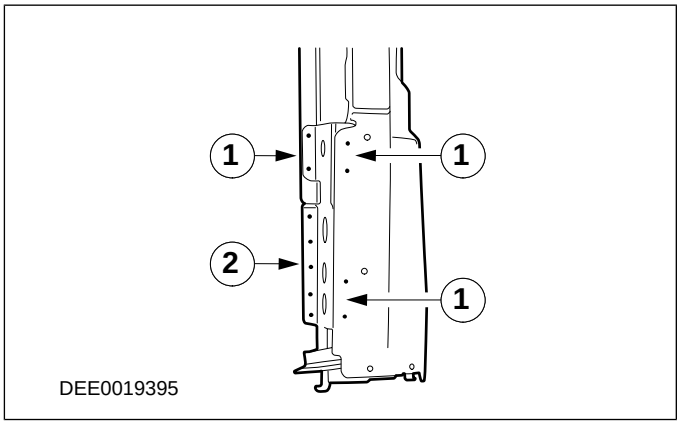
REMOVAL AND INSTALLATION

- Drill out the spot welds (2 panel thicknesses) and remove the flange remainder.



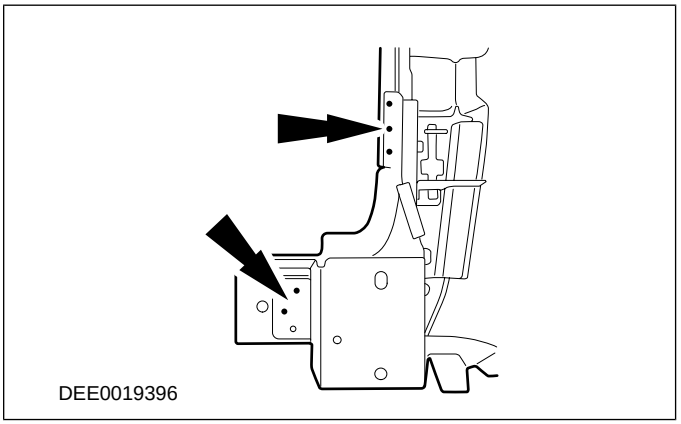
2. Prepare the new part

1. Add the missing spot welds.
2. Make holes for puddle welding.



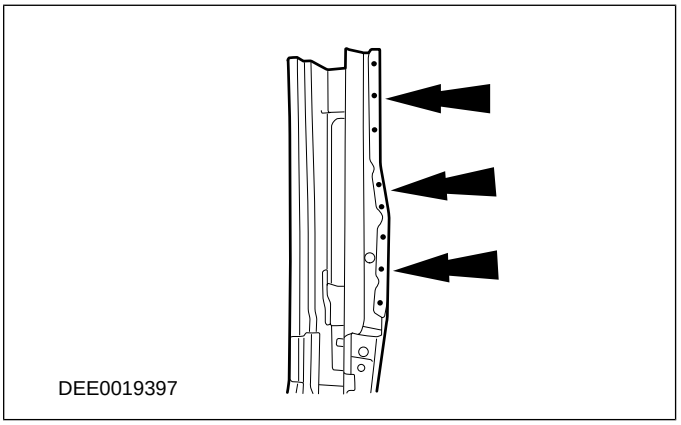
3. Prepare the new part

- Add the missing spot welds.



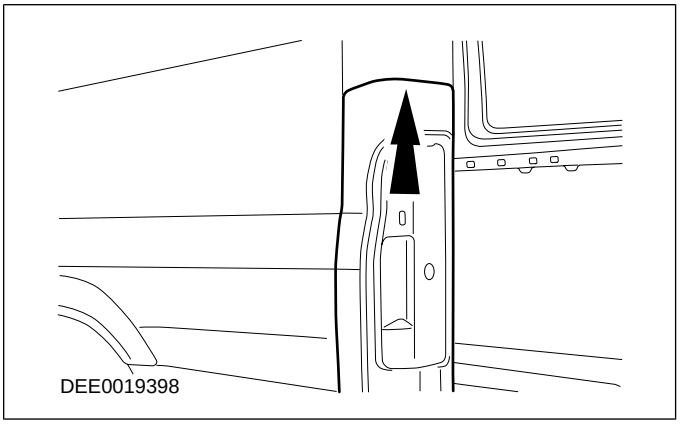
4. Prepare the new part

- Add the missing spot welds.



5. Box corner

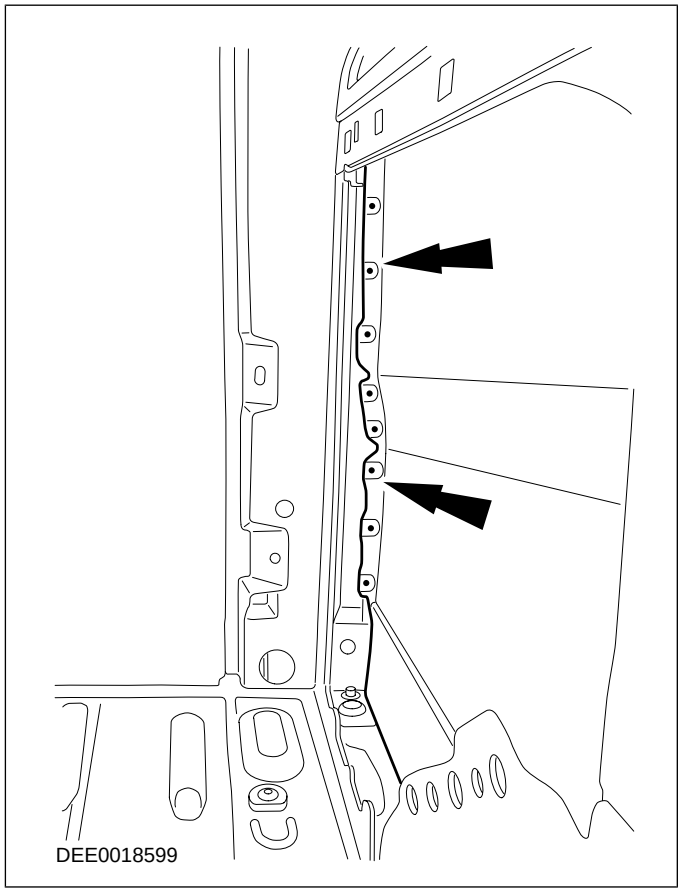
- Align the box corner and secure it. Produce a continuous MIG weld seam with gaps.



6. Neighbouring side panel

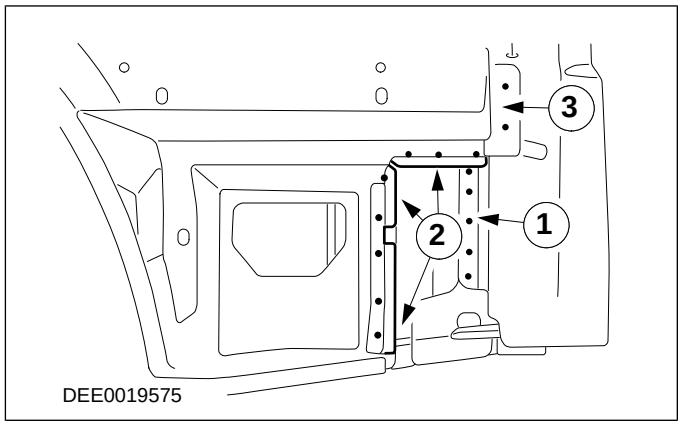
REMOVAL AND INSTALLATION

- Puddle weld.



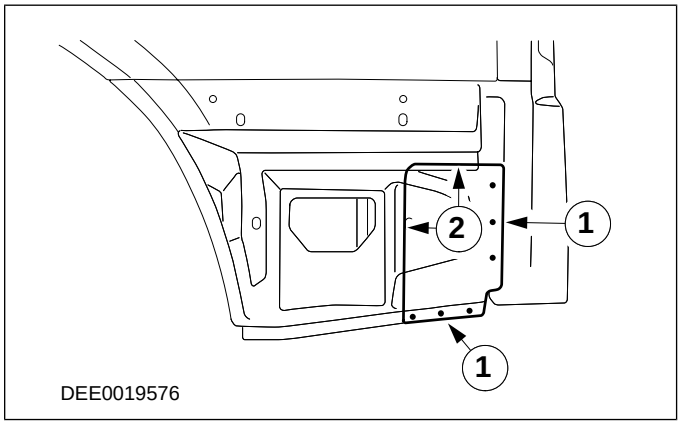
7. Box corner and neighbouring side panel

1. Puddle weld.
2. Spot weld a backing strip in place.
3. Lay the flange back down and puddle weld.



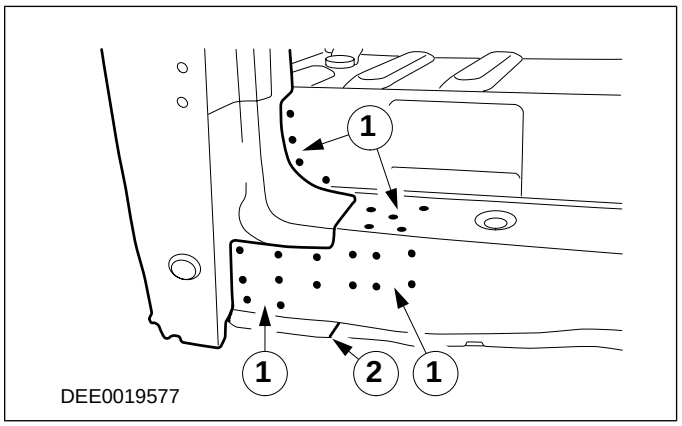
8. Neighbouring side panel

1. Puddle weld.
2. Continuous MIG weld with gaps.



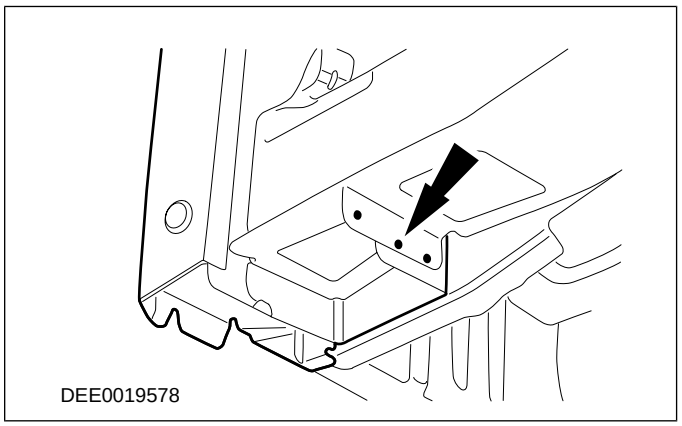
9. Box corner

1. Puddle weld.
2. Continuous MIG seam weld.



10. Box corner

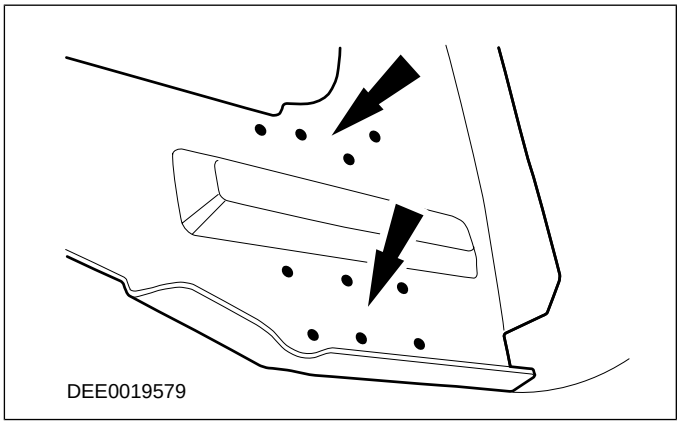
- Puddle weld.



11. Box corner (see from wheelhouse)

REMOVAL AND INSTALLATION

- Puddle weld (two panel thicknesses).



REMOVAL AND INSTALLATION

Back Panel and Crossmember

Materials	
Name	**Specification**
Rear panel with cross member	

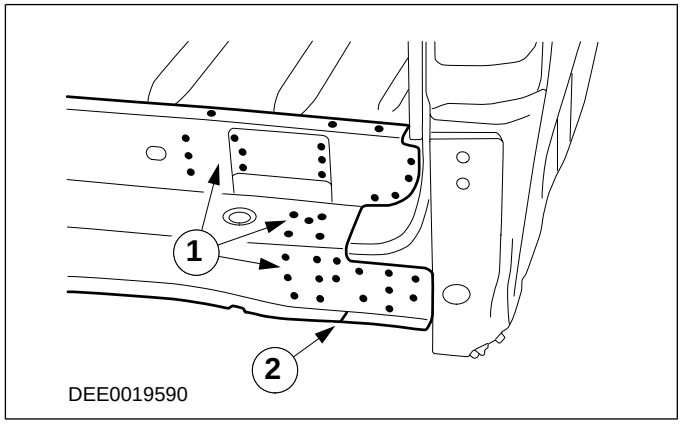
Removal

1. General notes

- Necessary removal work: Rear doors, whole bumper

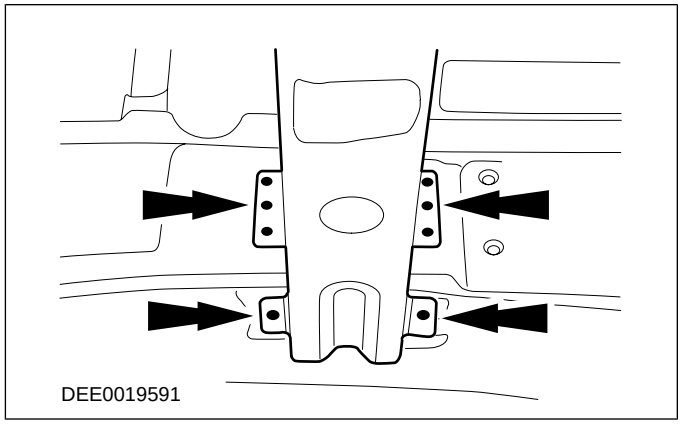
2. Rear panel with cross member

1. Mill out the spot welds (on both sides).
2. Rough separating cut (one panel thickness).



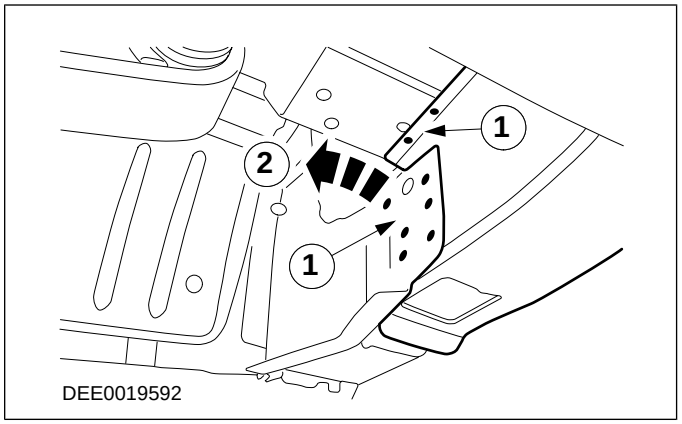
3. Rear side member

- Mill out the spot welds (on both sides).



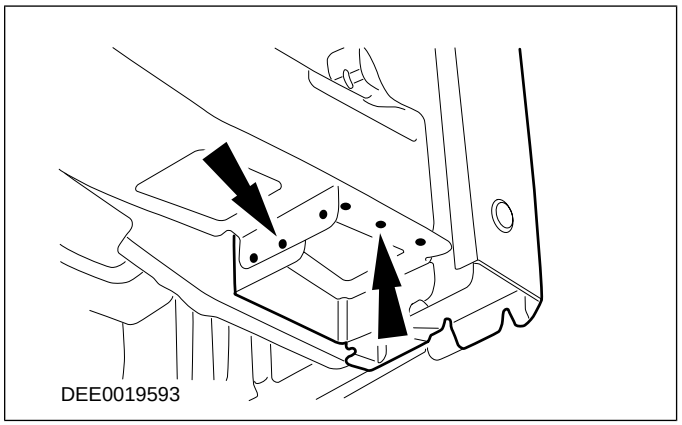
4. Rear panel with cross member

1. Mill out the spot welds (on both sides).
2. Bend up the flange (on both sides).



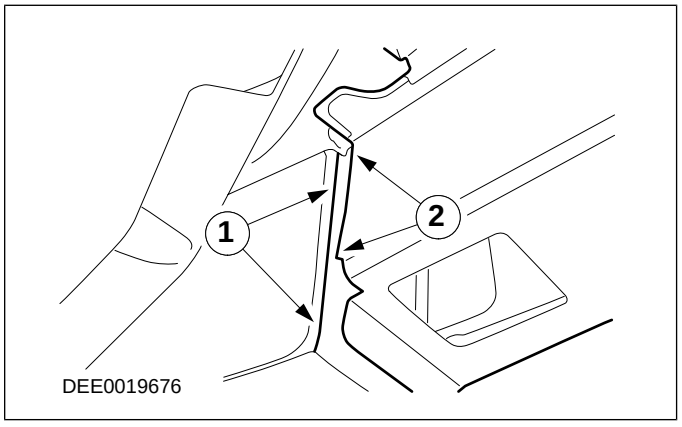
5. Rear panel with cross member

- Mill out the spot welds (on both sides).



6. Rear panel with cross member

1. Rough separating cut.
2. Rough separating cut (on both sides).

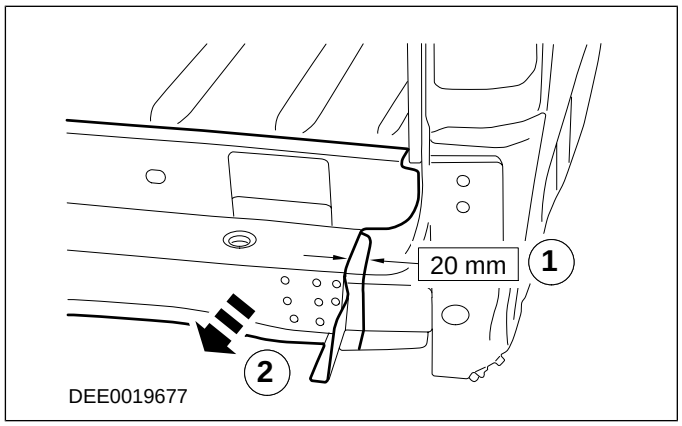


7. NOTE:The cut shown at one corner pillar is necessary to take out the complete old part and to install the new part. The part cut away will then be used again.

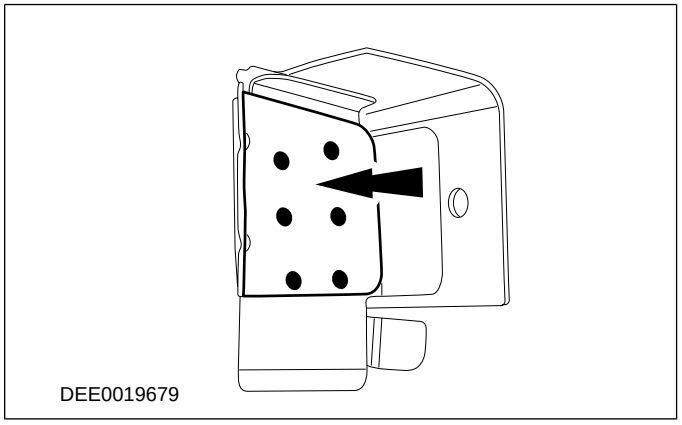
Rear panel with cross member

REMOVAL AND INSTALLATION

1. Rough separating cut.
2. Swing out the old part and remove it.



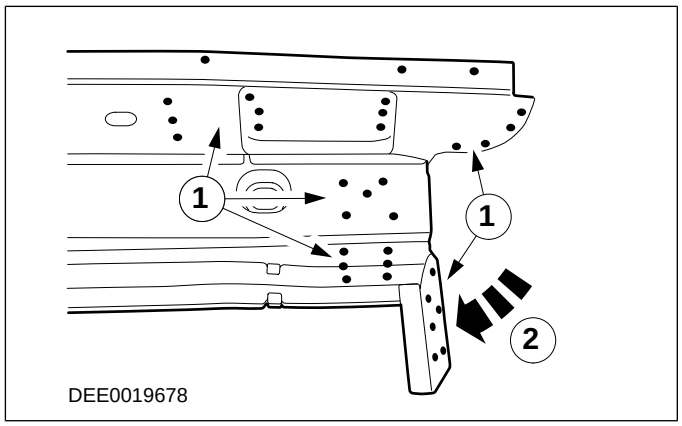
- Mill out the spot welds and remove the flange remnants.



Installation

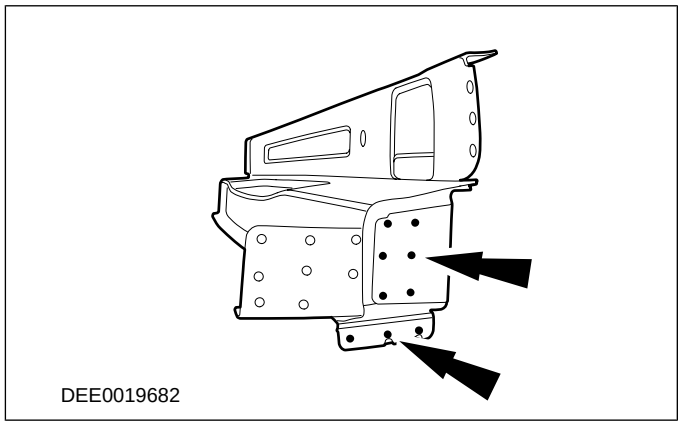
1. Prepare the new part

1. Make holes for puddle welding. Copy from the old part if needed (on both sides).
2. Rough separating cut. Bend up the flange by 90 degrees.



2. Prepare the new part

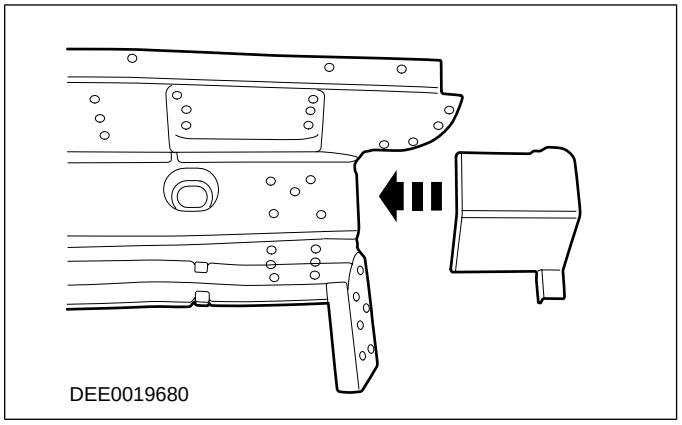
- Make holes for puddle welding (on both sides).



3. Corner pillar remnant part

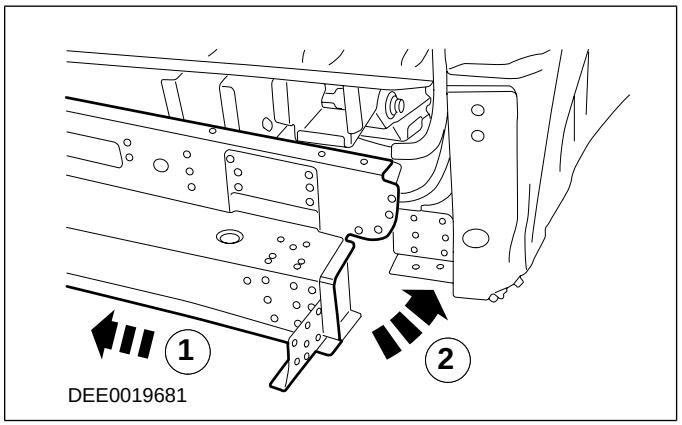
4. Prepare the new part

- Bring the corner pillar remnant part into the new part. DO NOT WELD.



5. Rear panel with cross member

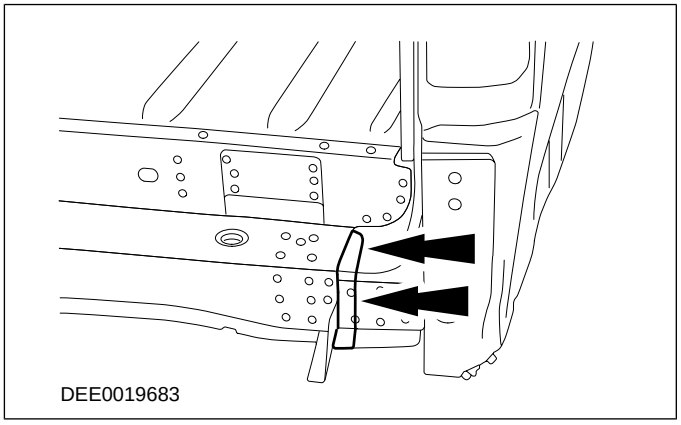
1. Bring in at the left-hand corner pillar.
2. Swing into final position, align and secure.



6. Corner pillar remnant part

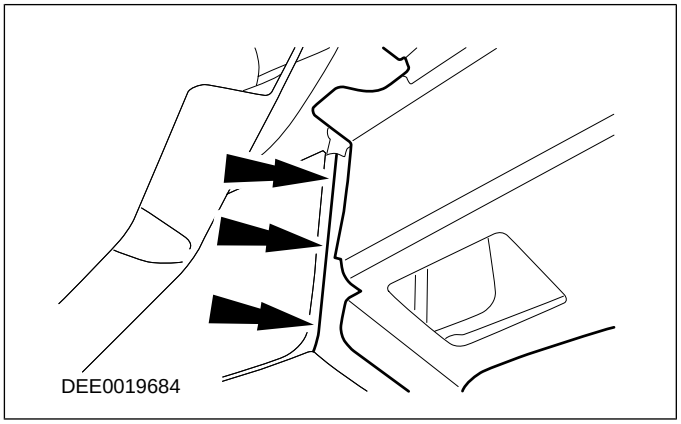
REMOVAL AND INSTALLATION

- Align the corner pillar remnant part and continuous MIG weld.



7. Rear panel with cross member

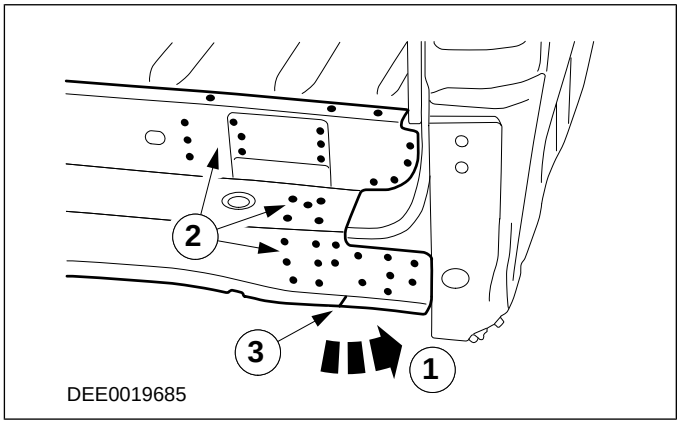
- Continuous MIG seam weld.



