

Body and Equipment Mounting Manual
FORD **TRANSIT** 2016.75

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1.1 About This Manual

1.1.1 Body and Equipment Mounting Manual (BEMM) Publication 05/2016

This BEMM is for 2.0L vehicles and comprises the new EU6 emissions powertrains, powertrain systems and further revised vehicle systems. This BEMM has been updated since the last publication dated 04/2016. It It is recommended to review this manual in full. The BEMM is a live document which can be viewed on www.etis.ford.com/BEMM. It is the vehicle converters responsibility to review the online version for the most current information prior to starting any conversion.

For an overview of the main differences please see below:

Refer to: 4.1 Wiring Installation and Routing Guides (page 76).
Trailer Tow Electrics (A055).

Refer to: 4.3 Charging System (page 95).
Hardwire Input text updated for grounding advise.

Refer to: 4.19 Electrical Connectors and Connections (page 178).
High Specification Vehicle Interface Connector table revised.

1.1.2 Introduction

This manual has been written in a format that is designed to meet the needs of Vehicle Converters. The objective is to use common formats with the workshop manual which is used by technicians worldwide.

This guide is published by Ford and provides general descriptions and advice for converting vehicles.

It must be emphasized that any change to the basic vehicle which does not meet the enclosed guideline standards may severely inhibit the ability of the vehicle to perform its function. Mechanical failures, structure failure, component unreliability or vehicle instability will lead to customer dissatisfaction. Appropriate design and application of body, equipment and or accessories is key to ensuring that customer satisfaction is not adversely affected.

The information contained within this publication takes the form of recommendations to be followed when vehicle modifications are undertaken. It must be remembered that certain modifications may invalidate legal approvals and application for re-certification may be necessary.

Ford cannot guarantee the operation of the vehicle if non-Ford -approved electrical systems are installed. Ford electrical systems are designed and tested to function under operational extremes, and have been subjected to the equivalent of ten years of driving under such conditions.

Not all information in this manual applies to all territories. For availability of options and parts please contact your National Sales Company representative or Local Ford Dealer.

1.1.3 Important Safety Instructions

Appropriate conversion procedures are essential for the safe, reliable operation of all 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 does not follow the instructions provide 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.

1.1.4 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).

1.1.5 How to Use This Manual

This manual covers vehicle conversion procedures.

The pages at the start of this manual list the content, by group. A group covers a specific portion of the vehicle. The manual is divided into five groups, General Information, Chassis, Powertrain, Electrical and Body. The number of the group is the first number of a section number. Each title listed in the contents links to the relevant section of the manual.

In some section of the book it may refer you to see additional sections for information, links have been provided, these links are in blue text.

This manual is also designed to be used as a printed document, where there are links page numbers in brackets have been added, which will help guide you to the start of the section which contains the relevant information.

There is also an alphabetical index at the back of the manual. As with the contents pages you will be able to link to sections. To do this just click on the page number.

All left and right handed references to the vehicle are taken from a position sitting in the driver seat looking forward unless otherwise stated.

All references to ADR vehicle standards are only applicable to the Australian and New Zealand markets. Where no ADR is specified the EU standard is recommended.

1.1.6 Supplemental Information

2D Engineering Drawings can be downloaded in DWG format via www.etis.ford.com/fordservice/vehicle conversions'BEMM Drawings tab, this will then give you the option to navigate though a drop-down menu to specific drawings.

3D CAD data in IGES format can be requested by contacting the Vehicle Converter Advisory Service, vcas@ford.com

Signwriter's Guides, which have been produced for Transit to assist companies applying labels to the sides of the vehicle, can be requested by contacting the National Sales Representative.

1.2 Commercial and Legal Aspects

1.2.1 Terminology

NOTE: Any modifications to the vehicle must be noted in the owner's handbook or new descriptive literature included with the owner's documentation.

Vehicle Converter refers to any re-seller altering the vehicle by converting the body and adding or modifying any equipment not originally specified and/or supplied by Ford.

Unique component or similar wording refers to non-Ford specified or after sale fitment not covered by Ford warranty.

1.2.2 Warranty on Ford Vehicles

Please contact The National Sales Company in the country where the vehicle will be registered for details of the terms of any applicable Ford warranty.

The Vehicle Converter should warrant its design, materials and construction for a period at least equal to any applicable Ford warranty.