8. Align the rear panel with the cross member again.

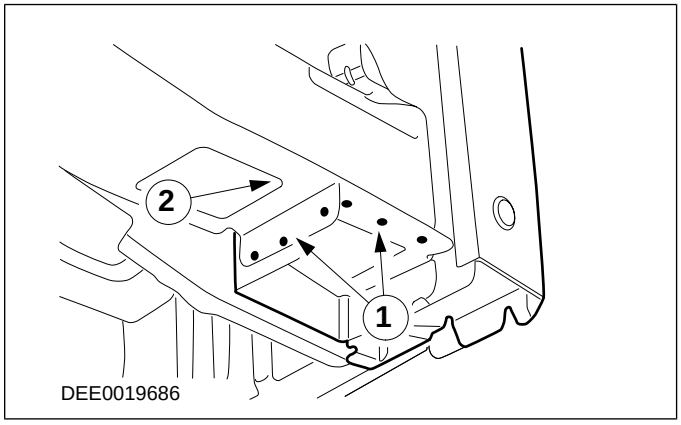
9. Rear panel with cross member

1. Position the flange.
2. Puddle weld (on both sides).
3. Continuous MIG seam weld.



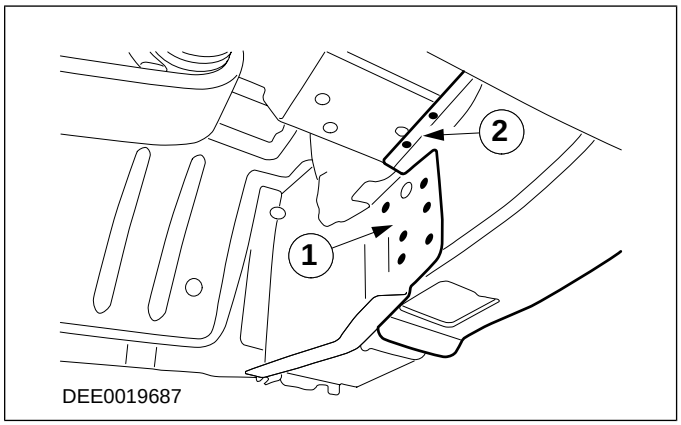
10. Rear panel with cross member

1. Puddle weld (on both sides).
2. Puddle weld the hidden spot welds (on both sides).



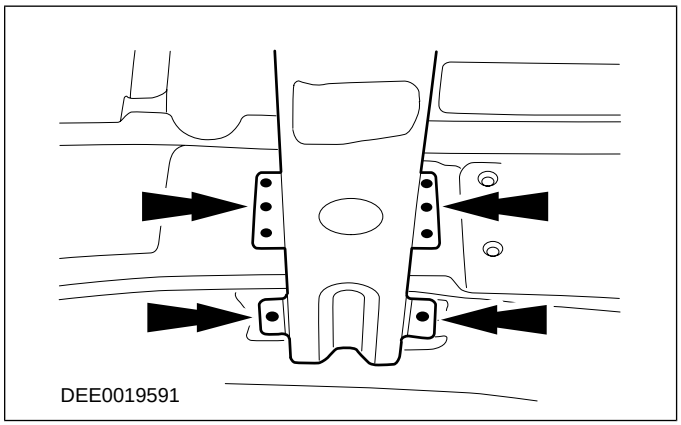
11. Rear panel with cross member

1. Position the flange and puddle weld (on both sides).
2. Puddle weld (on both sides).



12. Rear side member

- Puddle weld (on both sides).



REMOVAL AND INSTALLATION

Rear Side Member Section

General Equipment

Measuring and straightening system

Materials

Name	Specification
Side member section	
Side member corner section	
Bracket	

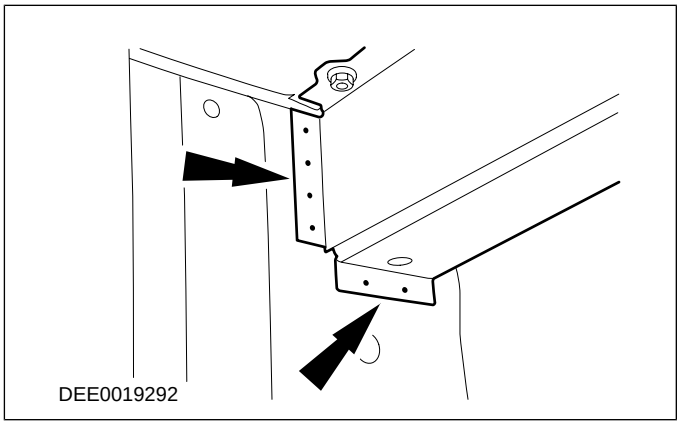
Removal

1. General notes

- Necessary removal work: Undo the rear spring mounting
- Pay attention to the cut of the replacement part.

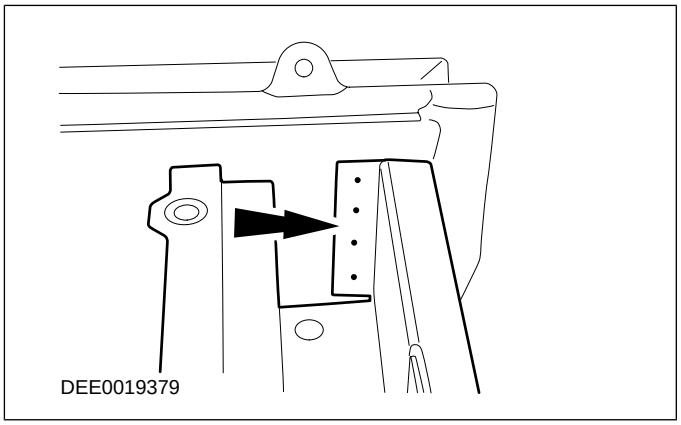
2. Side member corner section

- Mill out the spot welds.



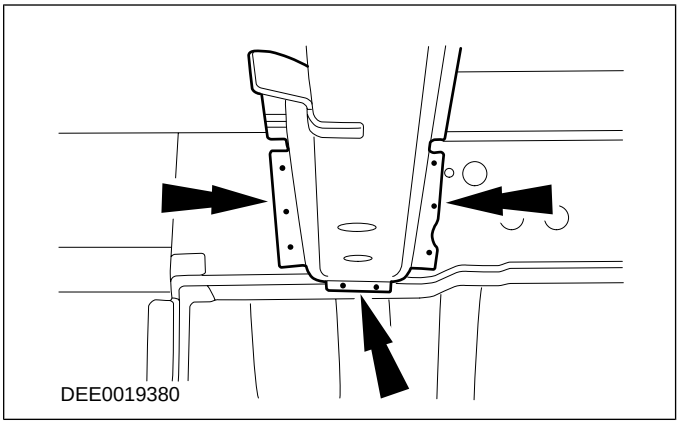
3. Side member corner section

- Mill out the spot welds.



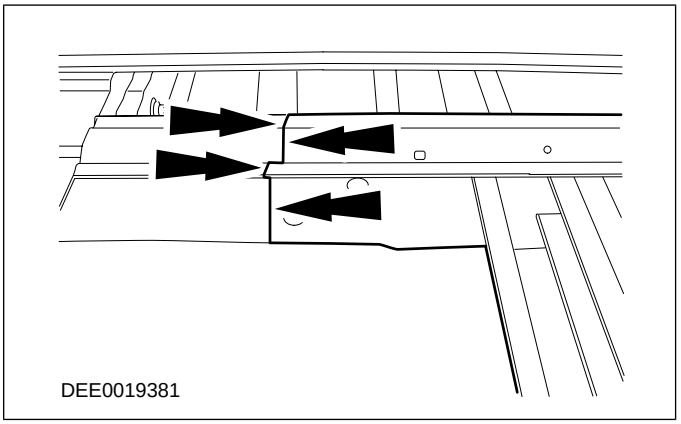
4. Crossmember

- Mill out the spot welds.



5. Side member

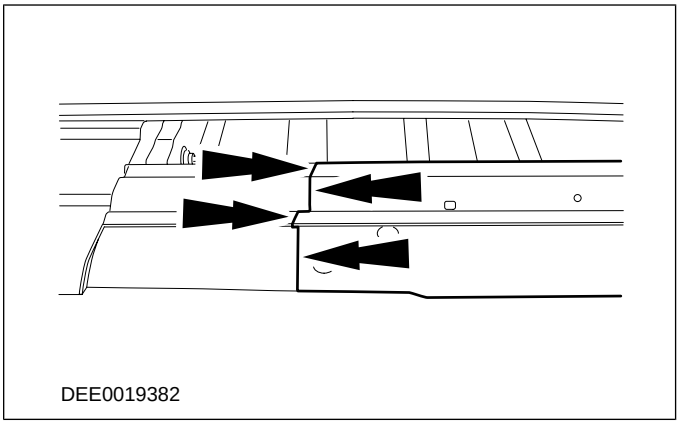
- Cut point.



Installation

1. Side member

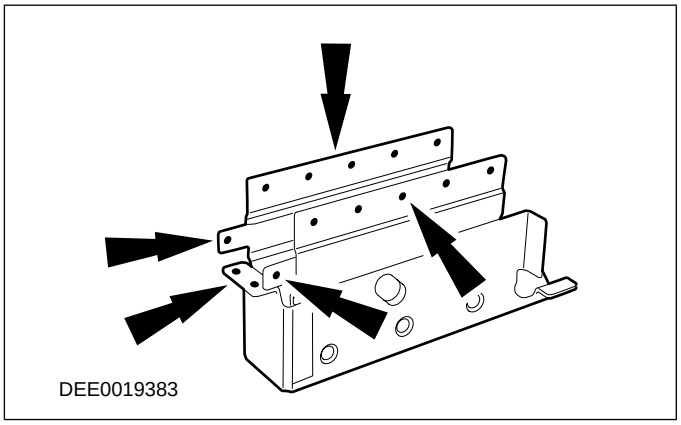
- Tack the new part with several spots of weld. Then produce continuous MIG weld seams with gaps.



2. Prepare the new bracket

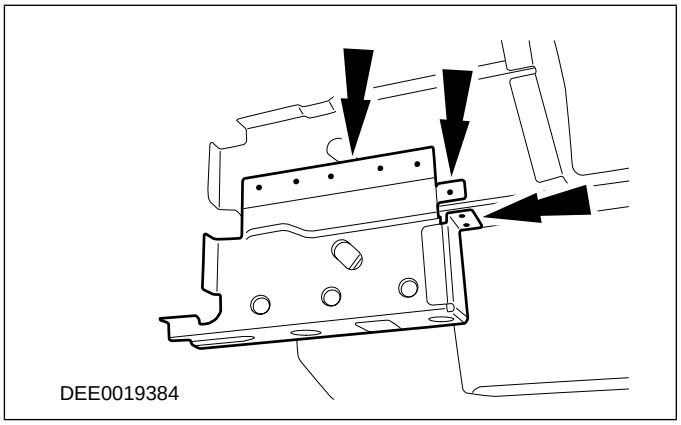
REMOVAL AND INSTALLATION

- Make holes for puddle welding.


DEE0019383

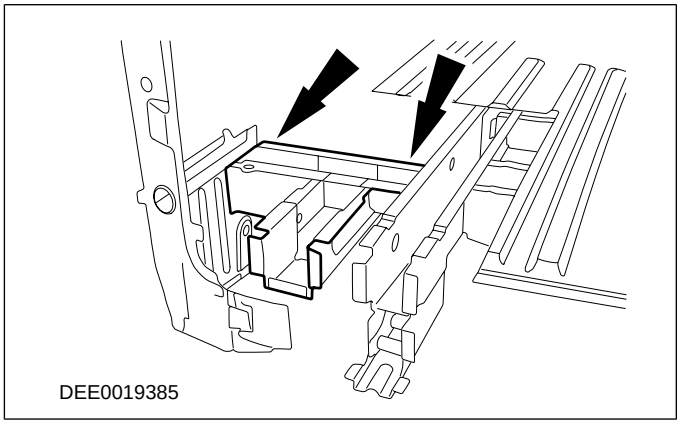
3. Bracket

- Puddle weld.


DEE0019384

4. Side member corner section

- Offer up the new part, secure it and resistance spot weld it.


DEE0019385

SECTION 501-36 Paint - General Information

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications 501-36-3

DESCRIPTION AND OPERATION

Description and Usage of Paint Literature 501-36-4
Symbols 501-36-5
General 501-36-5
Hazardous materials designations 501-36-5
Instructions on measures to be taken for personal protection 501-36-7
Icons 501-36-7
Health and Safety Precautions 501-36-10
General instructions for the paint shop and handling paint materials 501-36-10
Personal protection 501-36-10
Environmental Regulations 501-36-12
Waste disposal in the repair paint shop 501-36-12
The new VOC (Volatile Organic Compounds) solvent regulation 501-36-12
Factory Paint Application 501-36-13
General fundamentals of paint technology 501-36-13
Painting process and corrosion protection 501-36-13
The structure of an original paint finish 501-36-14
Colored fillers applied in production 501-36-14
Paintwork Defects and Damage 501-36-15
Diagnosis and Damage Assessment 501-36-15
Paint damage guide 501-36-15
Paint damage caused by environmental factors 501-36-15
Mechanical damage 501-36-19
Damage due to corrosion 501-36-19
Damage caused by faults in treatment 501-36-19
Tools and Equipment for Paint Repairs 501-36-29
General work equipment 501-36-29
Filler and spray guns 501-36-29
Hand and machine sanding tools 501-36-31
Polishing and finishing tools 501-36-34
Infrared drying technology 501-36-34
Air dryers 501-36-34
Paint mixing system 501-36-35
Painting cabin 501-36-35
Refinishing Materials 501-36-36
Stopper materials 501-36-36
Primers 501-36-37
HS primer filler and HS tinted filler 501-36-38
Paint 501-36-38
Additional Materials 501-36-40
Adhesive sealants 501-36-40
Underbody protection 501-36-40

Paint additives 501-36-41
Additive materials..... 501-36-43
Paint Repairs..... 501-36-44
General information..... 501-36-44
Pre-treatment of the surface 501-36-44
Top coat application..... 501-36-46
Repair stages for repair painting..... 501-36-47
Polish..... 501-36-48
Aids..... 501-36-49
Painting Plastic Parts..... 501-36-50
General..... 501-36-50
Plastic groups..... 501-36-50
Painting new components..... 501-36-51
Unknown primer..... 501-36-51
Paint faults on plastic substrates..... 501-36-52
Spot Repairs..... 501-36-53
General..... 501-36-53
Repair process..... 501-36-54
Dirt inclusions..... 501-36-55
Corrosion Prevention..... 501-36-57
General..... 501-36-57
Operations after painting..... 501-36-57
Definition of the degree of rust..... 501-36-57
Color Identification and Chromatics..... 501-36-59
Basic color theory..... 501-36-59
Metallic and pearl pigments..... 501-36-60
Color codes and their determination on Ford vehicles 501-36-61
Matching tinted filler to the color code 501-36-64
Tips and Tricks..... 501-36-65
Comparing paint structures..... 501-36-65
Etching substrate..... 501-36-65
Masking the vehicle..... 501-36-65
Color shade problems..... 501-36-67
Isopropanol and water..... 501-36-67
Temperature reduction spray..... 501-36-67
Paint plane..... 501-36-67
Shading..... 501-36-67
Sanding marks..... 501-36-68
Improving touch-up work..... 501-36-68

SPECIFICATIONS

Description	Finis Code	Specification
Underbody protection	5 030 492	-
Anti-corrosion wax	1 219 834	WSK-M7C89-A
Cavity wax	5 030 081	-
Profiled butyl seal	1 128 983	S-M3G4620-A
Weld primer	1 205 996	-
Clinched flange protection	1 136 479	WSK-M4G245-B
Seam sealing compound	1 205 817	WSS-M4G364-A
Body sealing compound	1 143 255	-
Because the supply of paint materials to the dealer workshops has been handed over to paint suppliers, the specifications for these materials are not given in the table.		

DESCRIPTION AND OPERATION

Description and Usage of Paint Literature

Vehicle paints are subject to severe demands caused by external influences. Moisture, air-borne deposits in the form of various chemicals and UV light constantly affect a paint surface. Furthermore, mechanical damage occurs through grit, stones and sand. Bird droppings, insect residues, pollen and tree sap also attack the paint surface.

The present literature not only informs the specialist about current repair painting techniques, but also provides tips and instructions on modern and economical repair processes.

High quality bodywork paints require the use of the most modern technologies and regular updating of the technician's knowledge of painting techniques, because of the constantly new developments in paint technology.

Information about different materials is listed under Specification.

Furthermore, information on the fundamental principles of repair painting and paint materials is provided in several chapters. The safety instructions indicate the possible health hazards and other sources of danger. There are also notes about tools and materials as well as on basic painting methods.

In the model specific repair instructions, only the most important repair steps or special features are referred to. Detailed information on the generally applicable painting procedures is given in this paint manual.

Direct supply of repair paints by Ford has been discontinued. There is however an agreement with many paint manufacturers, which ensures fast and problem-free supply to the dealer undertakings.

Paint suppliers:

- DuPont
- Glasurit
- PPG
- Sikkens
- Spies Hecker
- Standox

When using painting materials, it should be taken into account that the manufacturers have exactly matched their products between each other. In order to avoid quality defects, difficulties in working and losses in corrosion protection, these may not be substituted with other products.

NOTE: The Ford Service Organization organizes basic and more in-depth training on much of the content of this paint manual. As well as the practical part of the training, a further component is the Student Information document, which offers supplementary information in the form of a brochure.

During all work it must always be ensured that personal safety and the operational capability of the vehicle are not threatened by the choice of methods, tools and components.

The information given in the diagrams in the chapter "Paint Damage" is provided by the repair paint manufacturer.

DESCRIPTION AND OPERATION

Symbols

General

Various symbols, signs, instructions and illustrations are used in this literature. Warnings and cautions have different meanings and require different ways of proceeding. Diagrammatic representations are provided with instructional signs for improved clarity. These are briefly explained below:

WARNING:This caption is used when failure to follow instructions exactly or failure to follow them at all may result in a hazard to persons or in persons being injured.

CAUTION:This caption is used when incorrectly following the test procedures or instructions or failure to follow them at all could lead to damage to the vehicle or components.

NOTE: This caption is used when attention needs to be drawn to special or extra information.

When reading this handbook, you will come across the points WARNING, CAUTION AND NOTE. These instructions are always given immediately before the corresponding job steps.

Hazardous materials designations

Many accidents occur because of ignorance. In the area of personal health protection, it is particularly important to clearly emphasize sources of danger and their effects on human organs.

Only with knowledge of hazardous material designations can it be certain that the necessary precautions are taken when handling substances which are harmful to health.

NOTE: Pay attention to the manufacturer's data on the containers and given in the Safety Data Sheet.

DESCRIPTION AND OPERATION

Hazardous material symbols



E59393

Item	Description
1	Very poisonous, T+ (extremely toxic), small quantities can be fatal.
2	Poisonous, T (toxic), causes serious damage to health
3	Corrosive, C (corrosive), destroys living tissue.
4	Harmful to health, Xn (noxious).
5	Irritant, Xi (irritant), can cause inflammation.

Item	Description
6	Explosive
7	Highly flammable, F+ (extremely flammable), already flammable at temperatures below 0° C.
8	Flammable, F (flammable), forms a flammable mixture with air.
9	Oxidizing, O (oxidizing), reacts with combustible substances.

DESCRIPTION AND OPERATION

As well as the danger symbols, there is more comprehensive manufacturer's information to be found on the containers and in the Safety Data Sheets, and you must pay attention to this information.

Instructions on measures to be taken for personal protection.

As well as the information about sources of danger, there are mandatory instructions which draw your attention to the personal protection measures to be taken.

Mandatory symbol

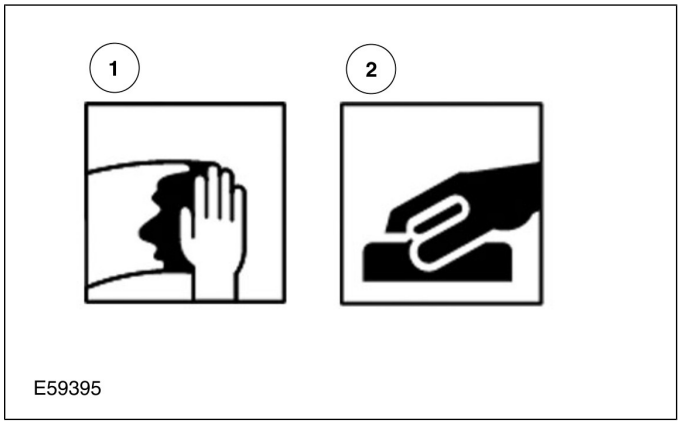


Item	Description
1	Breathing protection must be worn
2	Eye protection must be worn
3	Ear protection must be worn
4	Protective gloves must be worn
5	Protective footwear must be worn

Icons

So that the necessary information for optimal handling is clear, unambiguous and can be quickly understood, the leading paint manufacturers have agreed a standard symbolic language. Language independent representations in the form of icons provide handling instructions which are supplemented with quantity or time information.

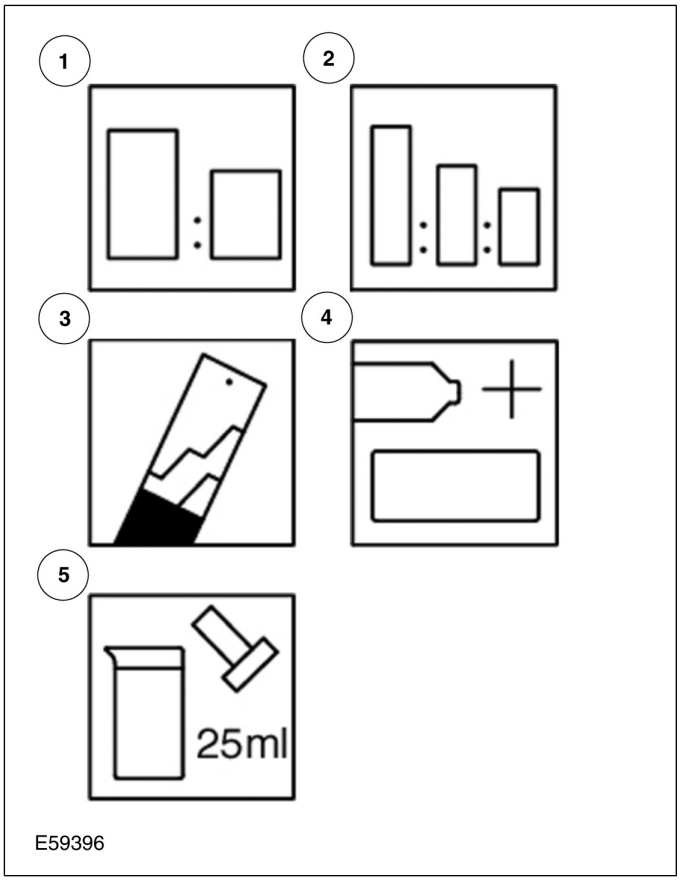
Pretreatment



Item	Description
1	Clean
2	Sand

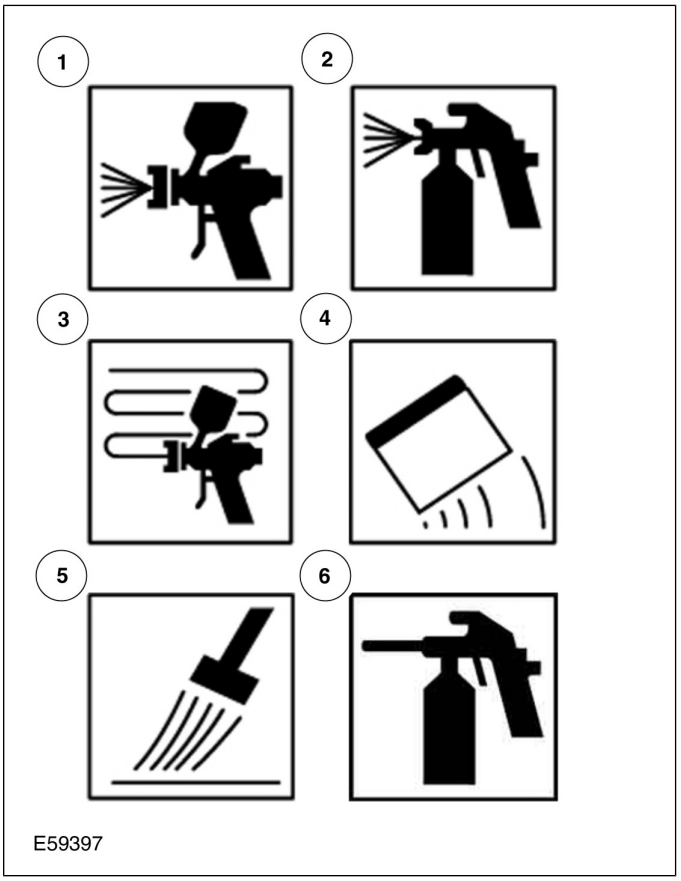
DESCRIPTION AND OPERATION

Mix



Item	Description
1	2 component mixture
2	3 component mixture
3	Use a measuring rod
4	Addition of hardener
5	Addition of additives

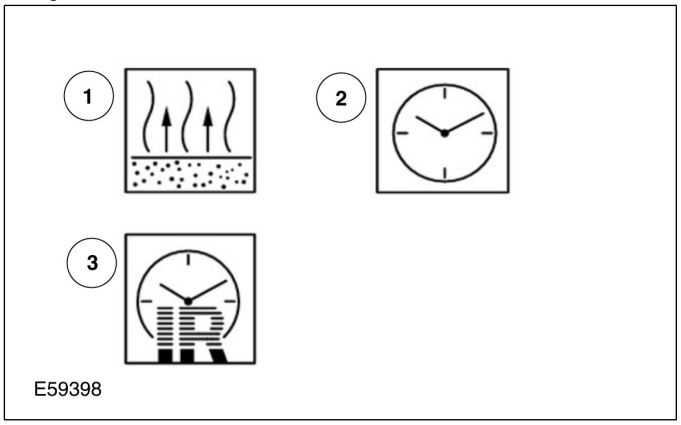
Process



Item	Description
1	Flow-beaker spray gun
2	Suction-beaker spray gun
3	Spray passes
4	Filler
5	Coat
6	Underbody protection spray gun

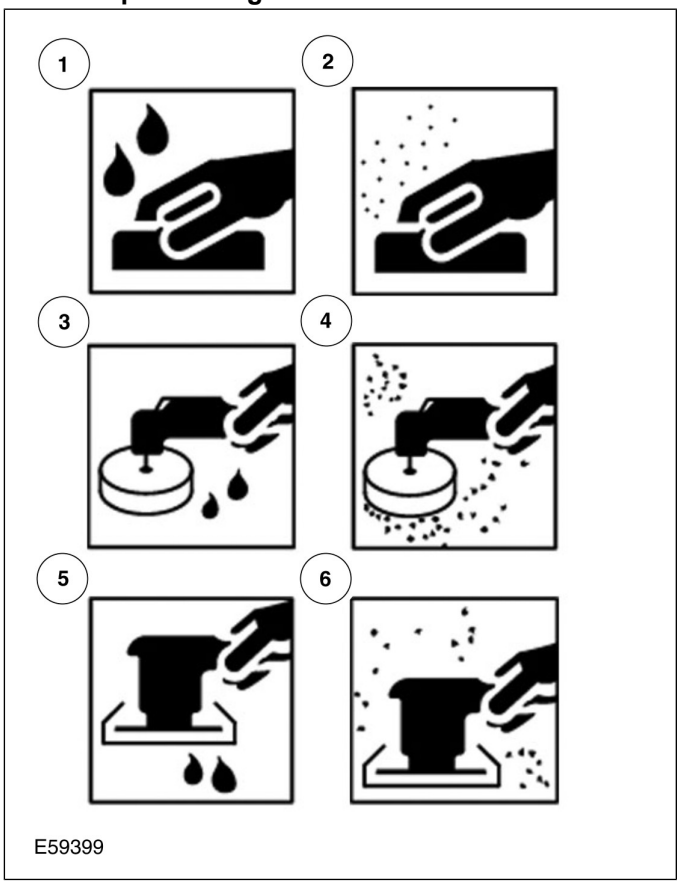
DESCRIPTION AND OPERATION

Dry



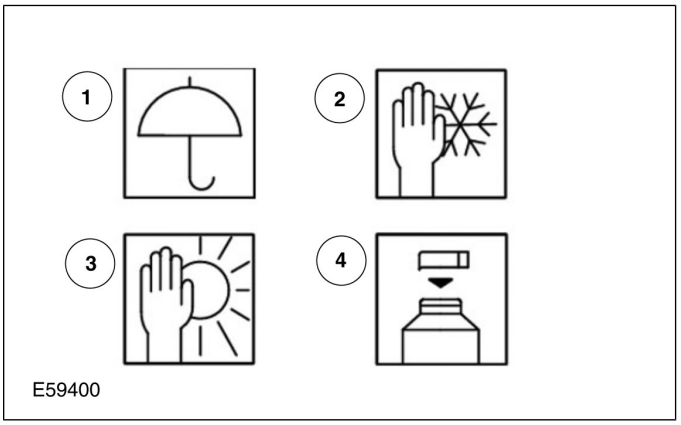
Item	Description
1	Ventilate
2	Drying time
3	Drying time with infra-red dryer

Further processing



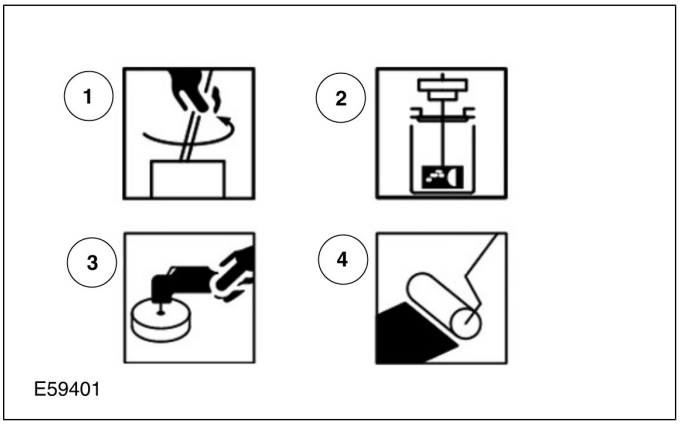
Item	Description
1	Hand abrade (wet)
2	Hand abrade (dry)
3	Eccentric sander (wet)
4	Eccentric sander (dry)
5	Oscillating sander (wet)
6	Oscillating sander (dry)

Store



Item	Description
1	Protect from moisture
2	Store in a frost-free environment
3	Store in a cool place
4	Close the container

Other



Item	Description
1	Stir by hand
2	Stir using a mixing machine
3	Polish
4	Roll

DESCRIPTION AND OPERATION

Health and Safety Precautions

General instructions for the paint shop and handling paint materials

Hazardous areas in repair paint shops:

- Danger from fires, explosions and hot surfaces.
- Dangers to health and safety from the effects of harmful substances because of their absorption through the skin and/or inhalation.
- Dangers caused by electricity, compressed air, power tools and noise.

WARNING:During painting work there is an increased danger of fire or explosion. Prevent any sparks being created. Fire, naked lights and smoking are forbidden.

Measures:

- Wear protective footwear made from anti-static material.
- Only use tools made of wood, brass or copper to clean stands and extraction ducts. Do not use tools made of steel.

Only fill or decant paint materials in a specially marked area.

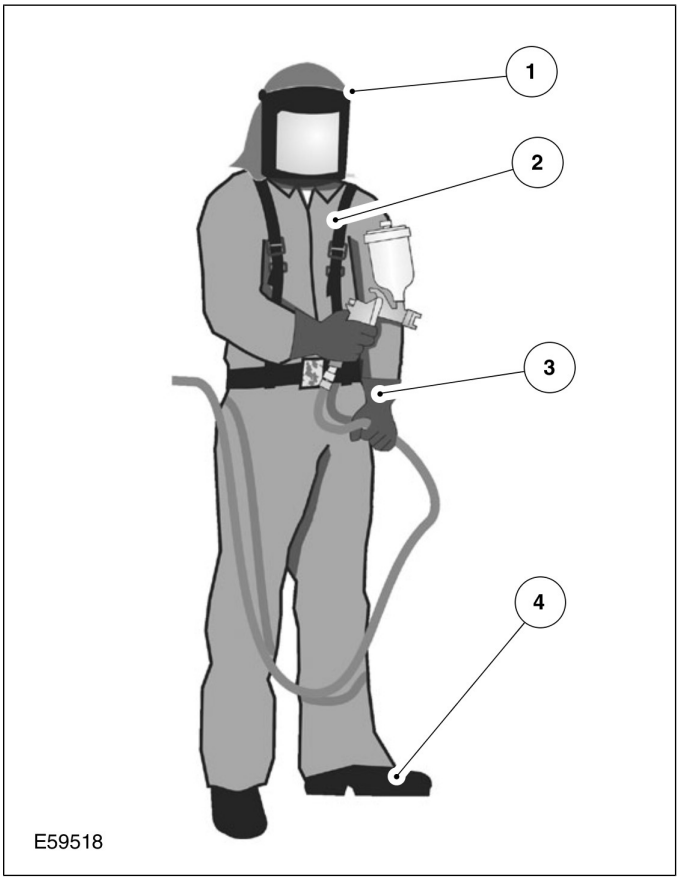
As well as these general instructions on the dangers in repair paint shops, all national and international regulations must be observed:

- Health and Safety at Work Act
- Ordinance on Hazardous Substances
- Technical Rules for Hazardous Substances
- Regulations for the Prevention of Industrial Accidents
- EU Directive on Hazardous Substances, 98/24/EU
- EU Directive on Noise, 2003/10/EU
- EU Directive on Volatile Organic Compounds (VOC), 1999/13/EU, 2001/81/EU, 2004/42/EU
- Safety instructions of equipment and tool manufacturers

Personal protection

Besides the body and limbs, several organs vital to life are in very particular danger. Because damage is mostly irreparable, special attention and comprehensive protection are necessary.

WARNING:Solvents cause damage to the health through inhalation. Splashes in the eyes or on the skin can cause bodily harm. When working with solvents, always use suitable means of protection.



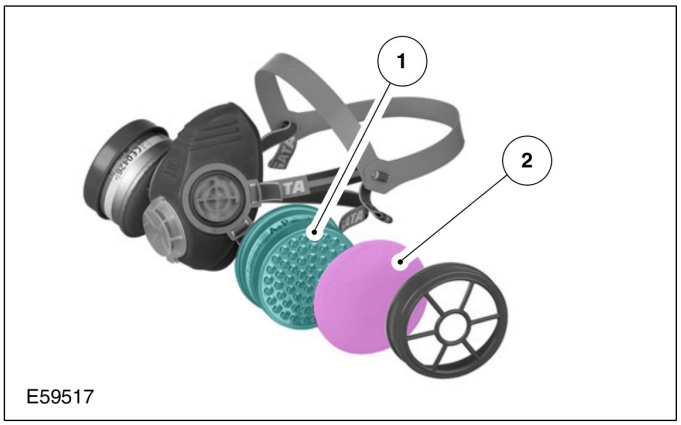
Item	Description
1	Protective hood with fresh air supply
2	Protective clothing
3	Protective gloves
4	Protective footwear

Breathing protection

During painting work and in the preparations for painting, gases, vapors, mists or dusts can appear in dangerous concentrations in the areas where fellow employees breath.

For short periods of work or minimal concentrations of hazardous substances, breathing protection devices with a combination filter are suitable as breathing protection equipment.

DESCRIPTION AND OPERATION



Item	Description
1	Activated charcoal filter
2	Coarse filter

For higher concentrations of harmful substances, breathing protection devices which are independent of the local atmosphere are suitable.

In these types of isolation systems, a compressed air hose carries natural air from the compressor line into the protective mask. During supply, the air undergoes pressure reduction, water removal, fine filtration and usually warming to natural breath temperature.

WARNING:Vapor or spray mist containing isocyanate as a paint base or hardener can cause toxic respiratory disease (conditions similar to asthma) leading to permanent damage, even when inhaled in the lowest concentrations.

Filter masks with wadding, sponge or colloid filters and also paper masks are all unsuitable for working with coating materials because they do not stop solvent vapors.

The instructions for use provided by the manufacturer must be observed when working with breathing protection equipment.

Skin protection

Spray painters who are subject to considerable exposure to coating materials must wear suitable protective work clothing (flame-proof and anti-static).

NOTE: Also, when working with water based materials, comprehensive skin protection must be worn, because these materials are very easily absorbed through the skin.

The protective clothing must be changed at the proper intervals. Items of clothing which are contaminated with coating materials can easily catch fire.

When selecting protective clothing, it must be taken into account that cloth containing a high proportion of easily melted plastic thread considerably increases the degree of burns injury (melted plastic on the skin!). This must also be taken into account in the choice of underwear.

For areas of skin which are not covered by protective clothing, suitable skin protection, skin cleaning and skin care agents must be used.

Eye protection

Working with portable hand sanding machines on which the tools move unguarded, at speed and with power is fundamentally dangerous.

Goggles must be worn not only when sanding, but also when working with paints and their additives. These contain substances which are harmful to the eyes. Damage ranging from irritation of the cornea to incurable illnesses are possible.

The protective goggles must be inert toward splashes of solvent, and fully enclose the areas at the side of the eyes on both sides. The best protection during spray painting is offered by full mask respirators or helmet respirators with a built-in visor.

Ear protection

Noise disturbance in repair paint shops caused by various sources is particularly high. Sanding and compressed air machines, paint cabin extractor fans (compressors) and extractor ducts in the work rooms are the causes of the high levels of noise.

WARNING:Avoid damage to your hearing! Wear ear protection.

Suitable ear protection is offered by ear plugs or ear defenders.

DESCRIPTION AND OPERATION

Environmental Regulations

Waste disposal in the repair paint shop

More than ever before, since the introduction of EU directives, rigorous attention is paid to the avoidance of waste materials and to recycling in repair paint shops. In this respect, repair paint shops must take into account and comply with the following requirements:

- Separate waste according to its recycling and disposal methods.
- Produce evidence for the correct transport and disposal of waste.

NOTE: The organization of disposal in the plant must comply with the requirements of the Waste Avoidance and Management Act: The avoidance and recycling of waste must always take priority.

However, despite all measures which may be taken, waste cannot be completely avoided.

NOTE: Waste which is not allowed in household rubbish, and which can no longer be utilized, must be disposed of as special waste.

Paint residues containing solvent, application residues, sanding dust, waste containing peroxides, solvents, soiled cleaning cloths and paint slurry all count as special waste. Each of these must be collected in a separate, sealed and suitably labeled metal container and properly disposed of using a specialist company.

Careful separation allows some waste to be usefully re-used.

- Empty metal containers can be sent for scrap instead of being disposed of as waste.
- Contaminated cleaning thinners can be separated by distillation.
- Packing material and masking paper can be added to the recycled paper collection.

Residues which cannot be used must be correctly disposed of.

All remaining waste must be treated as commercial waste and disposed of according to the local regulations.

The new VOC (Volatile Organic Compounds) solvent regulation

Keeping the air clean protects the environment and the population from the heath-damaging effects of air pollutants.

In certain atmospheric conditions, volatile organic compounds contribute to summer smog.

NOTE: For comprehensive information, please refer to the European VOC Directive, 1999/13/EU. Furthermore, the effective national regulations must be complied with.

The European VOC (Volatile Organic Compounds) Directive has controlled the limits for such compounds since August 2001. It applies to production coating companies and those which undertake repair painting of private and commercial vehicles.

Not least because of the VOC legislation, modern, low solvent and solvent-free lacquers and paints are finding greatly increased distribution across industry and the trade. Up to the year 2007, emissions from painting work will drop by at least 40%.

At the same time, the paint manufacturers guarantee for example that they will produce a ready-to-spray product consisting of base paint + hardener + thinners, with a permitted VOC level.

A company in business today can conform with the stipulated requirements by introducing water-based paints and using the other necessary products from the relevant paint manufacturers.

For more detailed information, please refer to the EU VOC Directive.

DESCRIPTION AND OPERATION

Factory Paint Application

General fundamentals of paint technology

Paint is a pigment-containing liquid which undergoes chemical and/or physical processes after it has been applied to a surface, so changing into a solid film covering.

Repair paint consists of binder, pigments, filler and solvent.

NOTE: Organic solvent is being replaced by solvent based on water.

Constituents of paint

- Binder
  - Mostly semi-fluid resins which bind together the other components of the paint when it dries.
  - Makes the paint durable.
  - Ensures good surface coverage.
- Pigments
  - Fine, colored powders, which give color to the paint.
  - Cover the components below (covering power).
- Additives
  - Additives give the paint special properties.
  - e.g. flow improver, softener, drying accelerator, thickener.
- Solvent
  - Thins the paint and allows it to flow more freely.
  - Evaporates during drying.

Painting process and corrosion protection.

In production, painting consists of individual steps which are optimally matched to each other.

Bodywork consists almost entirely of steel panels which have been pre-coated with zinc. The zinc layer is between 5-10 µm thick and acts as the first corrosion protection layer of the steel panel.

Production sequence:

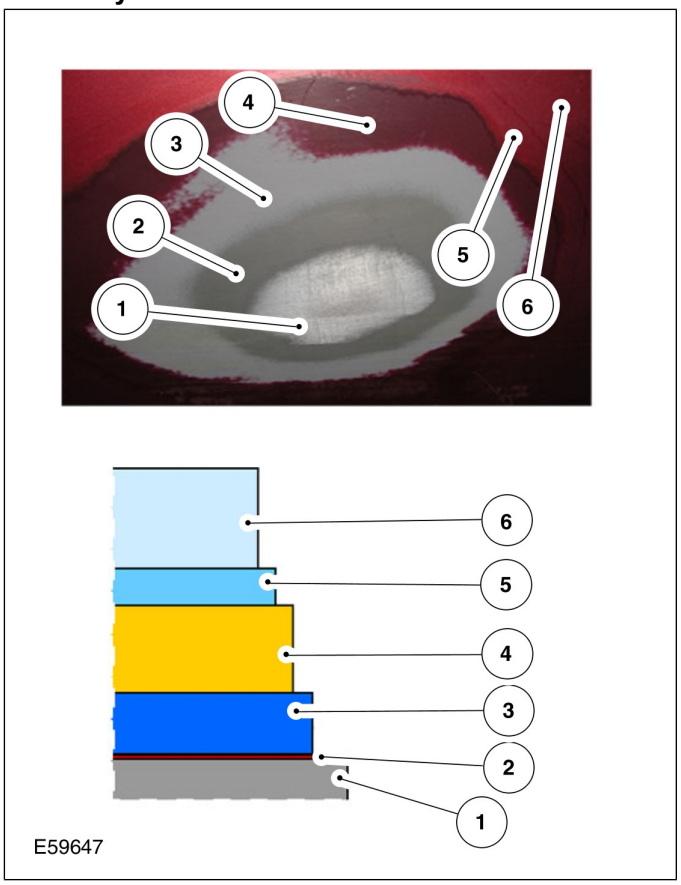
- Clean and de-grease
  - In the first step, the bare bodywork is initially dipped in a cleaning bath and cleaned with a degreasing solution.
- Phosphatising
  - The cleaned bodywork is dipped in a bath containing various phosphate salt solutions. This creates a crystalline metal-phosphate layer which offers the optimal prepared surface and also corrosion protection.
- CDP base
  - The cataphoretic dip paint (CDP) base acts as a further corrosion protection layer.
  - In this process the bodywork is completely immersed in a bath consisting of a paint and electrolyte solution.
  - By application of an electric voltage, an electric field is created.
  - Positively charged paint particles settle on the negatively charged bodywork and form a protective layer up to 20 µm thick.
  - Next the bodywork is placed in a dryer, where the CDP base is hardened at 180°C.
- Sealing, stone-chip protection
  - Edges, seams and but joints are sealer with a sealing compound.
  - Vulnerable areas are coated with stone-chip protection.
- Filler
  - Filler protects the body panels from stone impacts. Furthermore, any unevenness of the metal surface is flattened out, in order to create the most homogenous and fault-free undersurface possible.
  - Once the filler is dry, it serves as the base on which paint is applied.
- Top coat
  - The top coat is applied as a single layer or two layers of paint.
  - When working with two layer paint, in the first job step the initial colored base paint is applied. In the second job step, a clear lacquer is applied, giving the base paint shine and hardness.

DESCRIPTION AND OPERATION

The structure of an original paint finish

During construction of the original paint, a total surface thickness of between 120 and 130 µm is achieved. The thicknesses of the layers may vary however, because they are greater for horizontal surfaces than vertical ones.

Paint layers



Item	Description
1	Steel panel
2	Phosphate layer 2.9 g/m², corresponding to 2 µm.
3	Cathodic dip paint 30-35 µm
4	Filler 30-35 µm
5	Base paint 15-20 µm
6	Clear varnish 55 µm

Colored fillers applied in production

Filler which gives color is used in production. Its use makes the base paint and clear varnish unnecessary on certain vehicle interior surfaces (engine, doors).

Not every exterior paint has its own matching filler. It is more that the tones of the filler are color compatible, i.e. they have similar intensity to the top coat.

During repair painting the filler color tones must be used according to the manufacturer's instructions.

DESCRIPTION AND OPERATION

Paintwork Defects and Damage

Diagnosis and Damage Assessment

Paint concerns, regardless of their causes, are part of the everyday work in the paint shop. Correct damage assessment and determination of the cause are preconditions for a professional resolution of a paint concern.

Paint concerns can still occur through a variety of causes, despite improved paint materials and new spray methods.

NOTE:A first appraisal of the paint damage should be done before cleaning. External factors such as rust, droppings, incorrect or insufficient paint care can then be more easily detected.

Diagnosis is best done in daylight but not in direct sunlight. Exact evaluation can also be done under artificial light from special luminescent lamps.

Paint damage guide

The most important paint damage concerns which make a paint repair necessary are:

- Damage from biological paint contamination such as bird or insect droppings, tree resin and aphids.
- Chemical paint damage caused by industrial contaminants such as smoke, fuel, acids, oils.
- Mechanical damage caused by stone impact during operation, scratches in the car wash and parking.
- Damage caused by faults in treatment. Application defects such as paint runs or orange peel.
- Dirt inclusions in the paint layer, e.g. caused by dust in top coat or textile lint.
- Damage due to corrosion.

Before repair of such paint concerns, exact diagnosis must be performed to determine the cause exactly. On the spot diagnoses using simple aids and processes are often enough.

Diagnosis without disturbing the paint is done by:

- Optical inspection without visual aids, under suitable light conditions from a suitable angle and correct distance.
- Optical inspection with the help of a magnifying glass.
- pH paper.
- Measurement of the thickness using FE / NFE coating thickness meters for ferrous (FE) and non-ferrous metals and non-magnetic steel (NFE) - magnetic process on steel panels, eddy current process on non-metals.

A test method where the traces of testing can be easily removed again is the finger nail test. With suitable experience the existing hardness of the paint can be determined.

Test methods where the paint is partially destroyed are:

- Pencil hardness test.
- Adhesion test using adhesive tape.
- Lattice cut test process to check the strength of adhesion.

Under certain circumstances these test methods are not enough for a certain diagnosis. In this case, paint diagnosis under laboratory conditions must be performed.

Measuring and testing equipment for painted surfaces

Coating thickness measuring devices

Magnifying glass

pH paper (together with water)

Suitable photographic equipment with macro lens

Shine measuring equipment

Paint damage caused by environmental factors

- Bee droppings
- Bird droppings
- Insects
- Tree resin and sap
- Aphid secretions
- Tar spots
- Cement, plaster and slaked lime
- Rust film/deposits from industrial fallout
- Battery acid
- Brake fluid

DESCRIPTION AND OPERATION

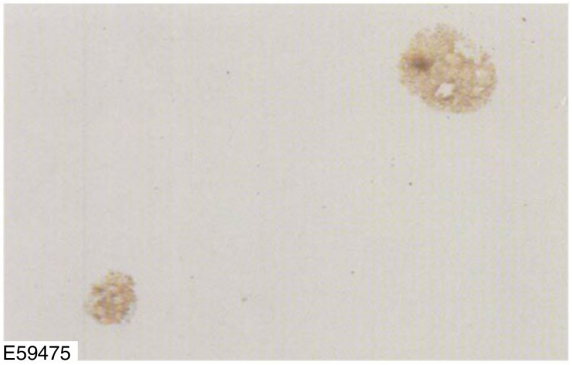
In all the cases of paint damage described below, if the damage is irreversible a new paint finish must be applied.

Paint damage cause by bee droppings

Bee droppings can be recognized on a paint surface through its yellow or brown color and sausage or drop-like shape with a diameter of 3-4 mm.

Cause/damage pattern:

- In combination with heat and high air humidity, bee droppings leave discolorations and cause paint decomposition.
- The paint can be destroyed down to the filler.


E59475

Repair of damage:

- If the damage is light, perform a polishing repair.

Paint damage caused by bird droppings

Bird dropping damage appears most often as matt, etched topcoat areas of various sizes. If left on the vehicle for a long time, crack formation and etching down to the filler will occur.

Cause/damage pattern:

- Bird droppings are particularly harmful in combination with heat and moisture. The urea (white part) has a very high salt content and is very aggressive.
- The intensity of the damage varies depending on the type, quantity, contact time and extent.
- Cracks, etching, marks up to dissolution of the top coat are the results.


E59476

Repair of damage:

- If the damage is light, perform a polishing repair.

Paint damage caused by insects

At insect impact locations on the hood, roof and bumper, small etched or etched through paint marks with partially visible spots of filler.

Cause/damage pattern:

- The top coat layer is destroyed in a short time by surface swelling and etching.
- Colliding insects stick to the paint surface. In combination with moisture and heat, because of the resulting acids the insect bodies sink into the paint top coat.
- The corrosion is G, C, U or O shaped and is only a few millimeters thick.


E59477

Repair of damage:

- Wash the vehicle, treat the affected area with insect remover. Clean the paint surface several times.
- Protect with hard wax.

DESCRIPTION AND OPERATION

Paint damage caused by tree resin or sap

Small yellow-brown marks or drops on the horizontal parts of the vehicle. The drops melt in sunlight. Resin damage only occurs in the warm summer months.

Cause/damage pattern:

- Because of their chemical composition, tree resins combine with or adhere very well to paint top coats and cause them to swell. The higher the temperature, the more intensive is the chemical bonding between the resin and the paint topcoat surface.


E59478

Repair of damage:

- Soak several times using a cloth saturated with a petrol & paraffin mixture.

NOTE: After successful cleaning the top coat must be preserved.

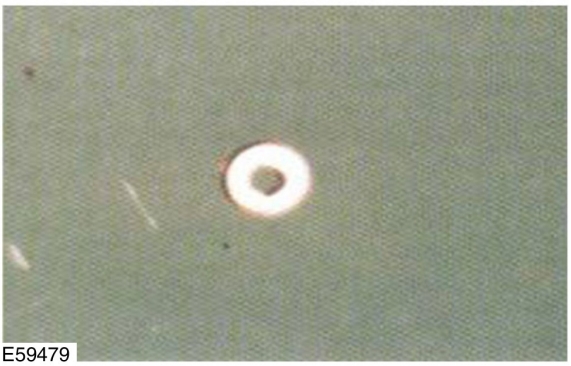
- Swellings can be removed by warming.

Paint damage from aphid secretions

Small, round, matt marks about 1 mm diameter and etching with small islands down to the filler. Fresh aphid excrement looks like small drops of honey.

Cause/damage pattern:

- Aphids produce a mixture of starch, leaf acid and sugar from sap in leaves. Under the effects of warming and moisture this can turn into alcohol.
- The round shape of the damage and the island of intact paint are typical.


E59479

Repair of damage:

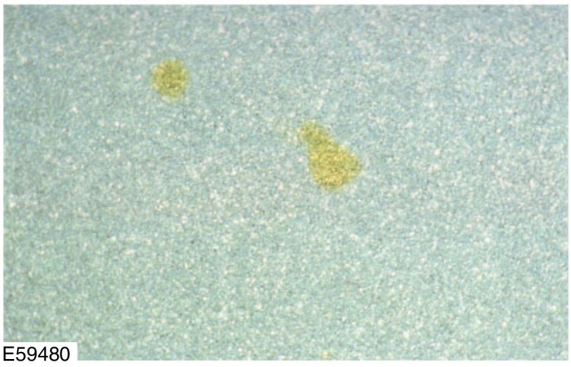
- Remove the excrement as soon as possible.
- Small single matt locations without etching can be repaired using a polishing repair.

Paint damage caused by tar spots

Yellow or dark marks.

Cause/damage pattern:

- Firmly stuck spots of tar which lead to discoloration of the surface. In some cases penetration through the clear lacquer into the top coat.


E59480

Repair of damage:

- Clean the paint surface with tar remover and polish.

Paint damage caused by cement, plaster and slaked lime

Damage appears as whitish matt marks on the top coat.

Cause/damage pattern:

- Corrosive alkaline compounds interacting with moisture.

DESCRIPTION AND OPERATION


E59481

Repair of damage:

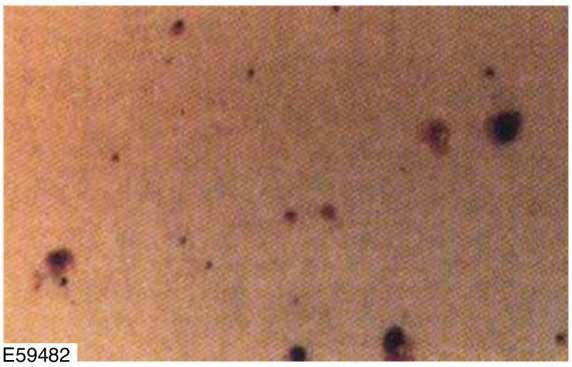
- Wash immediately if the contamination is fresh.
- If the contamination has dried on, dissolve and neutralise it with vinegar, then thoroughly wash off with water and rinse.
- Rectify mild damage using a polishing repair.

Rust film/deposits from industrial fallout

Small round marks, about 1 mm in size, in all shades from black, grey, blue to reddish, on the horizontal surfaces of the vehicle.

Cause/damage pattern:

- Deposits from oil fired systems and industrial plant, especially at high humidities and inversion weather conditions, cause damage to the paint top coat.
- As the activity time increases so called rust halos form. They spread as long as the deposits corrode.
- Industrial fallout containing iron will no longer be removable after a few days!


E59482

Repair of damage:

- Remove the dust using an industrial fallout remover and thoroughly wash.
- Polish the paint surface.

NOTE: Never try to remove the particles of industrial fallout by polishing or rubbing!

- Use cleaning dough.

Damage caused by battery acid.

Splashes of battery acid caused by carelessly topping up the battery.

WARNING:Batteries contain sulphuric acid. When working near the battery, or where there is battery acid on the vehicle body, protect the skin and eyes from contact with the acid. If battery acid contacts the skin or enters the eyes, flush the affected area immediately with water (flush for at least 15 minutes) and call a doctor without delay. If acid is swallowed, call a doctor immediately. Failure to follow these instructions may result in personal injury.

NOTE: High temperatures accelerate the attack on the top coat. At 50°C the top coat layer breaks down after about 15 minutes!

Cause/damage pattern:

- Etching of the paint layer to decomposition of the paint finish.


E59483

Repair of damage:

- Flush the acid splashes with plenty of water and neutralize with car washing liquid.
- If the contact time of the acid was short, perform a polishing repair.