The Vehicle Converter must ensure that any alteration made to a Ford vehicle or component does not reduce the safety, function, or durability of the vehicle or any component.

The Vehicle Converter shall be solely responsible for any damage resulting from any alteration made by the Vehicle Converter or any of its agents to a Ford Vehicle Component.

The Vehicle Converter releases Ford from all claims by any third party for any cost or loss (including any consequential damages) arising from work performed by a Vehicle Converter unless Ford has given its prior written consent to such liability.

1.2.3 Whole Vehicle Type Approval (2007/46/EC) Regulations - European Union Markets only

WARNING: For non European Union territories, please refer to local legislation.

Fitment of Parts and Accessories

The objective of the 2007/46/EC Whole Vehicle Type Approval (WVTA) legislation or applicable local legislation is to ensure that new vehicles, components and separate technical units put on the market provide a high level of safety and environmental protection. The aim is not to be impaired by the fitting of certain parts or equipment after vehicles have been placed on the market or have entered service.

Vehicle Converters are advised to check whether the fitment of parts require either Type Approval or Individual Vehicle Approval before the vehicle is registered.

- Type Approval requires a Conformity of Production (CoP) inspection to be carried out at the conversion location to demonstrate that all vehicles of the same type will conform to the type approved specification.
- IVA requires inspection of an individual vehicle to establish compliance.
- **Note:**Ford parts fitted in the plant are covered by the Certificate of Conformity (CoC).

Conversions from Commercial Vehicle N1, N2 to Passenger Car M1

Vehicle Converters of Passenger Car M1 vehicles need to be aware of the latest Whole Vehicle Type Approval (2007/46/EC) regulations or applicable local legislation, especially when the base vehicle is a Commercial Vehicle N1. This affects vehicles which are homologated to meet Passenger Car M1 regulations.

Guidance to Vehicle Converters for M1 registered vehicles:

- The Vehicle Converter is responsible for checking the vehicle ordered can meet all the regulations for type approval.
- Exemptions for certain regulations should be checked with latest regulation and Approval Authority.
- Where possible, order a Passenger Car M1 base vehicle such as Kombi M1.
- If specifying Air Conditioning, check that the base commercial vehicle refrigerant meets the latest completed vehicle regulations.
- If Tire Pressure Monitoring System (TPMS) is required, specify this when ordering.
- If seat belt warning it required, specify Passenger Airbag which includes the Belt minder function for the driver and passenger.
- Refer to: 5.6 Body Closures (page 249). For information on sliding door gap reduction on M1 Vehicles
- Special Purpose Vehicles such as Ambulances, Motor Caravans, Hearses and Wheelchair Accessible Vehicles may be allowed to use the base vehicle homologation for some regulations.

For additional information

Refer to: 1.5 Conversion Homologation (page 19).

1.2.4 Legal and Vehicle Type Approval

- All components embodied on Ford vehicles are approved to the applicable legal requirements.
- Ford vehicles have Type Approval for the intended marketing territories.

WARNING: Exception - Incomplete vehicles require further approval when completed by the vehicle converter.

- The Transit range has Type Approval for many territories, although the full range of vehicles shown in this manual are not necessarily released in all territories. Check with your local Ford National Sales Company representative.
- Significant changes to the vehicle may affect its legal compliance. Strict adherence to the original design intent for brakes, weight distribution, lighting, occupant safety and hazardous materials compliance in particular is mandatory.

1.2.5 Alternative Type Approval

If significant changes are made the vehicle converter must negotiate with the relevant authority. Any changes to the vehicle operating conditions must be advised to the customer.

1.2.6 Legal Obligations and Liabilities

The Vehicle Converter should consult with its legal advisor on any questions concerning its legal obligations and liabilities.

1.2.7 General Product Safety Requirement

The Vehicle Converter shall ensure that any vehicle it places on the market complies with the European General Product safety Directive 2001/95/EC (as amended periodically) or applicable local legislation. The Vehicle Converter shall also ensure that any alteration it makes to a Ford vehicle or component does not reduce its compliance with the European General Product Safety directive or applicable local legislation directive.

The Vehicle Converter shall release Ford from all liability for damages resulting from:

- Failure to comply with these Body Equipment Mounting directives, in particular warnings.
- Faulty design, production, installation, assembly or alteration not originally specified by Ford.
- Failure to comply with the basic fit for purpose principles inherent in the original product.

WARNINGS:

Do not exceed the gross vehicle mass, gross train mass, axle plates and trailer plate.

Do not change the tire size or load rating.

Do not modify the steering system.

Excessive heat can build up from the exhaust system, in particular from the catalytic converter and from the Diesel particulate filter (DPF). Ensure adequate heat shields are maintained. Maintain sufficient clearance to hot parts.

Do not modify or remove heat protection shields.

Do not remove labels provided with the base vehicle. Ensure appropriate visibility.

Do not route any electrical cables with the Anti-lock Brakes System and Traction Control System cables because of extraneous signal risk. It is generally not recommended to hang electrical cables off existing harnesses or pipes.

Do not change original location or remove warning labels provided with the base vehicle in view to the driver. Ensure that labels remain in full view.

Maintain functionality of the ERA-GLONASS (Emergency Response to Accidents - Global Navigation Satellite System).

Refer to: Emergency Call Systems (page ?).

NOTE: For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

Refer to: 1.3 Contact Information (page 11).

1.2.8 Product Liability

The Vehicle Converter shall be liable for any product liability (whether for death, personal injury, or property damage) arising from any alteration to a Ford vehicle or component made by the Vehicle Converter or any of its agents. Ford shall not be liable for any such liability (except as provided by law).

The Vehicle Converter or equipment manufacturer is liable for the:

- Operational reliability and road-worthiness of the vehicle to its original intent.
- Operational reliability and road-worthiness of any component or conversion, not listed in original Ford documentation.
- Operational reliability and road-worthiness of the vehicle as a whole (for example the body changes and/or additional equipment must not have a negative effect on the driving, braking or steering characteristics of the vehicle).
- Subsequent damage resulting from the conversion or attachment and installation of unique components, including unique electrical or electronic systems.

- Functional safety and freedom of movement of all moving parts (for example axles, springs, propeller shafts, steering mechanisms, brake and transmission linkage, retarders).
- Functional safety and freedom of the tested and approved flexibility of the body and integral chassis structure.

1.2.9 Restraints System

WARNINGS:

Modifications to the restraints system are not allowed.

Airbag are explosive. For safe removal and storage during conversion follow the procedures in the Ford workshop manual or consult your local National Sales Company representative.

Do not alter, modify or relocate the airbag, sensor and modules of the restraints system or any of its components.

Attachments or modifications to the front end or B-Pillar of the vehicle may affect the airbag deployment timing and result in uncontrolled deployment.

For additional information:

Refer to: 5.11 Airbag Supplemental Restraint System (SRS) (page 261).

1.2.10 Drilling and Welding

WARNING: Do not Drill or Weld Boron steel parts, see figure E167660 in the welding section of this manual.

Drilling and welding of frames and body structure have to be conducted following the guidelines in Welding and Frame Drilling and Tube Reinforcing sections.

Refer to: 5.15 Frame and Body Mounting (page 269).

1.2.11 Minimum Requirements for Brake System

It is not recommended to modify the brake system. If a special conversion should require modifications:

- Maintain original settings.
- Maintain brake certification load distribution.

Changes to the Anti-lock Brake System (ABS), Traction Control System (TCS) and Electronic Stability Control ESC (also known as ESP) system are not permitted.

1.2.12 Road Safety

The respective instructions should be strictly observed to maintain operational and road safety of the vehicle.

1.3 Contact Information

As a manufacturer, we want to provide you with the information you need for your vehicle conversion/modification. If the information you require is not in this manual or you have further questions, please contact your local National Sales Company Representative (NSC) or Local Ford Dealer in your Market.

If your Local National Sales Company Representative or Local Ford Dealer are unable to help you, please contact the Vehicle Converter Advisory Service at VCAS@ford.com.