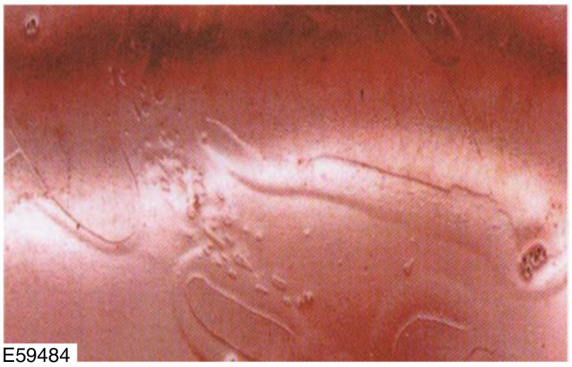
Paint damage caused by brake fluid.

Careless handling of brake fluid. The glycols contained in the fluid cause swellings.

DESCRIPTION AND OPERATION

Cause/damage pattern:

- The temperature and contact time are critical. Splashes lead to loss of shine and lightening of color.


E59484

Repair of damage:

- Flush immediately with plenty of water.
- The swellings can often be made to recede completely by treatment with the radiant heater or in the paint drying oven at max. 60°C for about 1 hour.

Mechanical damage

Stone impact damage or mechanical damage

Mechanical damage caused by impact of stones or other hard objects and extending down to the metal panel lead very quickly to corrosion and rusting under the paint on the adjoining surface.

Cause/damage pattern:

- Paint damage caused from the outside, down to filler, primer or metal panel.


E59485

Repair of damage:

- Sand or blast out.
- Use anti-corrosion primer.
- Apply top coat.

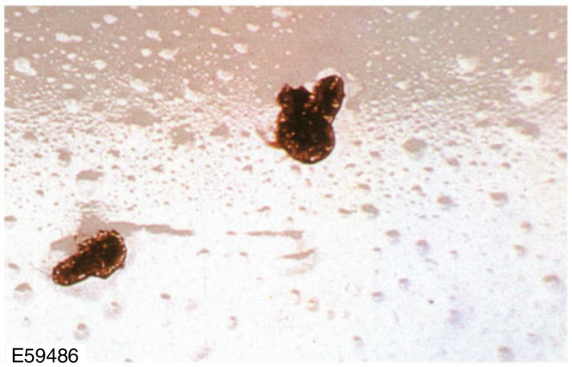
Damage due to corrosion

Blistering/rusting below

Air or water filled blister-shaped raised areas in the paint film.

Cause/damage pattern:

- Overpainting corroded steel panel.
- Condensation in the spray air.
- Sanding water not dried out or salt crystal residues.
- Road chippings and road winter grit containing salt.


E59486

Repair of damage:

- Sand the affected area of damage or the body component and re-create the paint finish.
- More severe and larger areas of rusting below must be repaired using the corresponding repair painting, Repair Level III or IV.

Damage caused by faults in treatment

- Craters
- Paint boils
- Adhesion defects
- Adhesion defects - clear lacquer
- Sanding scores
- Formation of stripes
- Peeling/blistering on plastic parts
- Blistering on polyester material
- Peroxide marks in metallic paints

DESCRIPTION AND OPERATION

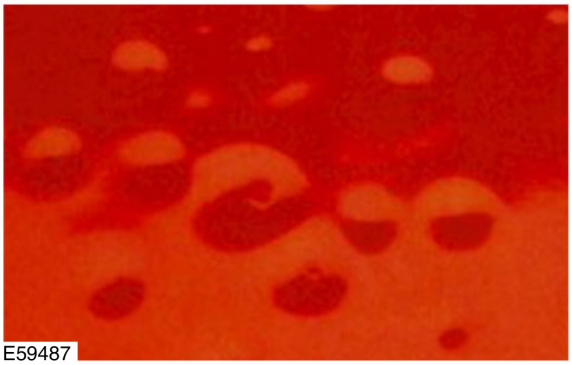
- Crack formation
- Shrinking back/zone edge marks
- Blistering
- Etching
- Paint wrinkles/puckering
- Cloud formation
- Spots/metallics
- Metamerism/color deviations
- Washing out
- Loss of gloss
- Covering ability/areas of thin paint
- Flow problems/orange peel
- Dirt embedded in metallic base paint
- Dirt embedded in top coat
- Water marks
- Paint runs
- Swirl marks

Craters

Crater-like single or extensively occurring depressions with raised edges, in top coat or the intermediate layers.

Cause/damage pattern:

- Substrate not adequately cleaned with silicone remover.
- Spray air contaminated by oil residues and water accumulations.
- Filter ceiling not adequate for requirements.
- Use of polishes, cleaning agents or sprays (e.g. interior sprays) containing silicone.
- Oil, wax, grease, silicone containing residues.
- Working clothes contaminated by materials containing silicone.


E59487

Repair of damage:

- Sand paint surface, clean with silicone remover and apply one thin spray pass. Let it begin to dry well, then apply several thin and dry sprayed passes.

Paint boils

Small, hard, closed or burst blisters in the paint top coat. They appear locally in groups or spread individually across the whole surface. Sanding opens up a larger cavity, under which the primer can often be seen.

Cause/damage pattern:

- Paint applied in layers which were too thick.
- Specified flash-off and drying times between coats were not adhered to.
- Specified working viscosity and spray pressure were not adhered to.
- Use of unsuitable hardener and thinner materials. (Solvent combinations in paint system not optimally matched).
- Poor booth conditions.


E59488

Repair of damage:

- Single boil blisters can be removed using polishing.
- After thorough drying, sand the top coat at the affected areas, clean with silicone remover and re-paint. Fill any fine pores still present with 2-component acrylic filler.
- On larger areas of damaged topcoat, sand completely away and apply new paint finish.

DESCRIPTION AND OPERATION

Adhesion defects

Whole coating detached from substrate or individual layers one from another. Sometimes adhesion defects can only be noticed after an external influence such as stone impact.

Cause/damage pattern:

- Substrate not adequately prepared (rust, grease, moisture, sanding, cleaning).
- Unsuitable material used.
- Drying times, flash-off times too short.
- Base paint not sprayed wet-in-wet, instead the intermediate drying times were too long.
- Failure to intermediate sand.
- Condensation formed because of temperature fluctuations.
- Unprofessional preparation (especially on plastics).
- Overheated CDP/intermediate filler.


E59489

Repair of damage:

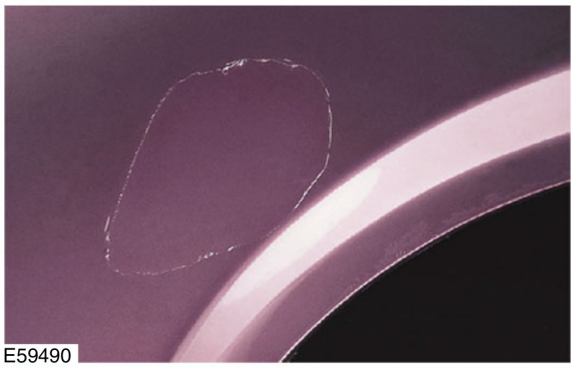
- Sand out the damage and recreate the paint finish. Create the paint finish strictly in accordance with the general technical information.

Adhesion defects in clear lacquer.

Clear lacquer detched from base paint.

Cause/damage pattern:

- Base paint layer too thick.
- Intermediate and final flash-off times of base paint too long.
- Incorrect mixture ratio clear lacquer/hardner.


E59490

Repair of damage:

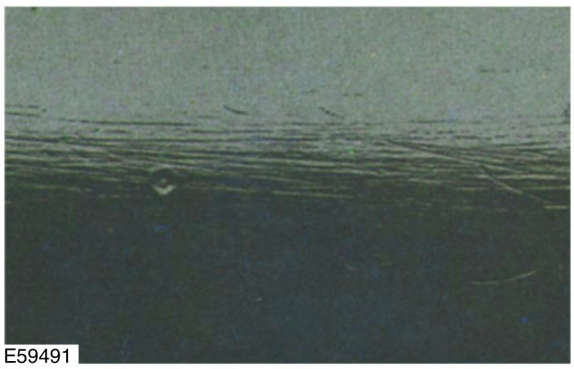
- Refinish sanding and recreate the paint finish.

Sanding scores

Single or wide area clusters of scoring or sanding marks, often with raised edges. Noticeable on metallic paints as light-dark stripes.

Cause/damage pattern:

- Stopper sanded too coarsely.
- Filler sanded too coarsely.
- Filler not thoroughly dried bfore sanding.
- Old paint sanded too coarsely.
- Soft elastic substrates, e.g. TPA base, treated with thinners which was too aggressive and therefore etched.
- Top coat applied too thinly.


E59491

Repair of damage:

- If the damage pattern is minimal, after the top coat has dried fine sand the paint surface and refurbish by polishing.
- If the damage is great or on metallic paints, sand the paint surface or substrates and if necessary remove them, then cover the bare metal and re-paint.

DESCRIPTION AND OPERATION

Formation of stripes

Differing, stripe shaped color/effect formations in dark/light areas of a metallic paint finish.

Cause/damage pattern:

- Spray gun (nozzle) not perfect.
- Incorrect spray pressure.
- Thinners not suitable.
- Incorrect spray viscosity.
- Flash-off time too short.
- Unsuitable working temperature.


E59492

Repair of damage:

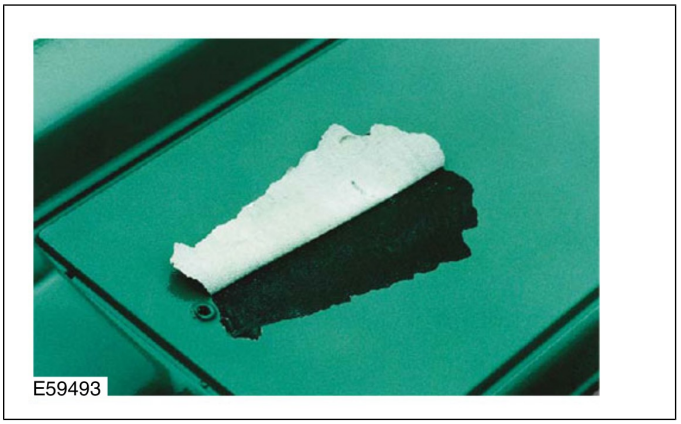
- Apply base paint evenly.
- Repair spray gun.
- After clear lacquer has thoroughly dried, sand surface and paint again.

Peeling/blistering on plastic parts

Paint adhesion insufficient between top coat and filler and/or primer layer. It often happens that the whole of the paint finish detaches from the plastic.

Cause/damage pattern:

- Plastic item not cleaned sufficiently, not or inadequately tempered.
- Unsuitable cleaning agent used.
- Unsuitable materials used.
- Moisture.
- Paint finish underbaked or overbaked.
- Poor or lack of intermediate sanding.


E59493

Repair of damage:

- Sand away faulty paint coats and re-apply paint finish.
- In extreme cases use a new part.

Blistering on polyester material

Color shade differences or marks in paintwork subsequently applied to previously unpainted plastic material.

Cause/damage pattern:

- Plastic material is not suitable for painting.
- Incorrect bonding agent.
- Paint used not solvent resistant.

Repair of damage:

- Repaint using suitable materials.
- Install unpainted new part (after consulting customer).

Peroxide marks in metallic paints

After longer period of drying, abnormal marks where the color shade varies.

Cause/damage pattern:

- Too much hardener added to polyester stopper (over 3% can cause this damage pattern).
- Polyester stopper not well enough mixed.

DESCRIPTION AND OPERATION


E59495

Repair of damage:

- Sand, fill with polyester or epoxide filler and re-paint.

Crack formation

Cracks of different lengths and depths running in all directions.

Cause/damage pattern:

- Layers too thick.
- Painted several times.
- Temperature fluctuations.
- Mechanical effects e.g. distortions.
- Substrate not thoroughly hardened.
- Old paint not completely dried out.
- No or insufficient hardener added.
- 2-component materials used on nitro or TPA.


E59496

Repair of damage:

- Sand away layers until sound substrate is reached and create new paint finish (prime, fill, apply topcoat).

Shrinking back/zone edge marks

Lifting or dropping in of edge zones (edges which accentuate themselves in the top coat), flow problems and loss of shine in top coat.

Cause/damage pattern:

- Old paintwork not rubbed down to a seamless transition.
- Stopper and filler on a viscoplastic base primer.
- Filler sanded and overpainted when not thoroughly hard.
- Previous materials overworked too early, substrate not sufficiently hardened.
- Primer applied in layers which were too thick, and not dried for long enough.
- Sanding paper too coarse.
- Top coat thinned too much.


E59497

Repair of damage:

- After hardening off the top coat, fine sand the surface and polish up, apply filler if necessary and paint once more.

Blistering

Small, spot-like, air-filled or water-filled blister shaped high-spots in the paint construction. Their dimensions can range from pin-head to pin-point size in a closed paint film. Arrangement and accumulation very variable. In the advanced stages, circular flaking of the paint from the substrate. These are neither boils nor corrosion.

Cause/damage pattern:

- Moisture absorption by substrate.
- Insufficient drying of the substrate after wet sanding (especially on polyester material).
- Humidity too high before painting; condensation formation because of temperature fluctuations.
- Pores/sink holes in substrate not sanded out.

DESCRIPTION AND OPERATION

- Polyester material not covered.
- Sweat from hands.
- Salts and minerals in sanding water.
- Spray air contaminated.


E59498

Repair of damage:

- Sand away damage, matt sand remainder of surface, clean with silicone remover, fill and re-paint.

Etching

The base paint is etched by the clear lacquer. This causes the aluminum pigments to change their alignments. The color of the etched base paint seems more grey than that of normal base paint. Result is that the surface structure of the clear lacquer becomes increasingly more matt.

Cause/damage pattern:

- Base painted too wet.
- No intermediate flash-off time.
- Layers too thick.


E59499

Repair of damage:

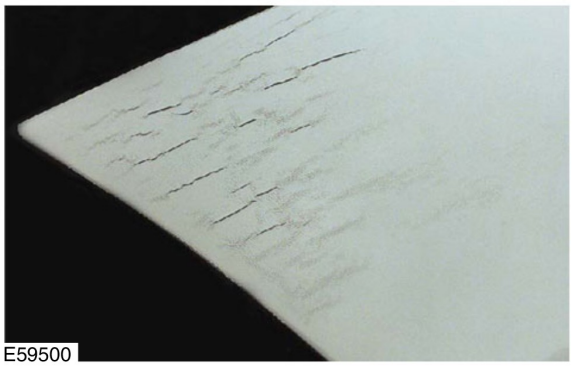
- Sand and re-paint.

Paint wrinkles/puckering

Lifting/puckering of the paint surface.

Cause/damage pattern:

- First paint not hardened through or can be etched.
- Areas of clear lacquer which were sanded through to base paint have not been not isolated with filler, or with unsuitable filler.
- Unsuitable substrate (e.g. spray can painting with TPA or nitro).
- Use of unsuitable primer, paint and thinner materials.
- Paint systems not matched to each other.
- In wet-in-wet process, specified flash-off times not adhered to.
- Synthetic resin top coat (alkyd resin) worked over too soon.


E59500

Repair of damage:

- After thorough drying, completely remove the top coat together with the attacked substrate at the affected areas and re-create a new paint finish.
- Before applying top coat, rub down the complete surface.

Cloud formation

Differing, blotchy color/effect formations in dark/light areas of a metallic paint finish.

Cause/damage pattern:

- Spray gun, spray nozzle, spray pressure not perfect.
- Varying spray viscosity, spraying method, flash-off times, spray booth temperature.
- Thinners not suitable.

DESCRIPTION AND OPERATION


E59501

Repair of damage:

- Droplet method before clear lacquer application.
- After clear lacquer has thoroughly dried, sand surface and re-paint.

Spots

Points rising up from the paint film.

Cause/damage pattern:

- Metallic base paint sprayed too dry, so that the metal particles could not incorporate into the paint. The clear lacquer could not cover these vertical standing particles because the spray air was too hot or the booth temperature was too high.


E59502

Repair of damage:

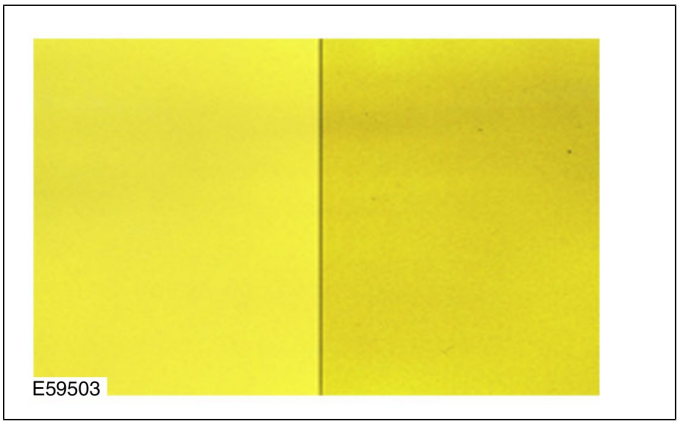
- After the paint surface has dried, lightly sand it with grade P800 sanding paper, clean with silicone remover and re-apply clear lacquer.

Metamerism/color deviations

Noticeable when identical color shades undergo a change of hue as the light source changes (daylight/artificial light). Different pigment composition between original and repair paint.

Cause/damage pattern:

- Use of paints with pigmentation which was not compatible with the standard, e.g. a green can be formulated from yellow and blue, or directly from green.
- Use of an unsuitable mixed or ready made paint to re-tone.


E59503

Repair of damage:

- Repaint using the correct paint.

Washing out

On paint which has been newly applied but not yet dried, the interaction of surface tension and very different specific gravities of the different pigments can lead to swirl-like turbulence which results in separation of the pigments.

Cause/damage pattern:

- Layer too thick, paint not stirred enough.


E59504

Repair of damage:

- Sand and re-paint.

Loss of gloss

Milky, dreary tarnishing of the paint with more or less even loss of gloss.

DESCRIPTION AND OPERATION

Cause/damage pattern:

- Cold with low air humidity.
- Heat with high air humidity.
- Substrate can be etched.
- Hardener fault or wrong hardener used.
- Paint thinned too much.
- Proportion of pigment too high because of poor stirring.
- Not optimum drying.


E59505

Repair of damage:

- After drying, remove the matt effect by polishing. If unsuccessful, rub down complete area and paint again.

Covering ability/areas of thin paint

Different color shades in the surface. The minimum layer thickness is not achieved here. The effects range from local minor shade variations through mottled spray zones to completely missing top coat.

Cause/damage pattern:

- No correct, uniform substrate (effect paint).
- On three-layer systems, wrong filler.
- Insufficient top coat application.


E59506

Repair of damage:

- Sand surface and recreate the paint finish.

Flow problems/orange peel

Surface structure bumpy, grained. The surface is similar to the peel of an orange.

Cause/damage pattern:

- Paint viscosity too high.
- Use of fast evaporating, highly volatile thinners.
- Booth temperature too high.
- Spray gun distance too great, too little material applied.
- Nozzle too large.
- Incorrect spray pressure.


E59507

Repair of damage:

- Small surfaces: fine sand and polish.
- Sand out the surface and recreate the paint finish.

Dirt embedded in metallic base paint.

Inclusions of contamination in metallic base paint, of different sizes and shapes (grains or lint).

Cause/damage pattern:

- Dust was not properly removed from the surface to be painted.
- Paint material not sieved.
- Function of the painting facilities not optimum.
- Filter contaminated.
- Wearing unsuitable clothing.

Repair of damage:

- Sand and repaint.

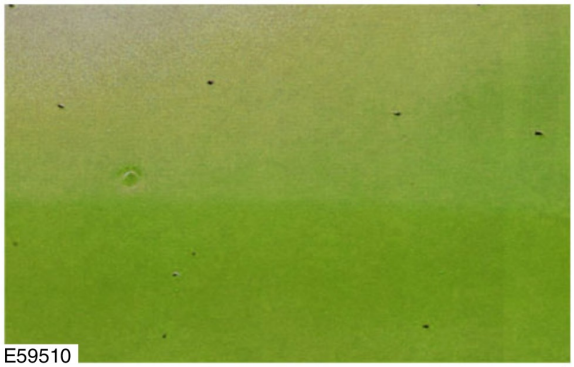
DESCRIPTION AND OPERATION

Dirt embedded in top coat

Inclusions of contamination in top coat or under paint layers, of different sizes and shapes (grains or lint). Optical adverse effect.

Cause/damage pattern:

- Dust was not properly removed from the surface to be painted.
- Paint material not sieved.
- Function of the painting facilities not optimum.
- Filter contaminated.
- Wearing unsuitable clothing.


E59510

Repair of damage:

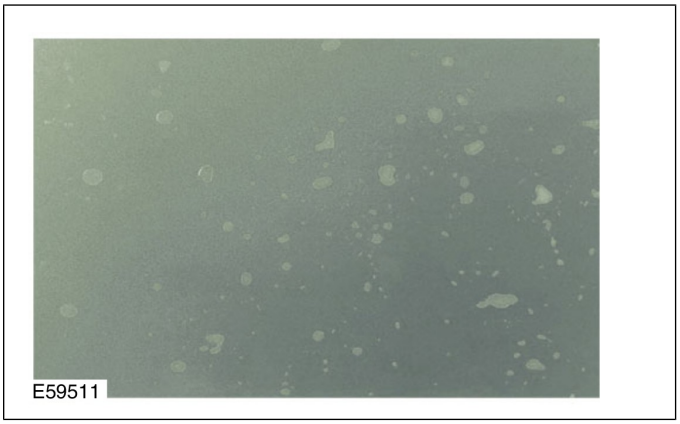
- Single inclusions: after thorough hardening, sand out using 1200 - 1500 grade paper and repolish using a suitable silicone-free sanding or painting paste.
- Large area contamination: sand and repaint.

Water marks

Ring shaped marks appearing on the paint surface.

Cause/damage pattern:

- Evaporation of water droplets on freshly painted and not yet fully hardened paint finishes (mostly only found on horizontal surfaces).
- Layer too thick.
- Drying time too short.
- Hardening faults or hardener no longer useable.
- Use of unsuitable thinners.


E59511

Repair of damage:

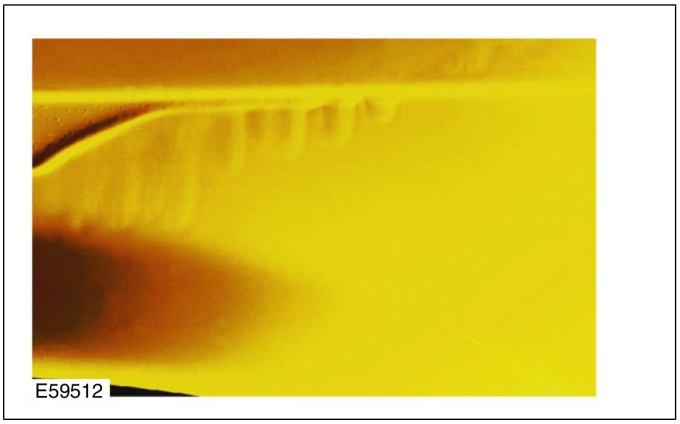
- Rub down only slight marks with sanding paper grade P1000 - P1200 and then polish.
- For heavy marking, sand the surface matt, clean with silicone remover and repaint.

Paint runs

Wave-like paint run tracks in top coat or in an intermediate layer on vertical surfaces. Mostly in the area of swage lines, seams or openings (there they are paint runs, otherwise curtains).

Cause/damage pattern:

- Uneven paint application.
- The specified viscosity was not complied with.
- Use of unsuitable thinner materials.
- Air, material or room temperature too low.
- Layers too thick.
- Spray gun (nozzle) not perfect.


E59512

Repair of damage:

- After thorough drying, sand unevenness flat, if necessary leave to dry afterwards.
- Small areas of damage can be equalised using the paint plane, then sand, polish or repaint.

DESCRIPTION AND OPERATION

Swirl marks

Three dimensional appearance in the paint surface in the form of smears or blotches. This effect is intensified in direct sunlight.

Cause/damage pattern:

- Polishing using polishing machine on paint which has not yet hardened throughout.
- Polishing intervals too long or none at all.
- Pressure too high while polishing.
- Incorrect polishing material or polishing tool.


E59513

Repair of damage:

- Allow the paint to harden completely and then polish.
- If the damage is irreversible, rub down and apply new clear lacquer.

DESCRIPTION AND OPERATION

Tools and Equipment for Paint Repairs

General work equipment

In the repair paint shop there is a range of painting tools which make the work of the painter easier and improve the quality of the repair paintwork.

Among these are small tools which are used for the following work:

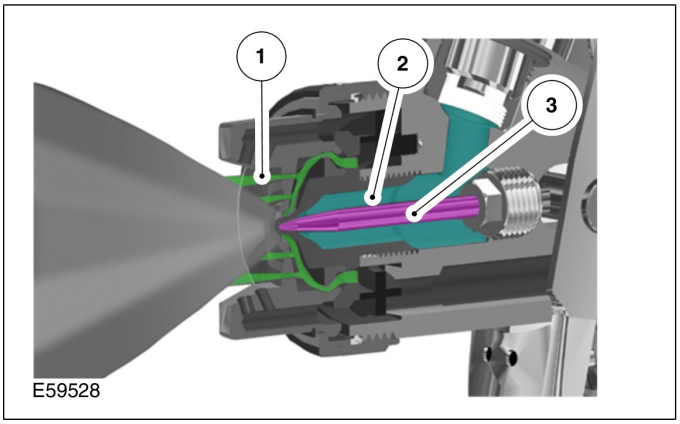
- **Measuring beakers** to measure and mix various paint materials.
- **Measuring rods** with which the required combination amounts of paint and primer filler are gauged and mixed.
- **Viscosity measuring beaker** with a calibrated opening of 4mm, used to set the correct paint viscosity.
- **Paint filter/paint sieve** for filtering foreign bodies out of mixed paint or primer. Care must be taken that the correct filter is used for each paint.
- **Color sample plates** onto which the mixed paint is applied, and the shade is then compared to that of the vehicle. Other aids which should help the painter to find the correct shade are **color sample cards** and **color panels**, which are offered by many paint manufacturers.
- **Dust bonding cloths** which are impregnated with a tacky resin and which pick up dust particles particularly well. A surface to be painted must be cleaned with a dust binding cloth immediately before paint is applied.
- **Compressed air guns** are used to remove sanding residues and to dry sanded surfaces.

Filler and spray guns

NOTE: Regular maintenance, cleaning after use and careful handling of all individual parts of the spray gun are essential for a high-quality paint finish.

The spray gun is the most important implement in the paint shop. Application of paint using the spray gun can produce a layer with absolutely constant thickness and a smooth paint surface.

Principle of operation



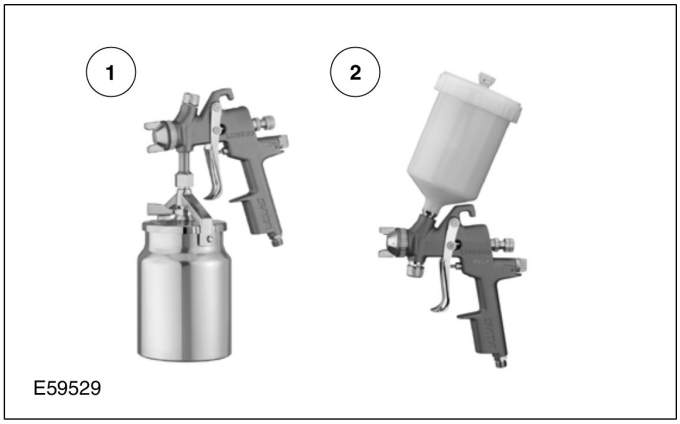
Item	Description
1	Air supply
2	Paint supply
3	Nozzle needle

Because of the construction design and with the aid of compressed air, a spray-ready paint mixture is dragged out of the container to the nozzle by the venturi effect, and is applied to the surface being worked.