Ford of Britain	
Contact:	Debbie Ling - CV Marketing
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	1082
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1.4 Conversion Type

1.4.1 Special Vehicle Option (SVO) Order Codes

Order Code	Description
Body	
A304	Omit Passenger Seat — No pedestal, not available on Double Cab in Van
A532	Spare Wheel Access — With rear doors closed
Electrical	
A003	RPM Speed Control — 1300-3000rpm
A738	2 High Performance AGM Batteries
A526	Auxiliary Fuse Panel
A606	Beacon Preparation Pack — Switch and wiring front and rear (includes A526 and mini overhead console - 1DIN)*
A607	Utility Vehicle Switch Pack — Provides 3 switches for beacon and two power outputs (includes A526, A606 and mini overhead console 1 DIN)*
A608	High Specification Vehicle Interface Connector — Provides a range of hard-wire signals (includes A526)**
A055	Trailer Tow Electrics - Trailer tow electrics (connector and wiring) without tow bar.
A540	Ford Programmable Battery Guard - Patented 10-mode progammable battery guard system capable of protecting Ford third party battery.
A550	Converter-High Power Supply System - Meets heavy power-take-off requirements by equipping vehicles with two high performance deep cycle AGM Batteries, 240A Alternator, Engine RPM Speed Control and the Ford Programmable Battery Guard
Additional	
GV	2 Tonne Towing Capability — Only available on Van, 125Ps and 155PS engines

It is necessary to take into account the anticipated usage of the modified vehicle in order to choose the appropriate specification of the base vehicle.

Availability of options will vary on territories.

*Not to be ordered with tachograph, as uses the same 1 DIN console.

**Not available with A607

1.4.2 Conversion Type - Reference Tables

NOTE: The following tables are for guidance only. Full reference to the Body and Equipment Mounting Manual (BEMM) should be made prior to starting any conversion.

NOTE: For any conversions requiring electrical power:

Refer to: 4.2 Communications Network (page 90).
Refer to: 4.17 Fuses and Relays (page 172).

The BEMM contains general and specific recommendations covering conversions to the new Transit range of vehicles. To assist users locate information by conversion type the following tables contain the relevant links within this Manual.

Chassis Cab Conversion	
Van Conversion / Multi Purpose Vehicle Conversions	Refer to: 1.13 Package and Ergonomics (page 29).
	Refer to: 1.16 Towing (page 43).
	Refer to: 3.7 Fuel System (page 73).
	Refer to: 4.4 Battery and Cables (page 102).
	Refer to: 4.18 Special Conversions (page 176).
	Refer to: 4.19 Electrical Connectors and Connections (page 178).
	Refer to: 4.18 Special Conversions (page 176).
	Refer to: 4.20 Grounding (page 206).
	Refer to: 5.15 Frame and Body Mounting (page 269). Rear Seat Fixings Positions.
	Refer to: 5.13 Roof (page 265). Roof Racks.

Refrigerated Vehicles	
Van Conversion	Refer to: 1.8 End of Life Vehicle (ELV) Directive (page 23).
	Refer to: 4.4 Battery and Cables (page 102). Generator and Alternator.
	Refer to: 4.5 Climate Control System (page 132).
	Refer to: 4.17 Fuses and Relays (page 172).
	Refer to: 5.13 Roof (page 265). Roof Racks.
Compressor Installation	Refer to: 3.3 Accessory Drive (page 65).

Dry Freight	
Box Van	Refer to: 4.4 Battery and Cables (page 102). Generator and Alternator.
	Refer to: 4.9 Tachograph (page 143).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 239).
	Refer to: 4.12 Exterior Lighting (page 155).
	Refer to: 4.18 Special Conversions (page 176). Auto Wipe and Auto Light for Vehicles with Large Over-Hangs
Pantechnicon	Refer to: 4.4 Battery and Cables (page 102). Generator and Alternator.
	Refer to: 4.9 Tachograph (page 143).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 239).
	Refer to: 4.12 Exterior Lighting (page 155).
	Refer to: 4.18 Special Conversions (page 176). Auto Wipe and Auto Light for Vehicles with Large Over-Hangs
Money Carriers	Refer to: 4.4 Battery and Cables (page 102). Generator and Alternator.
	Refer to: 4.9 Tachograph (page 143).
	Refer to: 5.13 Roof (page 265).
	Refer to: 4.12 Exterior Lighting (page 155).
Refuse Collection	Refer to: 4.4 Battery and Cables (page 102). Generator and Alternator.
	Refer to: 4.9 Tachograph (page 143).
	Refer to: 4.12 Exterior Lighting (page 155).