When the trigger of the spray gun is pressed to the first pressure point, only the compressed air passage opens. If the trigger is pressed further, the nozzle needle displaces and the air stream drags paint with it at high speed. This produces a spray mist consisting of micro-droplets of paint.

DESCRIPTION AND OPERATION

Types of spray gun



Item	Description
1	Suction-beaker spray gun
2	Flow-beaker spray gun

In the flow-beaker spray gun, the paint container is mounted above the spray gun. On the suction-beaker spray gun, it is below.

Furthermore, spray guns are categorized by their air pressure requirement into high and low pressure guns.

High pressure guns have the disadvantage that they exhibit high consumption of energy and materials. The spray pressure they require is between 1 - 6 bar.

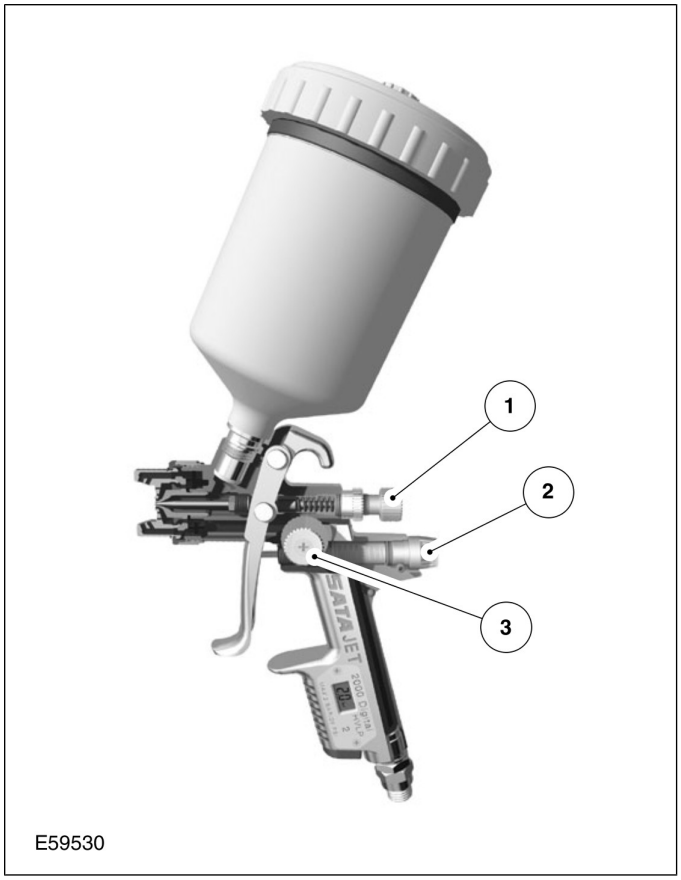
Because of the high air pressure and the large amount of air needed, the result is a powerful paint mist formation (paint transfer rate approx. 35%).

Current practice is mainly to work with reduced mist spray systems (RP and HVLP systems).

Reduced pressure (RP) guns are optimized high pressure guns which have an input pressure at the gun of approx. 2.5 bar and an atomization pressure at the air cap of 1 - 2 bar. In practice this spray technology is preferred for spraying clear lacquer because of the finer atomization.

Low pressure guns have the advantage that they exhibit minimal paint mist formation and because of this the paint transfer rate rises to approx. 65%. The spray pressure required in this case is between 1 - 5 bar. Nozzle sizes from 1 - 2.2 mm can be used.

HVLP spray guns



Item	Description
1	Quantity control
2	Working pressure control
3	Spray pattern control

The high volume low pressure (HVLP) spray gun is a high performance spray gun which forms a soft, fine and homogenous spray pattern. The atomization pressure at the air cap is 0.7 bar when the input pressure at the gun is 2.0 bar.

The low atomization pressure of 0.7 bar together with greatly reduced spray mist provide high material ejection. The low nozzle internal pressure minimizes rebound of the paint droplets from the object and thus the proportion of overspray.

This spray technology has a very high application efficiency. By matching the size of the nozzle, the HVLP spray gun can be used for all repair painting materials.

HVLP spray guns are often used in practice for the application of water based paints.

DESCRIPTION AND OPERATION

Mini spray guns are often used for small, localized touching-up work. Use of HVLP spray technology and nozzle sizes of 0.3 - 1.2 mm permits very fine work, so that the area of the repair can be kept as small as possible.

In order to ensure that a spray gun operates efficiently for a long time, careful cleaning is absolutely vital after use.

NOTE: During cleaning you must distinguish between water based and solvent based materials.

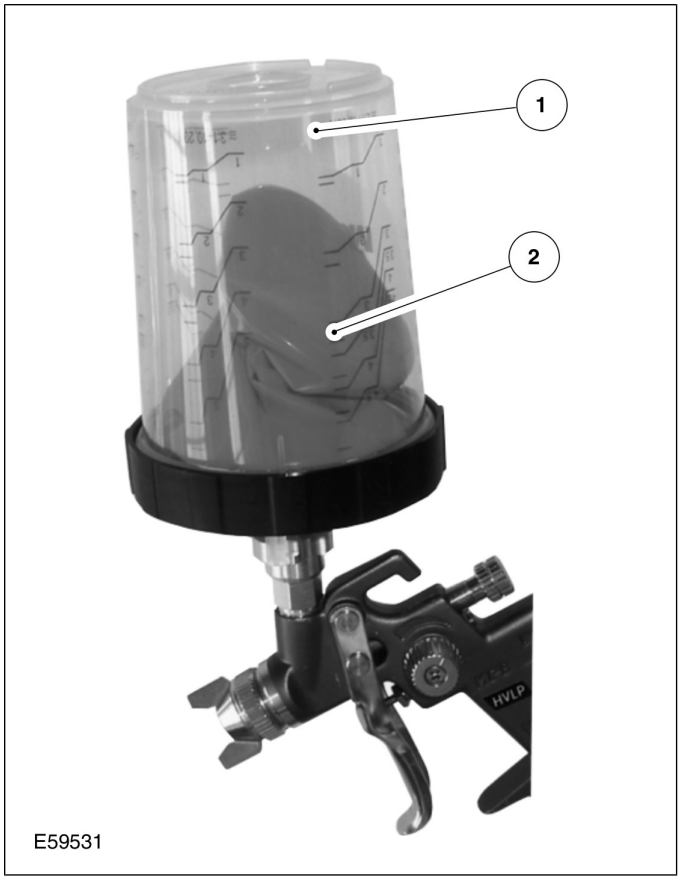
Cleaning by hand:

- Empty the paint beaker immediately after use.
- Flush the gun with cleaner.
- Clean it inside and outside with a brush.
- Dismantle the gun to clean it thoroughly.
- Clean the air cap using a suitable brush.
- Use nozzle cleaning needles to clean bores and nozzles.

A spray gun washing machine is recommended if the painting work is highly intensive.

New types of paint processing systems are replacing the conventional mixing beaker, filter and spray gun flow beaker. This reduces the amount of solvent required for cleaning and the amount of routine waste which remains.

Paint preparation system (PPS)



Item	Description
1	Beaker
2	Color bag

With this system, which is suitable for both suction and flow beaker spray guns, only one beaker is required for mixing and painting.

A bag is inserted in the beaker, in which paint can be mixed, processed and stored after use or completely disposed of.

The small quantity of paint remaining in the gun is removed using a minimum quantity of solvent from the pipette bottle.

The amount of cleaner used is reduced because only the spray gun needs to be cleaned.

Hand and machine sanding tools

Sanding is used to prepare a surface for application of a paint layer, enabling it to adhere well. Sanding materials have a great influence on the quality of a repair paint finish. The correct sanding medium must therefore be chosen for every material.

DESCRIPTION AND OPERATION

During sanding, material is mechanically removed from a surface.

In the paint shop, carborundum or silicon carbide abrasive on a substrate of paper or cloth are the most common sanding materials used.

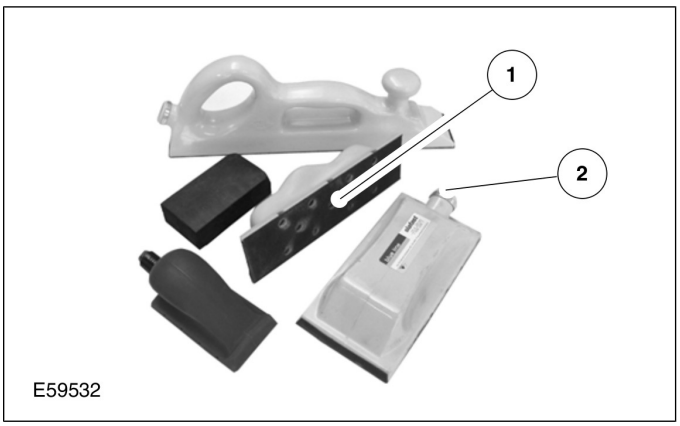
Carborundum is a very hard mineral consisting mostly of aluminum oxide. During use carborundum becomes blunt and wears away.

Silicon carbide has a very high degree of hardness, but is more brittle than carborundum. When silicon carbide is used, the mineral grains break. New long and pointed profiles are formed.

Use of the correct sanding paper depends on the application, the substrates and the tools used. The following table can be used as a guideline, but the recommendations of the supplier of the auxiliary materials and additive materials must be followed.

Application	Working area	Grade	Sanding system
Body work, corrosion damage	Equalizing paint system transition	to P150	Orbital sander, dry
			Hand sanding, dry
Stopper	Rough sand	P80 - P150	Orbital sander, dry
	Fine sand	P240 - P320	Orbital sander, dry
			Hand sanding, dry
Spray stopper	Rough sand	P120 - P180	Orbital sander, dry
	Fine sand	P240 - P320	Orbital sander, dry
			Hand sanding, dry
Filler sanding work	Filler fine sand	P400 - P500	Orbital sander, dry
		P800 - P1200	Hand sand, wet
Top coat	Old paint	P400 - P500	Orbital sand, dry
		P800 - P1200	Hand sand, wet
	Touch-up paint surfaces	P1000 - P2000	Hand sand, wet
Paint damage	Sanding out faults	P2000 - P3000	Hand sand, wet

Soft Pads are recommended for manual refinishing of contours, curves and difficult to reach areas. On a Soft Pad the abrasive is found on a coarse structured fleece. Because of this, it is very flexible, does not kink and does not slip in the hand. This enables a fine and even finish to be achieved.



Item	Description
1	Extraction bores
2	Connection for extraction equipment

Notes on working with sanding tools:

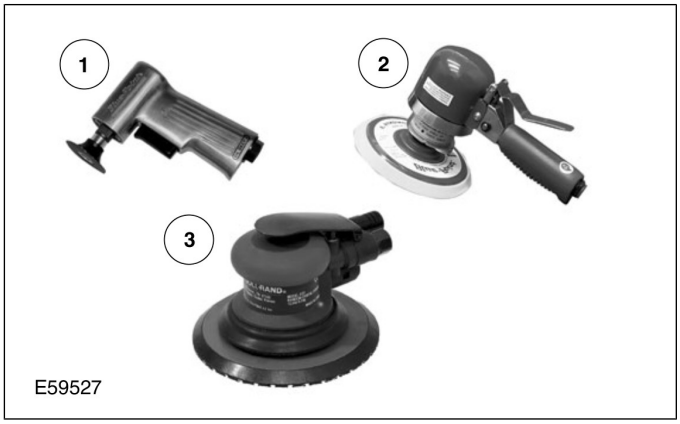
DESCRIPTION AND OPERATION

- Tools with a rigid backing pad do not adjust to fit the surface. They are used for flat surfaces.
- Tools with a flexible backing pad are used for fine sanding of a surface because they adjust to the shape of the surface.
- Build up an even working pressure over the sanding surface.
- Keep the sanding paper tight on the tool (use self-gripping systems).
- Align the extraction holes in the sanding paper with the holes in the tool.
- Guide the tool flat over the surface to be worked. Do not tilt it.

Hand sanding can be carried out dry but also wet. Wet and dry paper with particle size P 80 to P 1200 is used for this in the paint field.

Ways of sanding

Sanding tools are driven either by electricity or compressed air.



Item	Description
1	Sanding machine
2	Polishing machine
3	Orbital sander

The disadvantage of electrically driven machines is that their own weight is high compared with pneumatic systems. They also become warm during work. They do not however need any special operating equipment for their energy supply.

Sanding machines are categorized by their type of sanding movement.

Rotational sanders

On these machines the sanding paper turns.

- Advantage:
  - Ideal for heavy sanding work.
  - Fast and aggressive sanding possible.
- Disadvantage:
  - Large amount of heat developed.
  - Difficulty sanding flat surfaces.
- Application:
  - Removal of old paint layers.
  - Preparation of panel for stopper.
  - Removal of rust.

Oscillating sander

On these machines the sanding paper oscillates. The backing pad is rectangular.

- Advantage:
  - Large sanding surface.
  - Ideal for large and flat surfaces.
- Disadvantage:
  - Hardly useable on rounded surfaces.
  - Flexible backing pad not possible.
  - Vibrations because of the poor support of the backing pad.
- Application:
  - Sanding of polyester stopper.
  - Sanding processes on flat surfaces.

Orbital sander

On these machines the sanding paper turns and oscillates.

- Advantage:
  - Easy to handle and good sanding power.
  - Minimal heat development.
- Disadvantage:
  - Not suitable for sanding stopper on flat surfaces.
  - Smooth guidance important, otherwise sanding marks will occur.
- Application:
  - Sanding of paint layers.
  - Well suited for final preparation of a primer.

NOTE: Comply with the manufacturer's recommendations when setting the orbital sander.

DESCRIPTION AND OPERATION

On the orbital sander, stroke settings of approx. 3 mm for fine sanding work and approx. 5 - 7 mm for coarse sanding work have been established.

Polishing and finishing tools

The term polishing in the context of paint repairs means the elimination of paint flaws and high shine polishing of neighboring parts.

During polishing the fine sanded surface is returned to a high shine using a special abrasive polish.

Before the actual polishing, all flaws in the paint surface must be removed and the following working procedures must be adhered to:

- Thoroughly clean the vehicle.
- Remove spray mist from all surfaces.
- Sand out and polish particle inclusions.
- Sand down paint runs and polish them out.
- Examine the exactness of the color match in daylight.
- Remove masking edges.
- Remove sanding water, sanding dust and polish residues.

After the polishing process the results must be tested using a special test spray.

Infrared drying technology

The drying process in a painting/drying cabin occurs through heat conductance (convection). When an infrared dryer is used, the drying process is through heat radiation.



E59533

The infrared rays penetrate the air and the paint layer without warming them. Because the infrared rays are reflected from the steel panel, the paint coat is warmed from the inside outwards.

Advantages of infrared drying:

- The drying process occurs from the inside to the outside.
- The drying time is shorter than for warm air systems.
- Because the infrared dryer consists of several cassettes which can be switched on independently, the drying area can be optimally controlled.

Independent of the manufacturer's instructions, pay attention to the following:

- Flash-off time of the paint before switching on the infrared dryer.
- Distance between the infrared dryer and the surface.
- Duration of the irradiation.

The most common use of the infrared dryer is to dry stopper and primers. The wait time between the job steps is shortened without having to use the painting/drying cabin.

The painting/drying cabin can then be used exclusively for application and drying of topcoat.

There are two types of infrared dryer:

- Infrared dryer with short wavelength radiation.
- Infrared dryer with medium wavelength radiation.

As an indication, the following drying times are listed for some materials (at 80 cm distance):

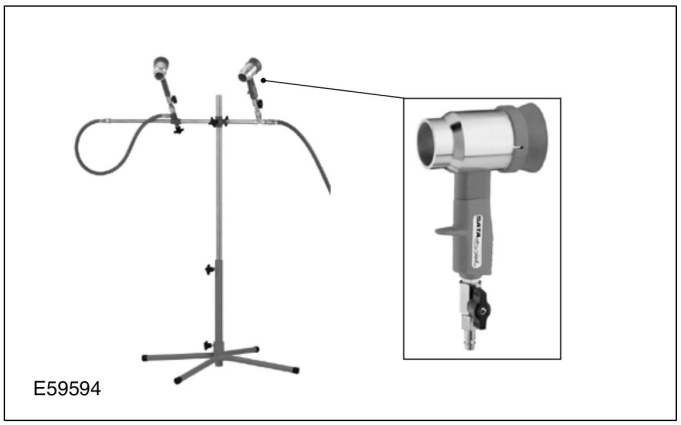
NOTE: Observe the material manufacturer's and supplier's specifications.

- Polyester stopper 2 minutes.
- Spray stopper 2 to 7 minutes.
- Water based primer-filler 7 to 9 minutes.
- Primer 3 to 8 minutes.
- Top coat 7 to 10 minutes.

Air dryers

The air dryer is suitable in places where drying needs to be done, but without great outlay (painting/drying cabin or infrared dryer).

DESCRIPTION AND OPERATION



NOTE: Air from the compressor is often too cold for effective drying.

Air dryers use the venturi effect to blow the warm ambient air over the paint surface in a gentle air flow.

Paint mixing system

Because of the many different color variants, it is now seldom possible to store all color shades as ready-made mixtures.

For this reason, vehicle manufacturers make the mixture proportions of their paints available as color codes. The required color shade can be obtained from the paint mixing system using this color code.

All the color components are combined according to their proportions by weight using a precise computer scales to produce a finished color shade.

Painting cabin

The air requirement in a painting cabin is large. The outside air which is drawn in must be passed through filtering and warming equipment. This particularly applies during colder times of the year and especially for combined types of building where the painting cabin is also used as a drying cabin.

It is primarily used to keep the air free of dust. At the same time, explosive solvent-air mixture concentrations are prevented

NOTE: Vacuum will lead to contamination of the newly applied paint. The outside air flows through door gaps, wall joints and other openings and as it does so, brings dust deposits with it.

The air supply quantity depends on the size of the painting space and the quantity of extracted air. Enough air must be supplied to cause positive pressure in the painting space. An air extraction : air supply ratio of about 1 : 1.05 is sufficient.

The filters should have a dust-removal grade of not less than 99.8% and must always be kept clean.

It is especially important that the air supply does not cause strong air currents in the painting cabin. If not, the following problems could occur:

- Paint contamination cause by paint mist, which persists in air eddies and gradually falls on the fresh paintwork.
- Flow problems in the paint because of the high speed of the air, causing the paint to thicken very quickly on the surface.
- Loss of gloss and wrinkle formation because the surface dries too fast.
- Painter disturbance while working.

In modern paint cabins the air supply is provided from the complete surface of the ceiling. The air speed should be 0.3 m/sec (measured in the unrestricted cross-section of the spray cabin). At the same time, the air in the cabin should change about 350 times per hour.

Air extraction is best achieved through extraction channels in the floor of the painting cabin.

NOTE: Refer to the manufacturer's specifications for the operating instructions, safety instructions and notes on the maintenance of a paint cabin.

Smooth walls in the paint cabin should prevent dust deposits. Regular cleaning is necessary however.

Special easily washed adhesive-bonding paint can be applied to the walls to protect the cabin from paint mist.

DESCRIPTION AND OPERATION

Refinishing Materials

The manufacturer's instructions must always be followed when dealing with all materials! The information given in the following text is data which is independent of the manufacturer, and it should only be used as an indication.

Stopper materials

- 1-component nitro-combination stopper
- 2-component polyester stopper
- 2-component plastic stopper

Use suitable primer to protect from corrosion areas which have been sanded bare before applying stopper.

1-component nitro-combination stopper

Nitro-combination stopper has mostly been superseded by 2-component polyester stopper.

Fast drying fine stopper for the smoothing of irregularities.

The working properties of 1-component nitro-combination stopper can be improved by the addition of nitro thinners.

Drying time increases with thickness of the layer.

Application	1-component nitro-combination stopper
Layer thickness	Max. 80 µm
Drying time	up to 2 hours at 20°C
Sand	P240 - P400

2-component polyester general stopper

CAUTIONS:

⚠ **Do not exceed the quantity of hardener specified by the manufacturer, excess peroxide can cause staining of the paint top coat.**

⚠ **Mix the stopper base and the hardener well to avoid a marble-like effect.**

Check that the manufacturer permits use on the substrate to which it will be applied.

2-component polyester stopper is available in coarse and fine grades. The coarse stopper can be used for very uneven areas and surfaces and fine stopper or spray stopper should be applied afterwards.

Application	2-component polyester coarse stopper
Use	Rough equalization of unevenness
Hardener quantity	approx. 3 - 5%
Working time	approx. 4 - 6 minutes
Drying	20°C approx. 12 minutes
	Short wavelength infrared approx. 4 minutes
	Medium wavelength infrared approx. 5 - 10 minutes
Sanding tool	Eccentric, sanding disk by hand
Grade	P80 - P150

Application	2-component polyester fine stopper
Use	Equalization of unevenness
Hardener quantity	approx. 3 - 5%
Working time	approx. 4 - 6 minutes
Drying	20°C approx. 12 minutes
	Short wavelength infrared approx. 4 minutes
	Medium wavelength infrared approx. 5 - 10 minutes
Sanding tool	Eccentric, sanding disk by hand
Grade	P80 - P240

DESCRIPTION AND OPERATION

Application	2-component polyester glass fiber stopper
Use	Equalization of unevenness; blending in of vehicle extensions; repair of GRP components
Hardener quantity	approx. 3 - 5%
Working time	approx. 4 - 6 minutes
Drying	20°C approx. 12 minutes
	Short wavelength infrared approx. 4 minutes
	Medium wavelength infrared approx. 5 - 10 minutes
Sanding tool	Eccentric, sanding disk by hand
Grade	P80 - P150

2-component polyester fine stopper should always be applied after 2-component polyester glass fiber stopper.

Application	2-component polyester spray stopper
Use	Equalization of unevenness
Hardener quantity	approx. 3 - 5%
Working time	approx. 25 - 30 minutes
Layer thickness	200 µm or 4 - 8 spray passes
Drying	20°C approx. 3 hours
	Short wavelength infrared approx. 10 minutes
	Medium wavelength infrared approx. 15 - 20 minutes
Sanding tool	Eccentric, sanding disk by hand
Grade	P80 - P150; fine sand - P280

Application	2-component plastic stopper for flexible thermoplastic
Use	Equalization of scratches or unevenness
Hardener quantity	approx. 3 - 5%
Working time	approx. 25 - 30 minutes
Drying	20°C approx. 15 - 30 minutes
	60°C approx. 15 min
	(Short wavelength infrared approx. 8 minutes)*
	(Medium wavelength infrared approx. 8-10 minutes)*
Sanding tool	Eccentric, sanding disk by hand
Grade	P80 - P150; fine sand - P280

***Infrared drying may adversely affect adhesion, therefore check the manufacturer's instructions.**

Plastic stopper has a very great tendency to shrink back, so that the edge of the stopper repair becomes visible.

Plastic stoppers are flexible and universally applicable on all types of plastic (except for pure PE and PP, these are plastics which cannot be painted). The manufacturer's instructions must be very exactly followed in order that no adhesion problems occur. A special plastic etch primer is specified for some materials.

Primers

Application	1-component primer
Use	Isolation of bare sanded areas.
Spray gun	HVLP 1.3 mm
Spray pressure	2.0 bar
Drying	20°C approx. 15 - 20 minutes
	60°C approx. 10 min

DESCRIPTION AND OPERATION

Application	1-component primer
Coat application	Wet on wet, no intermediate sanding

Application	2-component primer
Use	Corrosion protection and bonding agent (steel sheet, zinc coated steel sheet, aluminum)
Spray gun	HVLP 1.3 mm
Spray pressure	2.0 bar
Drying	20°C approx. 15 - 20 minutes
	60°C approx. 10 min
Coat application	Wet on wet, no intermediate sanding

HS primer filler and HS tinted filler

Note:

- Primer filler is available as 1-component and 2-component water based and solvent based forms.
- 1-component products are only suitable for isolation of sanded through bare areas and new painting.
- Water based products are also used for the skinning of thermoplastics and substrates which are sensitive to solvents.
- Tinted fillers can be individually matched to the top coat color and therefore find uses in effect paints and paints with poor covering power.
- Use dry sand or wet sand filler according to application in order to avoid unnecessary sanding work.
- On critical substrates the use of epoxy resin base filler is recommended in order to avoid adhesion problems.

Application	HS primer filler and HS tinted filler
Use	Equalization of unevenness, edge zones, sanding scores
Spray gun	HVLP 1.6 - 1.9 mm
Spray pressure	2.0 bar

Application	HS primer filler and HS tinted filler
Layer thickness	50 - 70 µm to 150 µm possible
Drying	20°C approx. 2.5 hours
	(60°C approx. 25 min)*
	(Short wavelength infrared approx. 8 minutes)*
	(Medium wavelength infrared approx. 10-15 minutes)*
Coat application	Wet on wet, no intermediate sanding

***In order to avoid boiling out, drying should be performed slowly.**

Paint

The base and the clear lacquer must be matched to one another.

Application	Water based paint
Use	Two layer metallic effect paint and Uni-paint finishes
Spray viscosity	At 20°C 18 - 20 s
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 bar
Layer thickness	15 - 20 µm
Drying	20°C approx. 2.5 hours
	60°C approx. 25 min
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes
Coat application	Wet on wet
Ventilation time	approx. 5 minutes

The base paint must be dried matt before the clear lacquer is applied.

DESCRIPTION AND OPERATION

Application	2-component HS clear lacquer
Use	Gloss providing protective coat for base coat substrate
Spray viscosity	At 20°C 18 - 20 s
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 bar
Layer thickness	50 - 70 µm
Drying	20°C approx. 10 hours
	60°C approx. 30 min
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Application	2K HS Uni top coat
Use	Color and gloss providing paint layer
Spray viscosity	At 20°C 20 - 22 s
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 bar - 3.0 bar
Layer thickness	50 - 70 µm
Drying	20°C approx. 8 hours
	60°C approx. 30 min
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 -15 minutes

DESCRIPTION AND OPERATION

Additional Materials

The manufacturer's instructions must always be followed when dealing with any materials!
The information given in the following text is data which is independent of the manufacturer, and it should only used as an indication.

Adhesive sealants

Adhesive sealants are permanently elastic, long-lived, can be painted and accept filler.

Application: Sealing of visible and normal seams.

Can be over-painted with 2-component paint, primer and fillers after having dried throughout.

Contamination can be removed using cleaner and thinner.

1-component PUR adhesive sealant

Note:

- Hardens using oxygen from the air. For that reason, it must only be stripped after it has completely dried through.

2-component MS polymer adhesive sealant

2-component MS polymer adhesive sealant is free of isocyanate, solvent and silicones and can be spot-welded.

MS polymer adhesive sealant

Can be over painted with water-based paints.

Suitable for spraying and brushing to obtain a composition true to the original.

MS polymer adhesive sealant is free of isocyanate, solvent and silicones and can be spot-welded.

Underbody protection

Underbody protection products are immune to abrasion, permanently elastic, adhere well and are suitable for a true to original texture.

Underbody protection based on solvent

Application:

- Underbody protection for visible areas.

Properties:

- Can be over-painted, also with 2-component paint.
- Can be colored with a proportion of up to 40% paint.

Note:

- Contamination can be removed using cleaner and thinner.

Water based underbody protection

Can be over-painted with water based paint.

Can be colored with water based paint.

Contamination can be removed using water.

Application	Water based underbody protection
Use	**Underbody protection** for visible areas
Spray viscosity	ready to use
Spray gun	Suction beaker HVLP gun 3 - 4 mm
Spray pressure	4 - 6 bar
Layer thickness	500 - 1000 µm
Drying	approx. 6 hours at 20°C
	approx. 45 - 60 minutes at 60°C
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

DESCRIPTION AND OPERATION

Application	Water based underbody protection
Use	**Isolation primer** for peroxide marks, bloomed old paintwork and thermo-plastics.
Spray viscosity	Thin as necessary with distilled water
Spray gun	HVLP gun 1.9 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	40 - 50 µm
Drying	approx. 2 hours at 20°C
	approx. 30 minutes at 60°C
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Paint additives

Application	Sanding test color
Use	To test sanding results
Spray gun	HVLP 1.7 - 1.9 mm
Spray pressure	2.0 bar
Layer thickness	Spray drifted

Application	Fixer additive
Use	Converts solid top coat into two layer solid; multi-color painting
Spray viscosity	18 - 20 secs at 20°C
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	max. 30 µm
Coat application	Wet on wet
Ventilation time	approx. 15 - 30 minutes

Maintain maximum layer thickness without fail.

Must always next be overpainted with clear lacquer.

Application	Drying accelerator
Use	Accelerates drying with only minimal reduction in working life
Working life	approx. 5 hours at 20°C
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 bar
Layer thickness	50 - 70 µm
Drying	approx. 6 hours at 20°C
	approx. 25 minutes at 60°C
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Cannot be used in all paints, read the manufacturer's instructions.

Particularly suitable for partial painting.

Application	Elastifier additive in primer material
Use	Elastifies the complete paint structure on plastics.
Addition	Up to 25%
Spray gun	HVLP 1.7 - 1.9 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	50 µm
Drying	approx. 4 hours at 20°C
	approx. 40 minutes at 60°C
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Application	Elastifier additive in top coat
Use	Elastifies the complete paint structure on plastics.
Addition	Up to 25%

DESCRIPTION AND OPERATION

Application	Elastifier additive in top coat
Spray gun	HVLP 1.7 - 1.9 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	50 - 60 µm
Drying	approx. 16 hours at 20°C
	approx. 45 minutes at 60°C
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Application	Matting additive in solid paint
Use	Elastifies the complete paint structure on plastics.
Semi-gloss addition	Up to 25% in the paint without hardener and thinner
Silk gloss addition	Up to 35% in the paint without hardener and thinner
Silk matt addition	Up to 45% in the paint without hardener and thinner
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	50 - 70 µm
Drying	approx. 8 hours at 20°C
	approx. 30 minutes at 60°C
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

CAUTION:Do not dry using infrared.

Application	Matting additive in clear lacquer
Use	Elastifies the complete paint structure on plastics.
Semi-gloss addition	Up to 25% in the paint without hardener and thinner
Silk gloss addition	Up to 35% in the paint without hardener and thinner
Silk matt addition	Up to 45% in the paint without hardener and thinner
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	50 - 70 µm
Drying	approx. 8 hours at 20°C
	approx. 30 minutes at 60°C

Note:

- When mixing, first put in the matting additive, then the hardener and thinners.
- Stir immediately after adding the matting additive.
- Do not store after addition of the matting additive, storage will change the degree of gloss.
- Also suitable for use on plastics without addition of elastifier additive.

Application	Matting paste
Use	Matts, elasticizes and gives structure to solid paint and clear lacquer during painting of bumpers or hard plastic.
Addition	1:1 or 2:1 depending on manufacturer in solid paint without hardener or thinners.
Spray gun	HVLP 1.2 - 1.3 mm
Spray pressure	2.0 - 3.0 bar
Layer thickness	50 - 70 µm
Drying	approx. 6 - 10 hours at 20°C

DESCRIPTION AND OPERATION

Application	Matting paste
	approx. 30 minutes at 60°C
	Short wavelength infrared approx. 8 minutes
	Medium wavelength infrared approx. 10 - 15 minutes

Note:

- **The paint must not be filtered.**

Application	Anti-silicone additive
Use	Prevents silicone craters
Addition	2% to maximum 5%

Note:

- Only add away from the paint cabin and immediately remove contaminated cloths.
- If anti-silicone additive is used in the first coat, then it must be used in the following coats, and in at least the same proportions.

Additive materials

Variety of adhesive tapes

For profile, fine and large area masking work.

Properties:

- Withstands heat.
- Withstands water-based paint.
- Accepts paint.
- Easily removed without leaving adhesive residues.

Masking film.

For masking of large areas on vehicles.

Properties:

- Accepts 2-component and water-based paints.
- Withstands heat.
- Withstands water spray and condensation.
- Withstands solvent.
- Easily cut.
- Environmentally friendly and can be recycled.

Polishing materials.

Polishing means microfine sanding. For this reason, polishes must only contain abrasives, and no silicones.

During polishing repair, a good shine is achieved through the step-by-step use of polishes, starting with a highly abrasive polish and ending with a polish having very slight abrasive action.

Polishes are available in graduations from coarse to fine.

Abrasives

Please refer to the "Tools" chapter for information on abrasives.

DESCRIPTION AND OPERATION

Paint Repairs

General information

There is a great difference between painting in production and repair painting.

In production, only the bodyshell is painted, it has no trim, upholstery or assemblies. Because of this, other paints, tools and processing techniques can be used.

In contrast to that used in production, paint used in the workshop must dry at low temperatures. Plastics and the vehicle electronics must not be subjected to temperatures greater than 70°C.

The painting process in the case of repair work consists of two phases:

- Pre-treatment of the surface for corrosion protection and the smoothing of irregularities.
- Top coat application.

The precondition for a professional paint finish on a vehicle is the permanently maintained cleanliness of work spaces, tools and equipment,

Original materials must be worked according to the manufacturer's instructions, so that no problems arise in the processing nor during drying.

The room temperature must be 20 - 25°C and the humidity must be low. Temperatures which are too low or too high can lead to porosity, poor flow and boiling. High humidity leads to paint damage such as tarnishing of the paint film (matt film), adhesion problems and craters.

Pre-treatment of the surface

Perfect preparation of the subsurface is the precondition for a brilliant paintwork result. Faults in the preliminary stages delay completion and cause unnecessary extra work. The working steps described here demonstrate how important it is to follow these instructions step by step.

NOTE: Thorough cleaning of the vehicle and especially of the area being repaired is particularly important because of the danger of contamination of the paint.

Clean the area of the damage


E59665

Clean the damaged surface thoroughly, to allow the extent of the damage to be seen. Use silicone remover to produce a grease-free surface.

NOTE: The treated surface must be rubbed with a clean dry cloth before the solvent evaporates, otherwise there will be no cleaning effect.

Effective de-greasing is important not only before the application of paint, but also before all sanding stages, for two reasons:

- During sanding of grease contaminated surfaces, globules may form with the sanding dust. Sanding marks will occur and the sanding medium quickly becomes unuseable.
- Oil and grease are embedded by the action of the abrasive particles, and are then very difficult to remove.

Establish the area of damage and the repair stages. In doing so, establish how much disassembly work must be undertaken. Perform a color test at this stage.

Mask off the area of the repair ready for preparatory work.

DESCRIPTION AND OPERATION

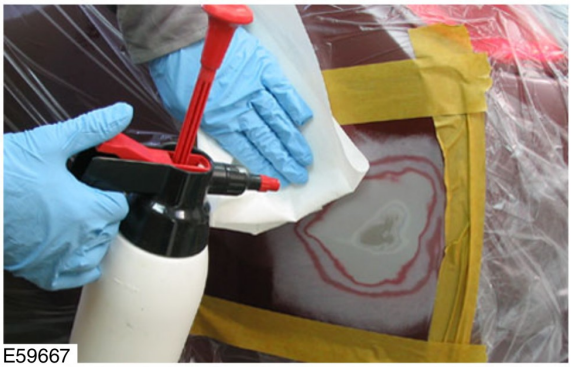
Sand out the damage location


E59666

When sanding, produce smooth transitions from the painted area to the bare metal.

Use an eccentric sander and P80 or P120 abrasive sheets. Finish off sanding with P150 or P180. The remaining adhering sanding dust must be completely removed.

Cleaning, de-greasing


E59667

Use silicone remover to thoroughly clean the surface in order to remove grease residues, sweat from the hands and other contamination.

NOTE: Use a solvent test to establish whether the old paint can be etched. Apply 2-component thinners to the damaged area using a clean cloth and rub lightly for about 1 minute. If the subsurfaces can be etched away, special pre-treatment is necessary. See "Tips and Tricks"

Apply primer filler


E59668

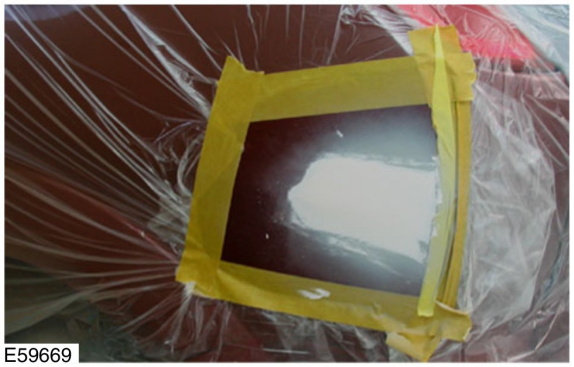
Before applying stopper, apply primer to the sanded and bare surface.

Allow the primer to dry and then lightly sand by hand using P220 - P400 dry.

NOTE: Most stopper can be applied directly to bare metal. But application of a primer filler provides better corrosion protection.

NOTE: Avoid sanding through to the bare metal. Points which are sanded through must be retreated with primer filler.

Stopper application


E59669

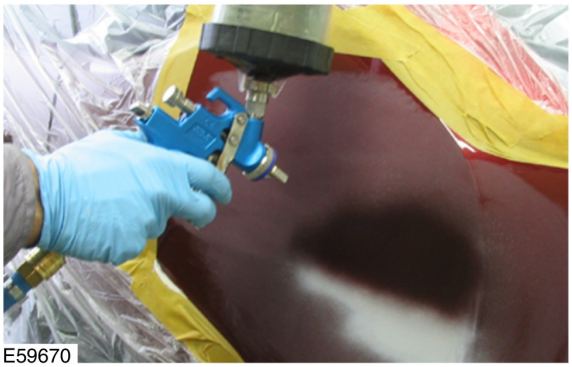
Pre-sand the hardened stopper using an eccentric sander and P80 dry, then final-sand using P120 - P140 dry. Clean the sanded surface using silicone remover.

Apply 2-component stopper to the filled surface. The stopper compound must only be applied thinly.

NOTE: Use of a testing powder is recommended so that the sanding process can be more easily checked.

DESCRIPTION AND OPERATION

Apply filler


E59670

Filler can now be applied to the dried repair area. Choose the correctly toned filler according to the manufacturer's instructions.

NOTE: Alternatively, filler with the correct tone can be mixed with the aid of colour matching cards.

Sand the filler.


E59671

The working area is expanded by applying new masking. This makes it possible to even out the transition from the damage area to the vehicle paintwork.

NOTE: The primer filler must be carefully sanded. Faults in the primer filler layer will be visible in the top coat.

The sanding process consists of two stages. Coarse sanding levels out the surface of the filler primer. Fine sanding ensures the necessary surface structure which allows the top coat to adhere well and cover sanding marks.

Sand the filler using the eccentric sander and P400 - P500 used dry. Clean the sanded filler finished surface using silicone remover.

The painted area is matted using a fine matting sponge, and then thoroughly cleaned.

Surface ready for paint


E59672

The surface which has been repaired and then prepared according to the manufacturer's instructions is now ready for basic paint application.

Top coat application

It is important for a good paint result that the recommended process data is adhered to, i.e. mixture proportions, layer thickness, viscosity, drying time etc.

First of all the work area is carefully masked ready for paint application. The correct adhesive materials and techniques must be used so that no hard transitions and edges are created during painting.

NOTE: The chapter "Tips and Tricks" gives in-depth information on masking work.

Thoroughly check the surface once more and rub-off with a dust-bonding cloth.

NOTE: Once more check the paint material and that the spray gun is correctly adjusted before applying the paint.

Paint application


E59726

The base paint is applied in two or three steps. First of all only the repair area is painted with the first paint application.

DESCRIPTION AND OPERATION

Flash off


E59725

Allow the paint application to flash off until the surface has a matt appearance. So that the transition to the original paint is optimally created, the next paint application is applied to a wider area.

After the base paint has dried for the specified time, the clear lacquer is applied. Next the transitions to the original paintwork are treated with fade-out remover. This removes the spray mist and forms an ideal paint surface.

Repair stages for repair painting

The required time and material data is divided into four painting levels for calculations concerning repair painting. Proceed according to these divisions for every calculation.

Level 1 - Painting of new components

On new components, all inner surfaces, seams and edges which will no longer be seen after assembly must be primed and pre-painted.

NOTE: The cathodic dip primer must not be sanded away. Cleaning with silicone remover or light sanding of the primer is all that is required.

Job steps:

- Wash off, prime and pre-paint inner surfaces, seams and edges which cannot be reached at all or only partly after the component is installed.
- Sand new component with P280 - P320 or a fine sanding pad.
- Clean subsurface with silicone remover.
- Carry out masking work (when painting an installed component).
- Apply one spray run of filler, dry.
- Sand the filler. P1200 wet or P500 dry.
- Clean filler application with silicone remover.

Then the prepared surface can be painted with solid or 2-component paint.

If the new part has mild transport damage, this must be rectified beforehand.

To do so, add the following steps:

- Grind out the scratch.
- Finely sand the surrounding surfaces.
- Use a steel cleaning agent to thoroughly clean and then rub dry.
- Apply corrosion protection primer to the bare areas.

Level II - Top surface painting (color tone matching)

Complete bodywork surfaces which are to be painted without the need to apply stopper belong to this group. In addition, surfaces with faults in the top coat surface which cannot be removed by polishing.

The following faults are included:

- Loss of gloss.
- Sanding scores.
- Heavy paint runs.
- Large dust and dirt inclusions.

The scope of the work is as follows:

- Sand the surface.
- Sand out paint damage and faults.
- Treatment of small areas which have been sanded through.
- Masking work (when painting an installed component).
- Apply top coat according to the painting process (one or several coat process).
- Dry the top coat and perform finishing work.

Level III - Repair painting with stopper applied to up to 50% of the surface.

If in addition to painting, work with stopper application must be performed, then the repair levels III or IV must be used.

In repair level III, apart from painting the complete bodywork surface, partial stopper work is carried out on up to 50% of the surface to be painted. The necessary primer and filler work are also included.

The following damage must be rectified in this level:

- Slight panel unevenness.
- Damage due to corrosion.
- Dented body surfaces.
- Weld locations.
- Deep scores or scratches.

DESCRIPTION AND OPERATION

The scope of the work is as follows:

- Fine sand pre-treated bodywork surfaces (e.g. lead-loaded areas).
- Sand out existing damage.
- Perform all necessary masking operations on the vehicle.
- Apply primer.
- Partial stopper application on up to 50% of the surface to be painted (two to a maximum of three stopper applications).
- Fill the repair area.
- Apply stone chip protection (when present in production).
- Apply top coat according to the painting process (one or several coat process).
- Dry the top coat and perform finishing work.

Level IV - Repair painting with stopper applied to more than 50% of the surface.

In repair level IV, apart from painting the complete bodywork surface, partial stopper work is carried out on more than 50% of the surface to be painted. The necessary primer and filler work are also included.

The following damage must be rectified in this level:

- Damage due to hail.
- More extensive stone chip damage.
- Extensively dented body panels.
- Sectional repairs with large weld seams.
- Surfaces with severe corrosion damage.

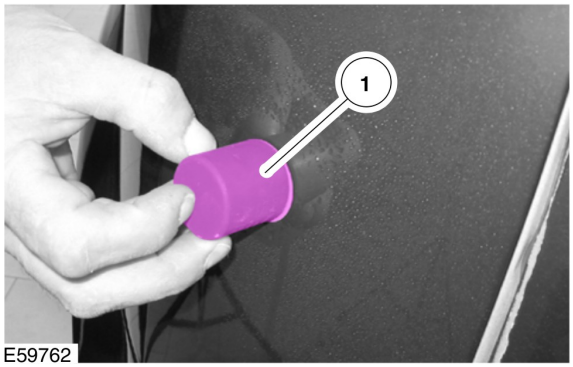
The scope of the work is different to level III because of the partial application of stopper to more than 50% of the area to be painted. In addition, more extensive sanding work is usually required.

Polish

In order to achieve faultless quality, it is sometimes necessary afterwards to polish a newly painted surface.

Even after the most careful painting, it sometimes happens that dirt inclusions and paint runs occur in work with top coat or clear lacquer. Before polishing, such paint faults must be removed with the sanding cylinder ("Finiball") and hand sanding or eccentric sander in a wet sanding process.

Sanding cylinder



The special sanding compound **-1-** (sanding bloom) for the sanding cylinder is self-adhering and available in grades from P1000 to P2500.

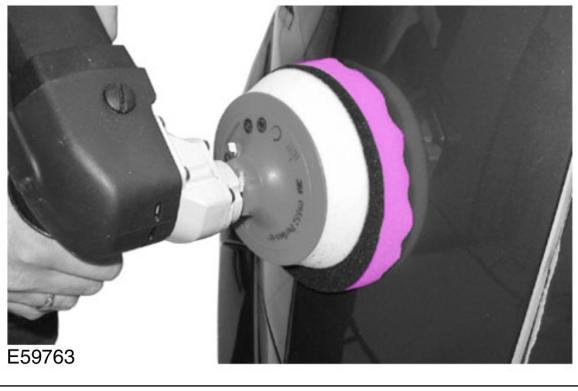
- P1000 - P1500 for pre-sanding of runs and large imperfections in the paint.
- P1500 - P3000 for subsequent sanding of runs and sanding out of dust inclusions.

A small eccentric sander can be used for more extensive working areas. When doing so, first of all put the eccentric sander in place and then switch it on, so that the danger of sanding through on edge is reduced.

Finally polish the sanded area to a high gloss with suitable polish. To this end the various manufacturers recommend materials and process techniques which are specially suited to their products.

NOTE: The polishing is to be done in the same way as that used to remove swirl marks.

Polish



NOTE: Before using the nap sponge for the first time and after any long pauses in working, dampen the nap sponge with polish.

DESCRIPTION AND OPERATION

Job steps:

- Clean and degrease the area to be polished using silicone remover.
- Apply the polish to the polishing disc and spread it.
- Place the polishing machine down flat on the area to be polished and before switching it on, gently distribute the polish over the underlying surface.
- Polish out the location for 10 - 15 seconds with the edge, working with a criss-cross motion.
- Subsequently polish the location for about 10 seconds with the machine laid down flat.
- Wash off and clean the polished location using the professional polishing cloth and then clean the polished surface.
- It is absolutely vital to carry out a visual check after finishing the polishing procedure. If any swirl marks are not completely removed by the first polishing procedure, then process must be repeated.

Aids

Cleaning putty

Cleaning putty allows deposits on the paint surface to be removed easily and gently. The following paint faults can be removed using cleaning putty:

- Metal deposits and iron dust.
- Paint or color mist.
- Tree resin and tar.
- Insect residues.

The surface to be worked must be thoroughly cleaned before the cleaning putty can be applied. Then the surface is sprayed with soapy water. Now the cleaning putty can be slid over the surface until all unevenness is removed.

DESCRIPTION AND OPERATION

Painting Plastic Parts

General

Although these days plastics can be produced in all colors and with a matt or gloss surface, painting is often necessary.

NOTE: Manufacturer's limitations concerning the feasibility of painting certain components must always be observed.

Reasons in favor of applying paint to plastic are:

- Individual coloring, matching the body paint.
- More gloss and color brilliance through painting.
- Removal of production imperfections.
- Protection from atmospheric exposure.

Nowadays painting plastic presents no problems because the materials are known and matched to the paint. In order that the painter can use the correct painting materials, the type of plastic must first be correctly determined.

To allow this, plastics are marked on the rear in accordance with the recommendations of the Association of Vehicle Manufacturers.

Once the type of plastic is determined it is an easy matter to assign special paint recommendations, matched to that particular plastic. Unmarked plastics require knowledge of materials so that a correct choice of paint materials can be made and the component can be reliably painted.

Plastic groups

Thermoplastics

When warmed these undergo a reversible transformation into a plastic deformable state and once cooled they maintain their shape. They consist of string-like (linear) or only slightly branched molecular chains.

Thermosets

Thermosets are hard and have the form of a close-meshed network in all directions. They do not undergo plastic deformation, are especially resistant to chemicals, are difficult to swell and are insoluble. At normal temperatures they are hard to brittle. At first the material does not undergo any change when heated, but when it reaches a critical point, the thermoset is totally destroyed.

Elastomers

Elastomers are characterized by high elasticity over a wide temperature range. They have properties like rubber or a sponge and after compression or distension they return to their original state.

Types of plastic

The plastics used in the automotive area:

- ABS - Acrylonitrile butadiene styrene (polymer)
- PA - Polyamide
- PC - Polycarbonate
- PE - Polyethylene
- PP - Polypropylene
- PP/EPDM - Polypropylene/ethylene propylene diene copolymer
- PC/PBT - Polycarbonate/Polybutylene terephthalate
- PBT/PC - Polybutylene terephthalate/Polycarbonate
- PUR - Polyurethane
- GRP - Glass reinforced plastic

NOTE:PE and PP are plastics which cannot be painted, or can only be painted using special techniques.

As well as the pure plastics, so-called 'blends' are also used. This means combinations of different plastics. If we were dealing with metals they would be called alloys.

Plastic identification

Normally the identifier is marked on the plastic components used in vehicle construction.

One method to determine the plastic group is the sanding test. In this a place is chosen which will not be visible later, and the finger belt sander is used to sand the plastic.

The plastic group can be determined using the pattern left by the sanding and the dust:

- Thermosets produce a white dust.
- Thermoplastics smear and do not produce dust.

The plastic group can be determined by a sound test:

DESCRIPTION AND OPERATION

- Degree of hardness - the higher-pitched the sound, the harder the plastic.
- Elasticity - the more muffled the sound, the higher the elasticity of the plastic.

Cleaning plastic

Plastic components are manufactured using complicated moulds and presses or other highly engineered tools, mostly using an injection moulding process or reactive injection moulding process.

In order to be able to remove the component from a particular tool, a separating agent is used, which in some cases adheres very strongly to the plastic.

This separating agent on the plastic components must be completely removed before any surface coating is applied.

Warm storage (tempering) before actual cleaning brings the following advantages:

- The separating agent sweats out of the plastic.
- Tensions in the plastic are released.
- Air inclusions can be recognized and removed.

Intensively clean the item several times using a pad and fresh cleaning agent.

NOTE:A single wipe, even with cleaning agent, is not usually sufficient in most cases. Clean textured components with the aid of a soft brush.

After cleaning, it is absolutely vital that cleaning agent absorbed by the plastic should be expelled by tempering again. If the ventilation is good and the room temperature is about 20°C the solvent can be evaporated away by overnight storage.

Painting new components

It is absolutely vital that the substrate of an unpainted new component is free of separating agent. Paint can only be applied directly to very few plastics. The plastic must first be identified exactly and then worked with a repair system which is matched to the type of plastic. In most cases a plastic etch primer must be applied as adhesion base to all plastics which can be painted.

NOTE: Plastics have a tendency to become electrostatically charged. This can easily cause contamination during painting. Special antistatic cleaning cloths prevent electrostatic charging.

Work process for thermoplastics:

- Thoroughly clean the surface.
- Temper the plastic.
- Afterwards clean with antistatic cleaner or antistatic cloths.
- Apply the bonding agent.
- Apply elastic filler. After it has dried, sand and clean.
- Apply one coat Uni-paint with elasticizer additive. For two layer painting the elasticizer additive is in the clear lacquer.

NOTE: Follow the paint manufacturer's guidelines during all work.

Work process for thermosets:

- As a rule, thermosets can be handled in the same way as normal body components.

Work process for PUR soft foam:

- The work process is the same as for thermoplastic.
- Instead of using bonding agent, a filler wash is applied to close the pores of the PUR soft foam.

The primer which has been applied to a primed new component can vary greatly. If no manufacturer's data is available, the composition and suitability for further working must be tested.

Painted components with an already ascertained and intact paint coat present no problems for possible repainting. After sanding and careful cleaning with plastic cleaner or thinners, painting can be done directly.

Unknown primer

When dealing with unknown substrates it is important to carry out an adhesion test on the existing paint before any repainting is attempted. First of all a mechanical test must be carried out, for instance using a lattice cut and tear-off band. If the adhesion of the old paint is not acceptable, it must be mechanically removed and new paint finish applied.

If the adhesion is acceptable, then an etch test is performed using 2-component thinners. If no etching can be detected in this test, application of the the paint finish can be started directly. Otherwise the old paint must be removed and a new paint finish created.

With the help of universal or special plastic primers and with only a few materials complementary to those previously present anyway, the painter can now apply a long-lasting paint finish to all popular vehicle attachments made of plastic.

DESCRIPTION AND OPERATION

Paint faults on plastic substrates

NOTE: Paint faults are fully described in the chapter Paint Defects and Damage.

The most common paint faults which can occur when painting plastic components and the methods of repair are briefly described.

Discoloration

Cause/damage pattern:
- Plastic material is not suitable for painting.
- Incorrect bonding agent.
- Paint used not solvent resistant.

Repair of damage:
- Repaint using suitable materials.
- Install a new unpainted component.

Softening

Cause/damage pattern:
- Substrate not carefully cleaned.
- Air humidity too high or working temperature too low.
- Drying time incorrect (too short).
- Materials for substrate not correctly matched to each other or not mixed correctly.

Repair of damage:
- Dry out, sand, re-isolate and paint.
- Sand away faulty paint coats and re-apply paint finish.

Paint damage caused by detachment, poor adhesion

Cause/damage pattern:
- Insufficient paint adhesion between top coat and filler. The whole of the paint finish detaches from the plastic.
- Plastic not cleaned sufficiently, not or inadequately tempered.
- Unsuitable cleaning agent or materials used.
- Poor or lack of intermediate sanding.
- Paint finish underbaked or overbaked.

Repair of damage:
- Sand away faulty paint coats and re-apply paint finish.

Paint damage caused by blisters, craters, sink holes

Cause/damage pattern:
- Painting on PUR plastic which was not painted in production.
- Surface of the plastic material too porous.
- Flash-off time not adhered to.
- Drying temperature too high.
- Moisture in plastic material.
- Layers too thick.

Repair of damage:
- Clean the damaged area, sand, re-isolate and paint.
- Remove the paint layers and re-paint.

Crack formation

Cause/damage pattern:
- Overexpansion of painted PUR plastic components.
- Use of unsuitable paint materials.
- Paint materials not suited to each other or incorrect mixture ratio.

Repair of damage:
- It is not possible to repair overexpanded PUR plastic components.
- On other plastics, sand away damaged layers, isolate and repaint.

DESCRIPTION AND OPERATION

Spot Repairs

General

In general, partial surface painting at a point is called a spot repair. Using this technique, minor paint damage can be resolved economically and to time.

Advantage of this method

Because this application remains confined to the area of the damage, it is often unnecessary to remove components or color match against neighboring components. The material used is very much reduced because only a part of the repair area is coated.

Practical application areas

Only occasionally can satisfactory results be achieved in the centre of larger surfaces and/or on difficult colors. In addition, unprofessional application may cause tear-off edges to appear in clear lacquer. Only certain application areas are recommended.

NOTE: The final decision on whether to spot repair or paint the component must be made by an expert.

Application areas:

- 2-layer paint.
- Depending on the damage zone, paint damage up to a diameter of 3.5 cm or a length of 10 cm.
- Scratches.
- Clear lacquer application up to an area of DIN A4 max.
- Smaller areas which are optically broken up by other components such as trim strip, tail lights, swage lines and edges.
- Boundary zones and edge areas of larger components.

The best application areas have proven to be optical break lines such as corners, narrow surfaces, fenders and wheel arches.



E59832

DESCRIPTION AND OPERATION

Because of their locations, the violet colored areas are the most suitable for spot repair painting. The turquoise areas are only marginally suitable and the rest of the areas are not suitable for spot repairs.

Repair process

Perfect preparation of the subsurface is the precondition for a brilliant paintwork result. Faults in the preliminary stages delay completion and cause unnecessary extra work. The working steps described here demonstrate how important it is to follow these instructions step by step.

Illustration of damage


E59833

A typical case for spot repair is a small stone chip on the fender.

Cleaning


E59834

First of all the component is thoroughly cleaned using silicone remover and refurbished using abrading and polishing paste. This re-creates the original degree of shine and ensures exact color matching on the touch-up surface.

Sand out


E59835

Sand out the damaged location using P180 - P320. Only small sanding blocks and small sanding machines must be used, so that the area of the repair remains as small as possible.

Sanding is completed by rubbing down the surrounding surface with a fine sanding pad or P1000 paper. Remove sanding residues and clean the repair area with silicone remover. The peripheral zone must then be masked for application of the filler.

NOTE: The size of the repair area must be kept as small as possible (maximum size DIN A4).

Filling


E59836

The filler layer is applied in stages. First of all, filler is only applied to the location which has been sanded away. After a wait time for flashing off, the second coat is applied so that it spreads over onto the existing paintwork.

The filler must be dried according to the instructions of the material supplier.

DESCRIPTION AND OPERATION

Rubbing down


E59837

The repair location is now rubbed down with P400 - P500 and the bordering surface with P2000 - P4000. Remove sanding residues and clean the repair area with silicone remover.

Paint


E59838

Before painting, clean the area for the final time using a dust-bonding cloth. Then apply the basic paint in thin layers using a spray gun until enough coverage is achieved.

After drying, apply clear lacquer in 1 or 2 coats (depending on product). In doing so, spray so that only the newly applied basic paint is completely covered. Finally a touch-up thinners is sprayed over the edge of the clear lacquer to dissolve the clear lacquer spray mist.

Dry


E59839

Now dry the clear lacquer according to the manufacturer's instructions using an infrared gun.

Polish


E59840

Polish the component using a polisher and polish and check the polished area for any swirl marks which may be present. Polish away any swirl marks which are present.

Dirt inclusions

Sand out


E59841

DESCRIPTION AND OPERATION

Minor damage can be removed with a small sanding machine or preferably with an eccentric sander with P1500 - P2000. Very fine spray mist can be removed using P2000 - P4000 paper and a larger eccentric sander.

DESCRIPTION AND OPERATION

Corrosion Prevention

General

Although corrosion protection measures and painting processes in production have reached a very high technical standard and will be continuously developed further, in the long term corrosion on a vehicle cannot be totally avoided. Further demands are therefore made of the paint specialist besides his knowledge of normal repainting of vehicles which have been repaired after an accident, in addition specialist knowledge is required for assessing and rectifying damage due to corrosion.

During repair painting, take care over the maintenance and re-creation of the corrosion protection applied in production, in view of the long-term warranty on Ford vehicles. Only those repair materials which are approved by Ford may be used for body repair work and repair painting.

For detailed information on corrosion protection measures during body repairs, please refer to chapter 501-25.

Furthermore, information on corrosion protection measures is repeated in individual chapters of the paint manual.

In particular, pay attention that the layer thicknesses specified in production are maintained. The complete system of solid one-layer on galvanized steel panels must equal at least 90 µm and the total system of two-layer on galvanized steel panels must equal at least 105 µm.

It is important that sealing operations, as far as they are necessary, should be undertaken after the application of the paint to specification, in order to ensure the best corrosion protection. All components which form hollow cavities such as pillars, rails, side components etc. must be provided with a coating of cavity protection wax.

Causes of corrosion

Corrosion of steel is an electrochemical process during which the steel combines with oxygen. The following factors lead to corrosion:

- Acidic compounds contained in the air, such as carbonic acid and sulphur dioxide, combined with oxygen from the air and/or water. Salts such as sodium chloride used as road salt accelerate the corrosion process.
- Mechanical damage such as stone chips and scratches which penetrate through to the steel panel.
- Lack of care by the vehicle owner of the painted and corrosion proofed surfaces or areas on the vehicle.
- Unfavorable weather or environmental conditions, as may occur in areas with high humidity, high salt content in the air or serious air pollution due to aggressive gases and dusts.

In the case of mechanical damage, formation of rust can often be seen, beginning to spread into the painted surface from a point (stone chip) or from a line (scratch). If these faults are not professionally rectified in good time, the result is rusting through from the outside to the inside. Rusting penetration from the inside to the outside occurs when for instance the cavity protection was inadequate.

Operations after painting

NOTE: The manufacturer's instructions must be followed when working with the various corrosion protection materials.

- After painting, treat all cavities in the repair area with cavity protection wax. In doing so, pay particular attention to the weld seams. In dead-end applications with a panel insert, the cavity protection wax must be applied so that it also reaches the area of the panel insert.
- Seals which were applied in production and not over painted must be reapplied. Seals protect vulnerable parts of the bodywork, keep moisture away, reduce wind and road noise and dampen vibrations.
- Apply transparent wax.

Definition of the degree of rust

In workshop practice, in order to be able to carry out a consistent and objective evaluation of the scope of the damage, a degree of rust on the scale of 1 to 5 is determined by the DIN 53 210 standard.

DESCRIPTION AND OPERATION

The main criterion here is the extent to which rust exists under the paint structure. It is determined in millimeters (mm).

Underlying rust grade: R1 < 1 mm

Corrosion starting with up to 1 mm of rust underlying (in the form of a spot or a line).

The damage can be rectified by cleaning the defective location and mechanically removing the underlying rust. For a small extent, apply a primer using a brush and allow it to dry. Touch-up the location with a paint pen or provide a new paint coating.

Underlying rust grade R2 < 1 - 2 mm

Advanced corrosion with up to 2 mm underlying rust.

Rectifying the damage:

- Clean the defective location.
- Remove the underlying rust mechanically down to the paintwork carrier.
- Apply 1-component filler and then 2-component "Vario" filler.
- Provide the damage location with new paint coat on visible outer surfaces. Only locally touch-up areas which are not optically conspicuous.

Underlying rust grade R3 < 2 - 4 mm

More advanced corrosion with up to 4 mm underlying rust. The damage must be rectified in the same way as for R2. A permanent cure of this type of damage pattern is still just possible

Underlying rust grade R4 < 4 - 5 mm

Notably advanced corrosion with up to 5 mm underlying rust. The damage must be rectified in the same way as for R2. If it is found that for whole areas this is only possible with a great deal of work, or is not possible at all, then a new component must be used.

Underlying rust grade R5 > 5 mm

Extreme corrosion, with more than 5mm underlying rust (panels, flanges or load-bearing components partially rusted or rusted through).

Such damage can no longer be repaired because in many cases the constructional strength of the component can no longer be produced. The risk in making a repair is too great. Install a new component and paint it.

DESCRIPTION AND OPERATION

Color Identification and Chromatics

Basic color theory

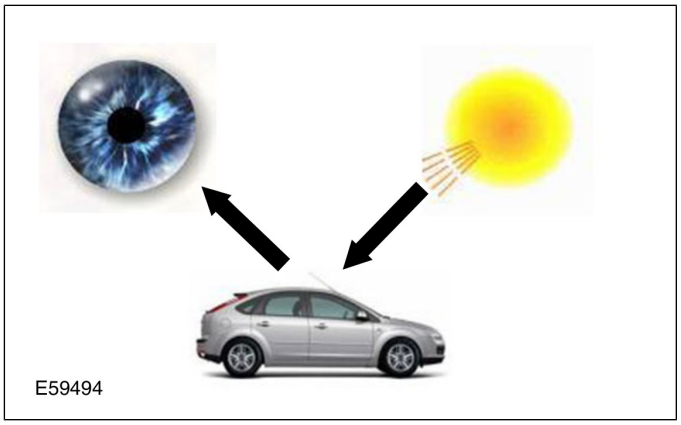
In order to achieve optically perfect painting results it is vital to understand the physical principles of the origin of color impression.

Color

Color itself is a sensory perception.

This perception arises through the combined effect of the following components:

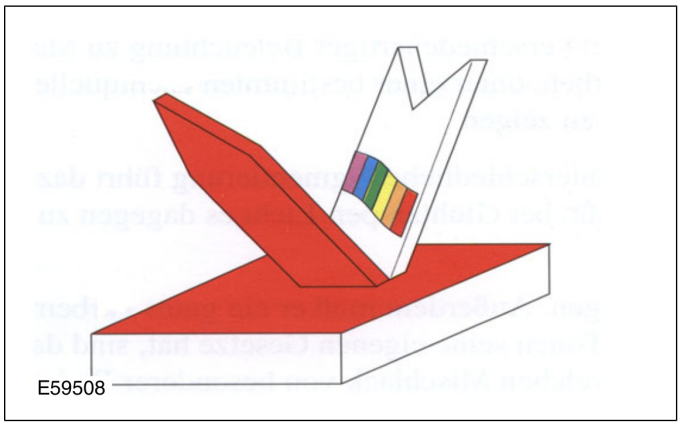
- Light (sunlight or artificial light irradiates the object).
- Surface of the object (reflection from the object of certain constituent parts of the light).
- Eye (perception of the reflections from the object).



Because the sensory impression of color is produced by all three of these components, it is dependent on the type, quality and function of the individual components. Practical examples make this clear:

- If a particular article is subjected to artificial light, then it gives a different impression of color to that which it gives in sunlight.
- An object with uniform color but different surface textures appears to have different colors (grained or ungrained dashboard).
- A person with perception disorder (colorblindness) cannot recognize certain colors or distinguish between them e.g. red-green weakness).

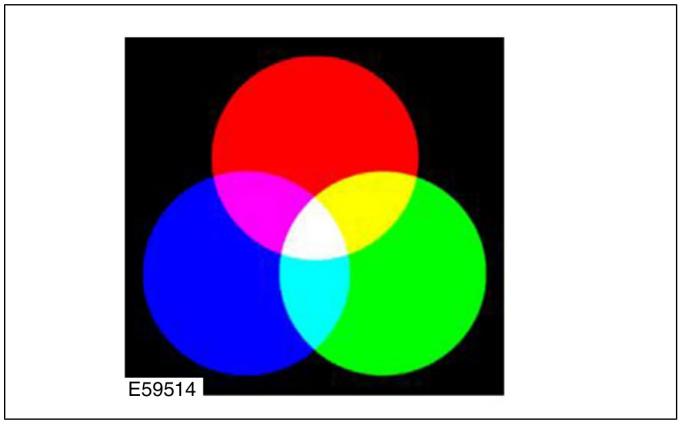
In turn the type of color is determined by the light absorption ability of an object. Light shines with all color components (spectral colors) onto an object, certain components of the light are absorbed (taken in) and other components are reflected (sent on). The components which are reflected produce the specific color impression.



The colors as we see them are the result of a combination of reflected colors from the spectrum. Physically speaking, these are electromagnetic waves with different wavelengths (and frequencies). The healthy human eye can recognize wavelengths between 0.36 µm (violet) and 0.78 µm (red).

If all the perceptible wavelengths of the spectrum impinge on the human eye at the same time, the impression of white light is produced.

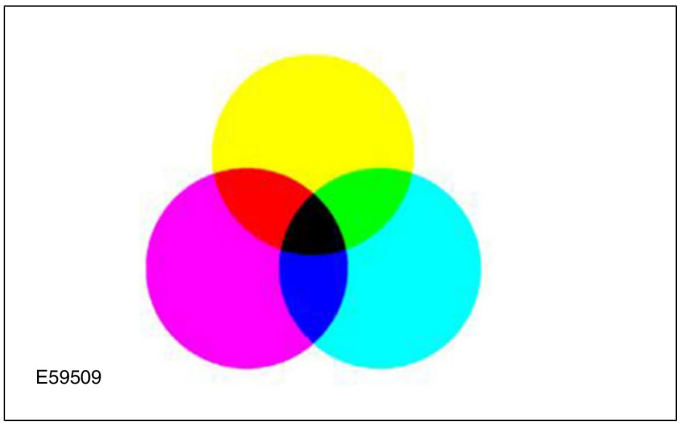
Additive and subtractive color mixing



Additive color mixing is the combination of light from different sources to give white. Different intensities of the additive primary colors red, green and blue allow millions of different colors to be represented (RGB colors).

Additive color mixing is always therefore used when light should enter the eye directly (without reflection off an object). Such as in the case of computer monitors or overhead beamers.

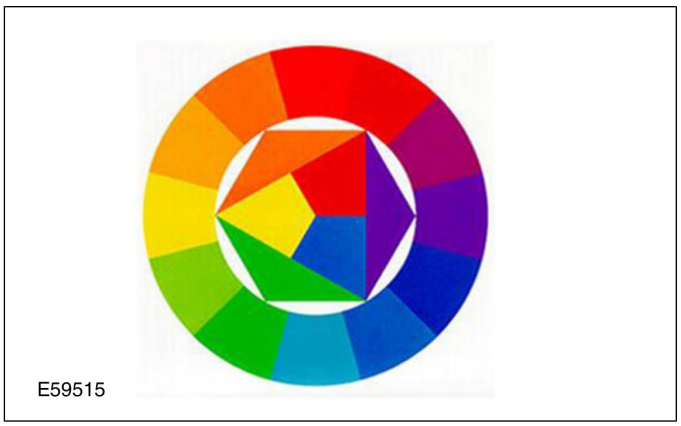
DESCRIPTION AND OPERATION



Subtractive color mixing means mixing the primary colors cyan, magenta and yellow to form a desired color (CMY colors).

Subtractive color mixing is used when light should enter the eye of an observer after reflection from an object. Such as happens with painting or in printing.

Oswald color circle



The Oswald color circle is based on subtractive color mixing, and enables the behavior of paints when they are mixed together to be represented.

Colors lying opposite each other are complementary colors and should not be mixed together as this will produce a dull (i.e. grey) shade. If green is added to red, the red becomes greyer, not greener.

Color shades which are side by side are partner colors and produce a mixed color shade. For instance, mixing red and blue produces a pure violet.

In addition, black and/or white may be necessary to produce a particular color shade.

- White makes the color shade lighter.
- Black makes the color shade darker.
- With black and white the color shade becomes more dreary or greyer.

Metamerism

Metamerism is the name of the effect which occurs when two colors appear identical in a particular light (e.g. artificial light), but the colors appear different under another light source (e.g. daylight).

The cause is the fact that the human brain, aided by the eyes, does not evaluate the wavelength, instead it evaluates the spectral intensity of the reflected light.

It is for this reason that color matching in practice must only ever be performed in daylight, or under special artificial light which is based on daylight.

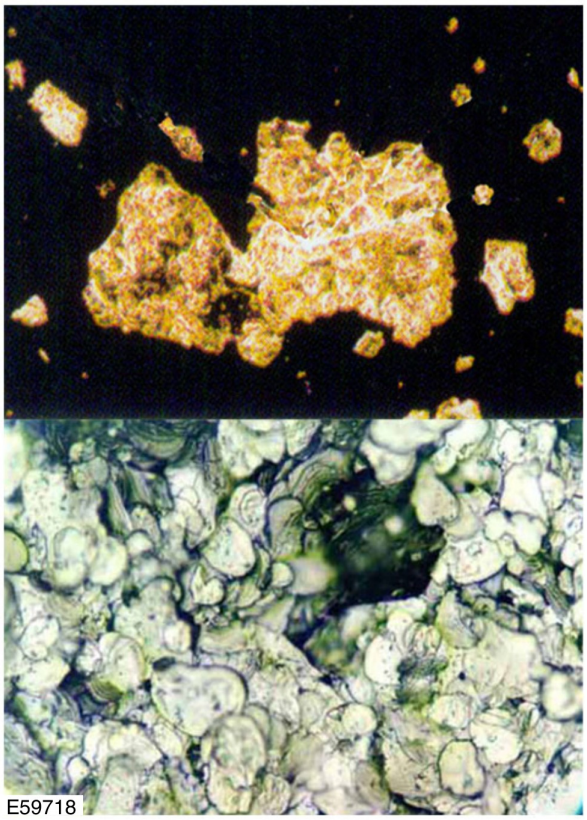
Metallic and pearl pigments

Colored paints achieve their color effect by the addition of pigments. Pigments are colored, solid, very fine organic and inorganic particles which are insoluble in the binding material.

Metallic pigments

Aluminum platelets are added as pigment to form metallic paint.

DESCRIPTION AND OPERATION


E59718

Depending on the size and shape of the aluminum platelets, different metallic effects can be achieved:

- Cornflake aluminum (1) causes very strong dispersion because of rough edges, low brilliance, very low flop and produces grey-silver shades.
- Dollar aluminum (2) causes hardly any dispersion because of the smooth surface, high brilliance, produces very light, almost white silver shades.

With metallic paints however, only a light-dark light reflection effect occurs.

Colored metallic paints are produced by the extra addition of color pigments to the metallic paint.

Pearl pigments


E59719

The basis of pearl pigments is formed by mica, which is metallized with a silver or gold layer.

Depending on the angles of light and observation, the mica platelets reflect different proportions of light. Because of this, the color of the paint appears to the observer to change.

Pearl pigments produce a colored and light-dark reflected light effect.

Color codes and their determination on Ford vehicles

It is necessary to determine the correct color shade of the original paintwork in order to perform a professional and perfect paint repair.

The original paint color shade can be found by:

- Inspection of the vehicle type plate with the color code stamped on it.
  - Later design
  - Earlier design
- Color shade catalog or color shade system of the manufacturer.
- The bare bodyshell plate with color designation.

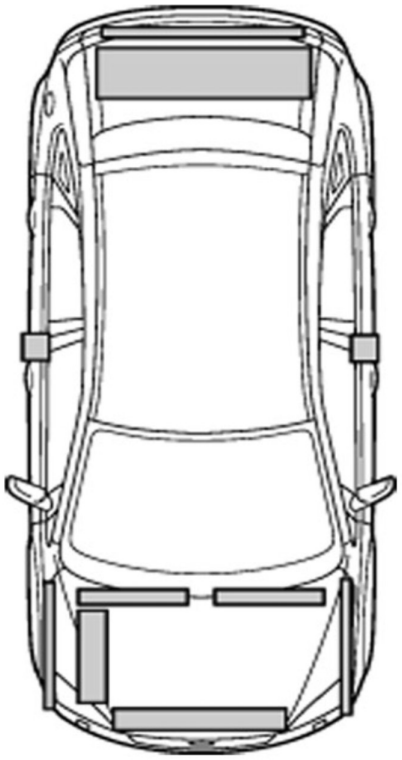
Type plate

Type plate - location on Ford vehicles:

- Right-hand B-pillar - door rebate
- Left-hand B-pillar - door rebate
- Hood lock panel
- Left-hand vertical edge of inner front wing
- Right-hand vertical edge of inner front wing
- Right-hand engine compartment side member
- Left-hand bulkhead
- Right-hand bulkhead

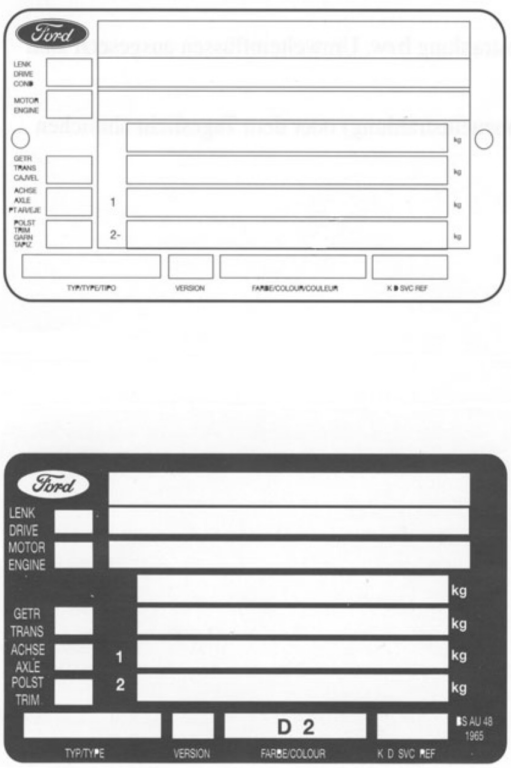
DESCRIPTION AND OPERATION

- Luggage compartment interior
- Inner rear panel - luggage compartment



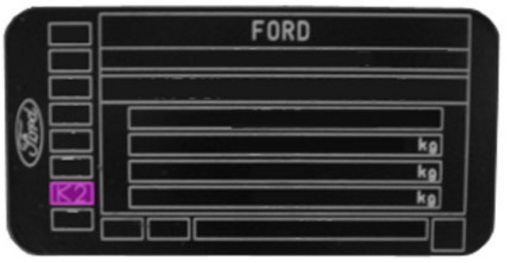
E59720

The type plate gives the color code in the last row.



E59721

On the newer type plates, the color code is given in the left-hand column, at the penultimate position.



E59975

Color shade catalog or color shade system of the repair paint manufacturer.

The repair paint manufacturers offer a variety of possible systems for the determining the production color shade of motor vehicles. There are electronic systems, color card systems and manuals for the determination of color shades.

DESCRIPTION AND OPERATION

Most repair paint manufacturers use the following systems:

- A tabular system based on the following parameters:
  - Color code
  - Make
  - Model
  - Build year
  - Color or color name
  - Ancillary codes
- A system with color cards based on the following parameters:
  - Make
  - Color shade
  - Build year



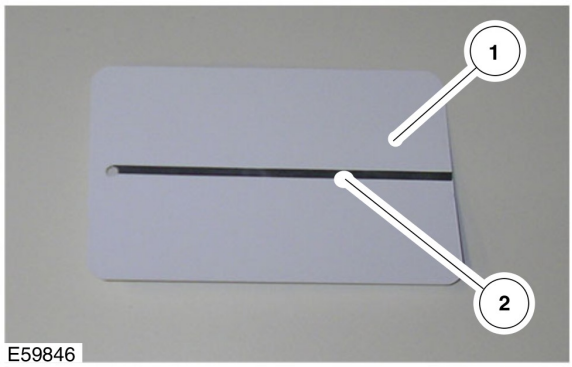
E59722

Because of the many parameters used, in a tabular system the color shade can also be determined by the lack of a parameter.

When using the color cards, emphasis is placed on matching of the original color shade with the color shade samples. For this reason this method is very helpful when the other parameters are not available.

Comparison of the results of both methods increases the certainty of using the correct original color shade and its formulation.

Additional certainty can be achieved during color shade determination by making a color sample plate. Here it is however important to apply the complete paint structure with base paint and clear lacquer onto a sample plate (1) in order to carry out a color shade and color coverage test.



E59846

The color shade comparison is done by comparing the vehicle paintwork with the sample plate (1). The color coverage test is possible by using the black test stripe (2): If the test stripe (2) is still visible after test painting of the sample plate (1), the coverage is not good enough.

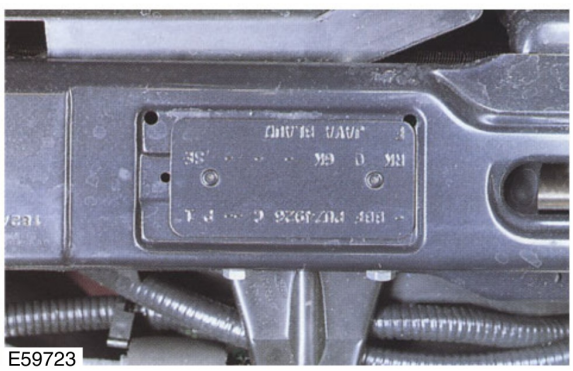
By using this determination of the original color shade, the formulation and information on any very slight fine adjustments which may be necessary can be established.

Bare bodyshell plate

The bare bodyshell plate is located:

- On the hood lock panel.
- Near the type plate.

The color name is stamped on in the last row.


E59723

DESCRIPTION AND OPERATION

Matching tinted filler to the color code

NOTE: Color samples must always be made from the same materials as the subsequent repair painting. Perform color shade matching in the fully hardened state, in natural light or under suitable artificial light.

Various tinted fillers are used during factory painting. In order to achieve the exact color shade of the factory applied paint, attention should be paid that the correctly matched fillers are used.



The repair paint manufacturers offer suitable precolored primers. The use of filler color cards allows the matching color shade to be determined.

DESCRIPTION AND OPERATION

Tips and Tricks

Comparing paint structures

It may happen that an area remains visible, especially when the area of the repair is small. The reason for this is the structural variation in the paint surface at the repair location compared with the original paint finish. The original paint finish has a slight orange peel effect while the repair areas is extremely smooth.

This effect can be reduced by fine sanding using P3000 of the area around the repair location and then polishing.

Etching substrate

If the substrate can be etched during the solvent test, suitable preparation must be done.

Job steps:

NOTE: Follow the manufacturer specific instructions.

- Sand the damaged area extensively using an eccentric sander and P80 or P120 abrasive sheets. Finish off sanding with P150 or P180.
- Remove the sanding dust and clean the area of the damage using silicone remover.
- Apply polyester stopper to the bare panel and to the damaged area.
- Sand the dried polyester stopper to an even surface using P80 - P150. Finish sanding using P180 - P240. If required apply more stopper, again only on the bare panel.
- Wet sand the residual old paint finish using P600 - P800. Transitions with P400 - P600. Clean with silicone remover.
- Prime bare metal areas with acid primer.
- After the acid primer has been left exposed to the air for the correct evaporation time, apply 2-component primer filler in thin layers over the complete repair area, leaving enough air exposure time in between coats.
- After the filler has dried, sand wet with P800 or sand dry with P400. Sanded through areas must be covered again with 2-component Nonstop filler primer.

Another possible method of preventing etching of the substrate is to use waterbased primer and filler materials.

Masking the vehicle

Masking and covering work are among the most important preparations required to achieve a high quality paint finish. Paint application onto neighboring components, paint mist and sharp paint transitions are quality faults. For this reason it is extremely important to take special care and to use suitable masking materials.

NOTE: When water based paints are used, all materials must be stable towards water.

Plan the masking work:

- Determine the sequence of masking work. Sometimes after masking film has been applied, it is difficult or impossible to reach certain areas.
- Prepare the masking material.
- Start with small difficult areas.

Pay special attention to the areas of profiled seals, edges, openings and paint transitions.

Masking tape

Masking tape is available in various widths for special application areas. In practice however, a wide tape has proved best for almost all areas, also taking into account the time required for masking work.

NOTE: Use of differing masking materials is often much more time-consuming.

Advantages

- Good coverage. Narrower tapes must often be applied in several layers.
- More resistant to tearing.
- Wide tapes can be applied deep into joints and therefore protect from paint mist and contamination.
- Removal is often easier.

Masking film

Transparent plastic film has become accepted as a practical method to mask large areas of a whole vehicle. It can quickly and easily be applied to the vehicle from the roll.

DESCRIPTION AND OPERATION

NOTE: Only mask the vehicle when it is dry. Moisture under the film can lead to matt paint in the drying process.

Using masking film

- Clean the vehicle before masking it.
- Pull the film over the vehicle. Because of the static charge, the film lies on the vehicle like a second skin.
- Cut out the repair area using the film knife and then mask it.

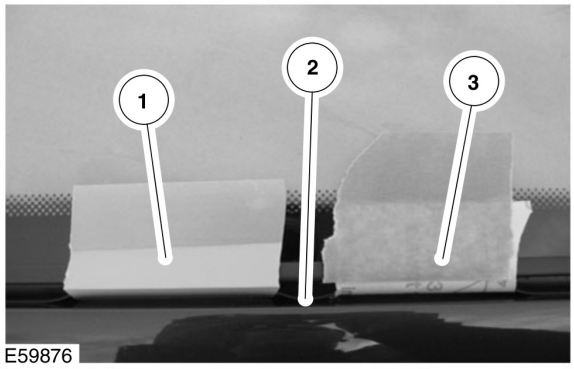
Other ways of masking a vehicle are:

- Masking using masking paper.
- Painting cloth (mostly used during filling work).

Profiled seals

If it is not possible to remove a profiled seal, then it must be masked in such a way that no edges can form due to paint accumulation.

To do this, the seal is lifted slightly and masked. The following techniques are possible:



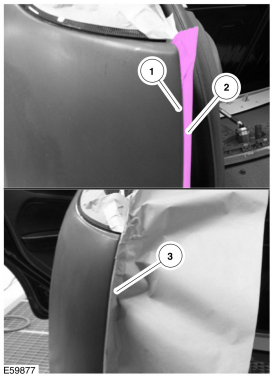
Item	Description
1	Masking tape with plastic strips
2	Sealing lip
3	Sandpaper with masking tape

- Laying a string or cord under the seal. Suitable for soft and elastic seal lips.
- Special masking tape with plastic strips for hard seal lips.
- Instead of using plastic strips, fine sandpaper cut into strips can be inserted and secured using normal masking tape.
- If the seal can be easily displaced, normal masking tape can also be used.

Edges/openings

Smooth paint transitions can be produced by positioning adhesive tapes.

NOTE: Pull the adhesive tapes away immediately after the paint has been applied and check the paint transitions.



Item	Description
1	Vehicle edge
2	Adhesive surface
3	Masking paper

Possible variations

- At edges apply one strip of masking tape half on the area not to be painted and mask using a second strip.
- On surfaces, two masking strips can be attached, each affixed by half their adhesive surface. The adhesive strip which arises is then applied with one half on the edge of the area to be painted. The other half is aligned and fixed in addition in the curves.
- Affix masking paper on one side over the area to be painted. Double back the masking paper and secure it.
- Affix round profiled foam at the edge of the area to be painted using masking tape.

Foam strips are suitable for affixing to openings such as door gaps.

DESCRIPTION AND OPERATION


E59878

NOTE: Choose a suitable profile diameter. A profile which is too thick will protrude from the opening, one which is too thin will leave a gap.

Clean the door opening well and affix the matching shape.

Color shade problems

If a vehicle color shade is taken from a vehicle on a hot summer day and the mixed color applied, this may cause color shade problems. Some colors change so much at higher temperatures that it can lead to an incorrect result. Red color shades are particularly prone to this shade behavior.

This means that color determination should always be done on the bodywork when it is at about the same temperature as the later working temperature will be. The best temperature of the item is between 15° and 25° C.

Isopropanol and water

Painted surfaces are very easily cleaned using a mixture of 70% water and 30% isopropanol (can be obtained through a laboratory supplies specialist or a pharmacist).

Temperature reduction spray

If finishing work must be performed on touched-up surfaces and newly painted plastic parts, problems may arise. The paint and the transitions are not yet fully hardened.

NOTE: When working with the polishing machine, make certain that each operating run lasts no longer than about 5 - 10 seconds, in order to prevent the paint becoming warm.

Even so, in order to be able to polish over transitions, temperature reduction spray must be applied to the surface. The transition area is then alternately sprayed and polished until a perfect transition surface is achieved.

Paint faults on soft plastic components where elasticizer additive has been used in painting must be wet sanded using grade P2000 - P2500 paper.

In doing this the sanding location and the surroundings are sprayed with temperature reduction spray and the paint faults sanded out by hand. Afterwards the location is polished as described above.

Paint plane

Dirt inclusions and paint runs can be removed with the sanding cylinder ("Finiball") and hand sanding or eccentric sander in a wet sanding process.

Another practical tool for removal of paint faults which lie proud of the surface is the paint plane.

NOTE: Guide the tool carefully with the minimum of force. It must not tilt, otherwise more serious damage may easily be caused.


E59879

This tool allows paint faults to be carefully removed in shavings. Afterwards the surface must be polished using suitable materials.

Shading

Even when all the rules, steps and corresponding instructions have been followed concerning possible shades, it may happen that the mixed color shade does not exactly match the vehicle color.

In these cases, shading must be done. Because there is no fixed formula for this, experience and a trained eye are important. Some rules must be followed for shading.

DESCRIPTION AND OPERATION

NOTE: Self-made color sample plates of the current colors are very helpful for determining the color shade. Refer to the chapter Color Determination and Color Theory.

- When shading, if possible only use the paint mixture that is also allotted in the color shade formula.
- Observe the rules concerning contrary colors (complementary colors) and partner colors according to the Oswald color circle.
- Complementary colors are not recommended during shading because they mutually inhibit and lead to muddy mixtures.

Sanding marks

In certain circumstances, the recommended sanding methods up to now are no longer suitable for light metallic color shades. Wet sanding with grade P1200 paper or a grey sanding pad can cause sanding scratches which can become very visible under certain lights.

In order to achieve an excellent paint result on difficult color shades, follow these working rules:

- Sand filler as before, rub down area to be painted with 3M ultra fine matting sponge and 3M matting gel.
- Sand filler as before, rub down area to be painted with soaked 3M wet sand paper P1500 - P2000.
- Sand filler as before, rub down area to be painted with 3M 260 L P1000 eccentric (Interface Pad).

Improving touch-up work

During application of special effect base paints, the effect particles align themselves exactly parallel to the surface in the paint layer while it is still liquid. This means a particular thickness of the paint layer is required.

Because during painting the layer thickness in the transition zones reduces from normal to zero, the effect particles can no longer align themselves. This leads to lighter, darker or cloudy zones.

If 1-component clear lacquer is sprayed before the base coat, this effect is prevented. An optically perfect transition will result.

SECTION 502-00 Uni-Body, Subframe and Mounting System

VEHICLE APPLICATION:2007.50 Transit

CONTENTS PAGE

SPECIFICATIONS

Specifications..... 502-00-2

REMOVAL AND INSTALLATION

Engine Crossmember — Vehicles With: 5-Speed Manual Transmission (MT-75)..... 502-00-3
Front Axle Crossmember..... 502-00-5

SPECIFICATIONS

Torque Specifications

Description	Nm	lb-ft	lb-in
Front axle crossmember retaining bolt	175	129	-
Lower arm to front axle crossmember front retaining bolt	200	148	-
Lower arm to front axle crossmember rear retaining bolt	300	221	-
Steering gear line bracket to engine crossmember nut	30	22	-
Steering gear retaining bolts	115	85	-
Transmission support insulator to front axle cross-member bolts	40	30	-
Lower arm ball joint retaining nut - with a flat diameter of 24 mm	150	111	-
Lower arm ball joint retaining nut - with a flat diameter of 30 mm	250	184	-
Engine support insulator to transaxle housing bolt	103	76	-
Engine support insulator to crossmember retaining bolts	23	17	-
Vibration damper retaining bolt	80	59	-
Engine crossmember retaining bolts	70	52	-
Engine mount retaining bolts	40	30	-
Engine mount retaining nut	103	76	-
Stabilizer bar link retaining nuts	55	41	-
Stabilizer bar clamp retaining bolts	30	22	-

REMOVAL AND INSTALLATION

Engine Crossmember — Vehicles With: 5-Speed Manual Transmission (MT-75)

General Equipment

Transmission jack

Removal

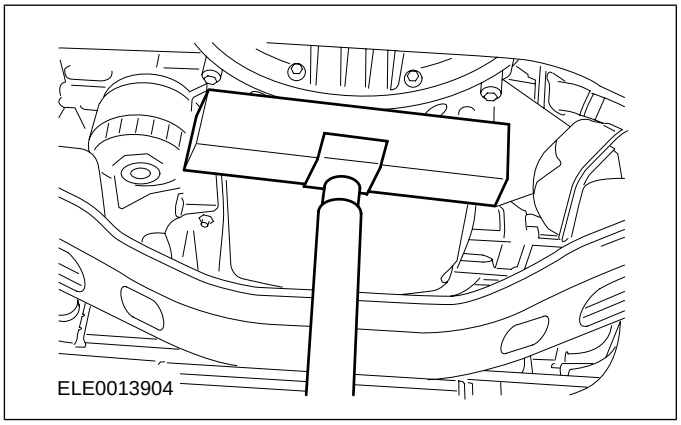
All vehicles

1. **Raise and support the vehicle. For additional information, refer to:(100-02 Jacking and Lifting)**

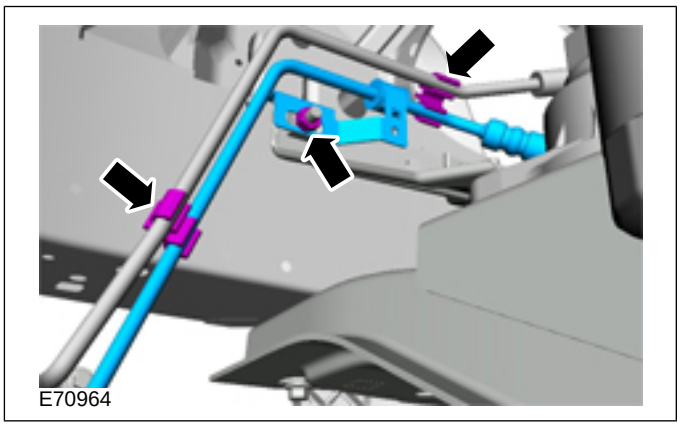
   Jacking (Description and Operation), Lifting (Description and Operation).

2. **⚠CAUTION:Support the engine between the oil pan and the transmission housing to prevent damage to the underside of the oil pan.**

   Using a transmission jack and a wooden block, support the engine.

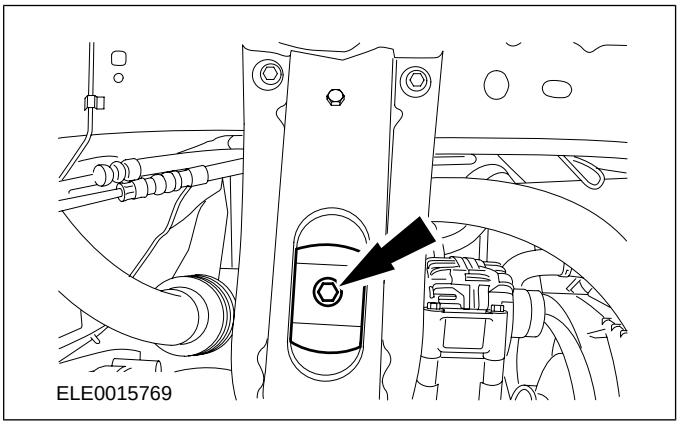


3. **Detach the steering gear line bracket from the engine crossmember (if equipped).**



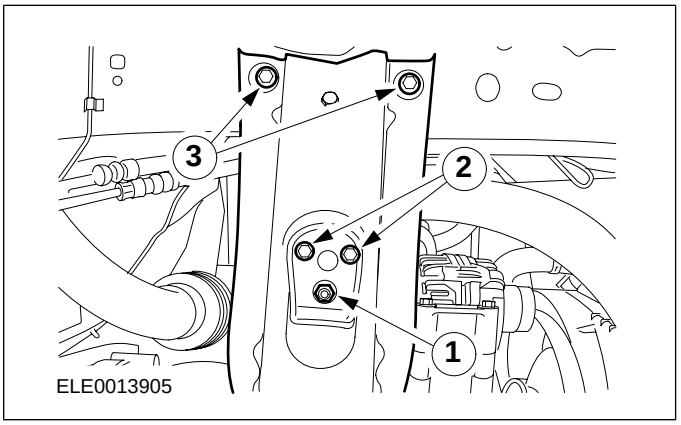
Vehicles with 2.4L diesel engine

4. **Remove the vibration damper from the engine crossmember on both sides.**



All vehicles

5. **Remove the engine crossmember.**
   1. Remove the engine front mount retaining nut on both sides.
   2. Remove the engine front mount retaining bolts on both sides.
   3. Remove the engine crossmember retaining bolts on both sides.



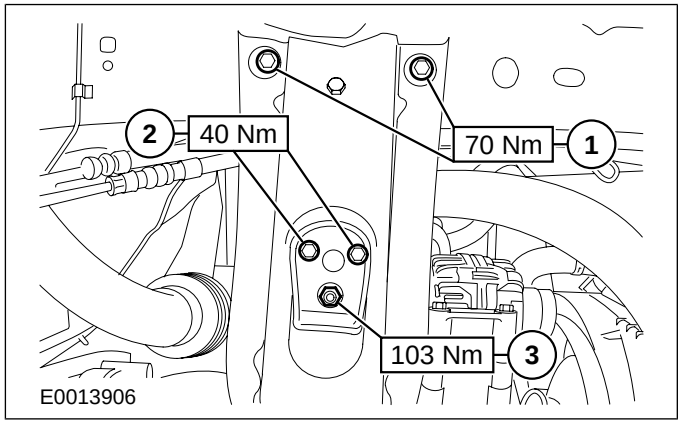
Installation

All vehicles

1. **Install the engine crossmember.**
   1. Install the engine crossmember retaining bolts on both sides.
   2. Install the engine front mount retaining bolts on both sides.

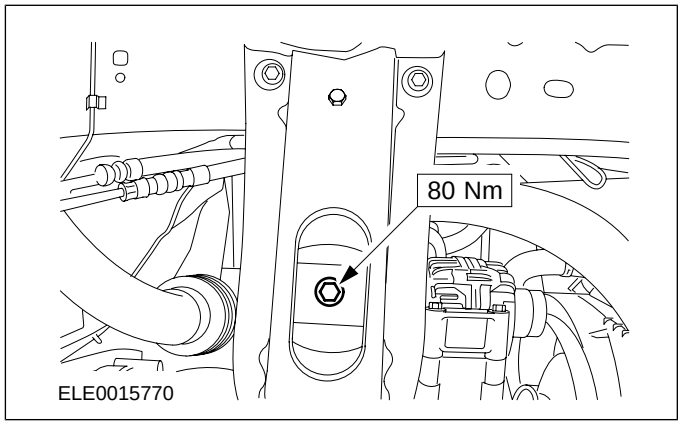
REMOVAL AND INSTALLATION

3. Install the engine front mount retaining nut on both sides.



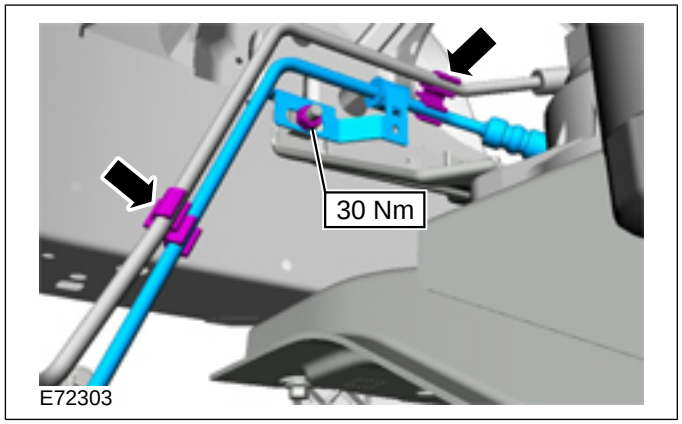
Vehicles with 2.4L diesel engine

2. Install the vibration damper to the engine crossmember on both sides.



All vehicles

3. Attach the steering gear line bracket to the engine crossmember (if equipped).



4. Lower and remove the transmission jack from the engine.

5. Lower the vehicle.

REMOVAL AND INSTALLATION

Front Axle Crossmember

General Equipment

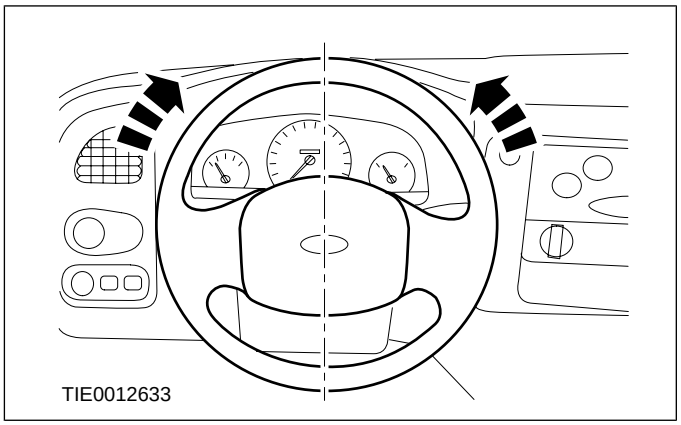
Transmission jack
Securing strap
Two leg puller

Removal

All vehicles

1. **NOTE:Make sure the road wheels are in the straight ahead position.**

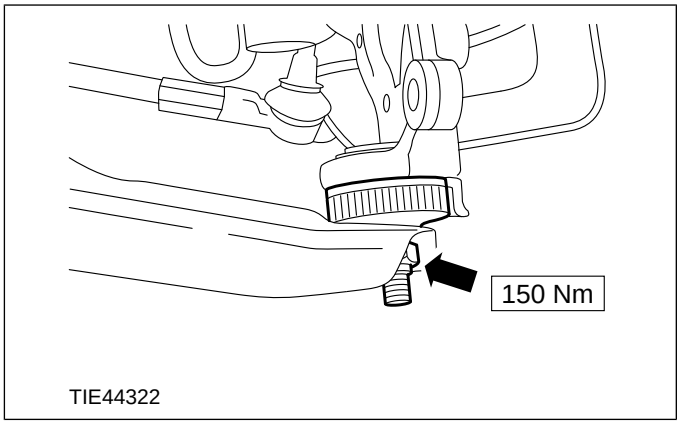
   Centralize the steering wheel and lock it in position.



2. **Remove the stabilizer bar.**

   For additional information, refer to:Front Stabilizer Bar (204-01 Front Suspension, Removal and Installation).

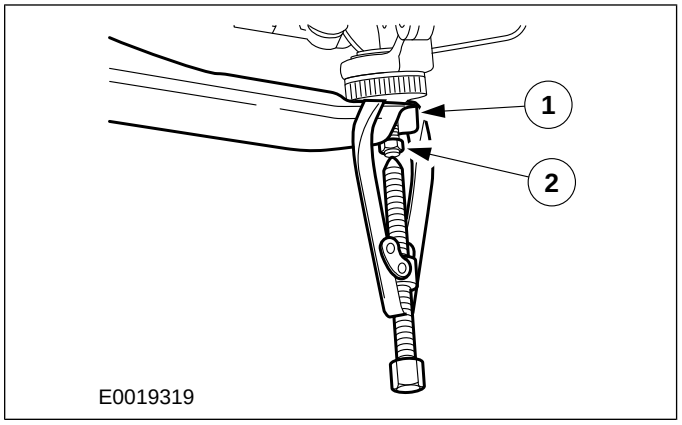
3. **Loosen the lower arm ball joint retaining nut.**



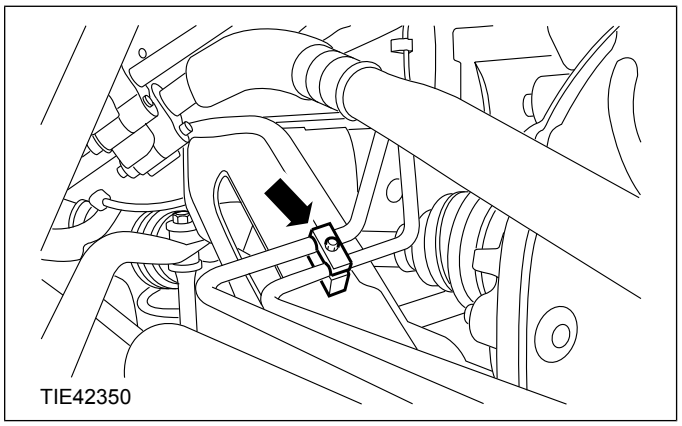
4. **CAUTION:Protect the ball joint seal using a soft cloth to prevent damage.**

   Using a suitable two leg puller, detach the lower arm from the wheel knuckle on both sides.

   1. Use a soft faced hammer to strike the lower arm.
   2. Remove and discard the lower arm ball joint retaining nut.



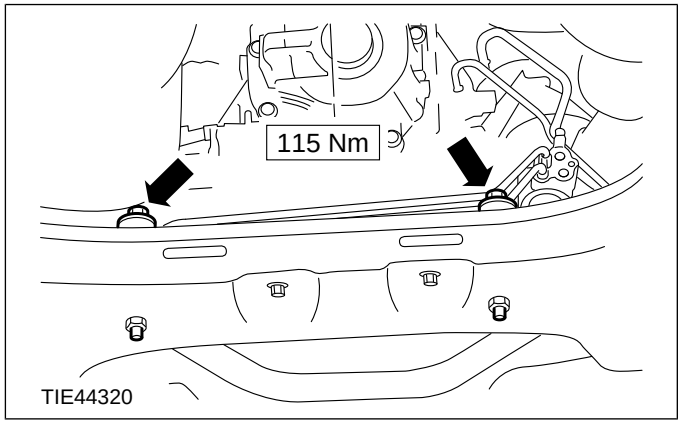
5. **Detach the power steering lines from the front axle crossmember.**



6. **Detach the steering gear from the front axle crossmember.**

REMOVAL AND INSTALLATION

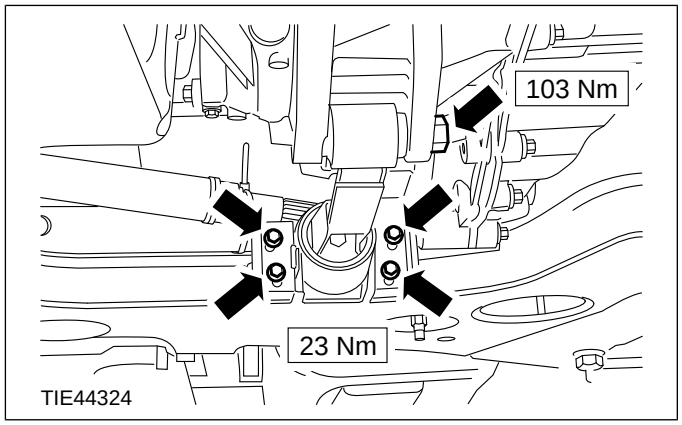
- Using cable ties, support the steering gear on both sides.



Vehicles with 2.2L diesel engine

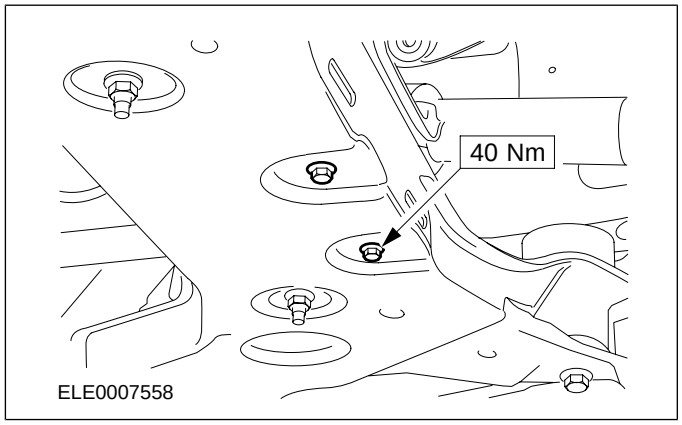
7. Remove the engine support insulator.

- Discard the engine support insulator to transaxle housing bolt.



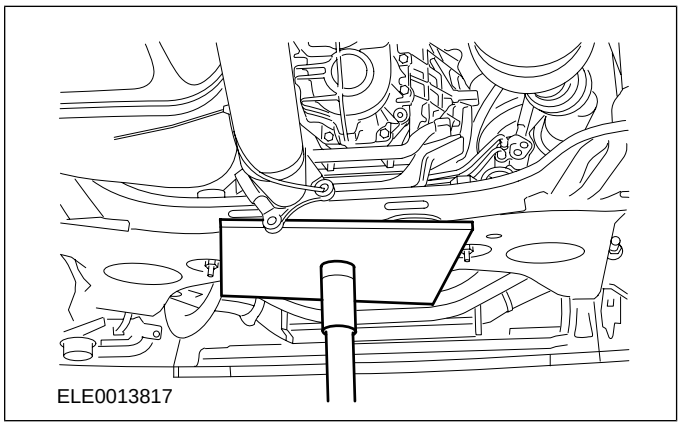
Vehicles with 2.3L engine or 2.4L diesel engine

8. Remove the transmission support insulator to front axle crossmember bolts.



All vehicles

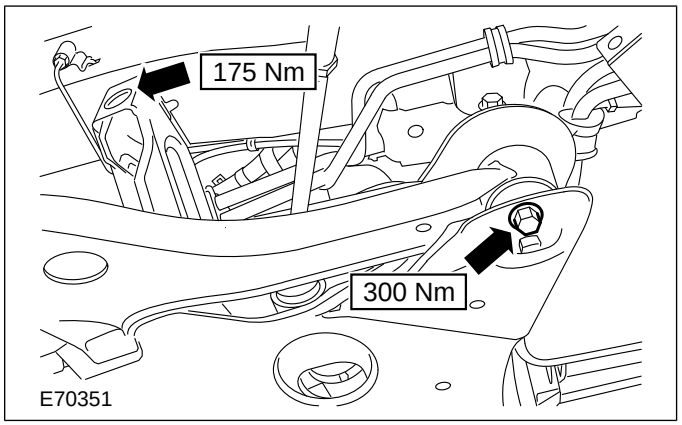
9. Using a transmission jack, support the front axle crossmember and lower arm assembly.



10. WARNING:Make sure the front axle crossmember is secured to the transmission jack. Failure to follow this instruction may result in personal injury.

Using a suitable securing strap, secure the front axle crossmember and lower arm assembly to the transmission jack.

11. Remove the front axle crossmember retaining bolts on both sides.

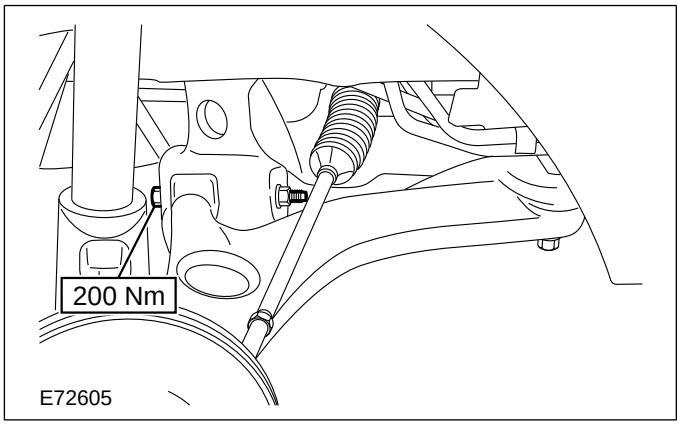


12. Remove the front axle crossmember and lower arm assembly.

13. NOTE:If installing a new front axle crossmember, remove the lower arms.

REMOVAL AND INSTALLATION

Remove the lower arm on both sides.



Installation

WARNINGS:

Make sure the front axle crossmember is secured to the transmission jack. Failure to follow this instruction may result in personal injury.

Install a new lower arm ball joint retaining nut. Failure to follow this instruction may result in personal injury.

NOTE: If installing a new front axle crossmember, install the lower arms.

NOTE: Install a new engine support insulator to transaxle housing bolt.

1. **To install, reverse the removal procedure.**
2. **Check the toe setting and adjust as necessary. For additional information, refer to:(204-00 Suspension System - General Information)**

   Specifications (Specifications),
   Front Toe Adjustment (General Procedures).