Emergency Services	
Ambulance (Front Line) / *Fire Brigade / *Armed Forces / *Police	Refer to: 3.2 Engine Cooling (page 63). Airflow Restrictions.
	Refer to: 4.4 Battery and Cables (page 102). Generator and Alternator.
	Refer to: 4.12 Exterior Lighting (page 155).
	Refer to: 4.13 Interior Lighting (page 166).
	Refer to: 4.17 Fuses and Relays (page 172).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 239).
	Refer to: 5.9 Seats (page 257).
	Refer to: 5.11 Airbag Supplemental Restraint System (SRS) (page 261).
	Refer to: 4.18 Special Conversions (page 176). Auto Wipe and Auto Light for Vehicles with Large Over-Hangs

Vocational Conversion	
Mobile Workshops	Refer to: 4.4 Battery and Cables (page 102). Generator and Alternator.
	Refer to: 4.9 Tachograph (page 143).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 239).
	Refer to: 5.3 Racking Systems (page 243).
	Refer to: 5.13 Roof (page 265). Roof Racks.
	Refer to: 4.18 Special Conversions (page 176). Auto Wipe and Auto Light for Vehicles with Large Over-Hangs
Mobile Shops / Offices	Refer to: 4.4 Battery and Cables (page 102). Generator and Alternator.
	Refer to: 4.9 Tachograph (page 143).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 239).
	Refer to: 5.3 Racking Systems (page 243).
	Refer to: 5.13 Roof (page 265). Roof Racks.
	Refer to: 4.18 Special Conversions (page 176). Auto Wipe and Auto Light for Vehicles with Large Over-Hangs
Glass Carrying	Refer to: 4.4 Battery and Cables (page 102). Generator and Alternator.
	Refer to: 4.9 Tachograph (page 143).
	Refer to: 5.1 Body (page 214). Racking System.
Racking Conversions	Refer to: 4.4 Battery and Cables (page 102). Generator and Alternator.
	Refer to: 4.9 Tachograph (page 143).
	Refer to: 5.3 Racking Systems (page 243).
Recovery Vehicles	Refer to: 4.4 Battery and Cables (page 102). Generator and Alternator.
	Refer to: 4.9 Tachograph (page 143).
	Refer to: 5.15 Frame and Body Mounting (page 269).
	Refer to: 4.18 Special Conversions (page 176). Auto Wipe and Auto Light for Vehicles with Large Over-Hangs

Passenger Carrying	
Taxi	Refer to: 1.2 Commercial and Legal Aspects (page 8). Restraints System.
	Refer to: 4.12 Exterior Lighting (page 155).
	Refer to: 4.13 Interior Lighting (page 166).
	Refer to: 5.9 Seats (page 257).
	Refer to: 5.10 Glass, Frames and Mechanisms (page 259).
	Refer to: 5.13 Roof (page 265).
	Refer to: 5.11 Airbag Supplemental Restraint System (SRS) (page 261).
Mobility	Refer to: 5.2 Hydraulic Lifting Equipment (page 239).
	Refer to: 4.12 Exterior Lighting (page 155).
	Refer to: 4.13 Interior Lighting (page 166).
	Refer to: 5.9 Seats (page 257).
	Refer to: 5.10 Glass, Frames and Mechanisms (page 259).
	Refer to: 5.13 Roof (page 265).
	Refer to: 5.11 Airbag Supplemental Restraint System (SRS) (page 261).
Coach Built	Refer to: 5.2 Hydraulic Lifting Equipment (page 239).
	Refer to: 4.9 Tachograph (page 143).
	Refer to: 4.12 Exterior Lighting (page 155).
	Refer to: 4.13 Interior Lighting (page 166).
	Refer to: 5.9 Seats (page 257).
	Refer to: 5.10 Glass, Frames and Mechanisms (page 259).
	Refer to: 5.13 Roof (page 265).
	Refer to: 5.11 Airbag Supplemental Restraint System (SRS) (page 261).
Wheelchair Accessible	Refer to: 5.2 Hydraulic Lifting Equipment (page 239).
	Refer to: 4.12 Exterior Lighting (page 155).
	Refer to: 5.9 Seats (page 257).
	Refer to: 5.10 Glass, Frames and Mechanisms (page 259).
	Refer to: 5.13 Roof (page 265).
	Refer to: 5.11 Airbag Supplemental Restraint System (SRS) (page 261).
	Refer to: 4.12 Exterior Lighting (page 155).
	Refer to: 4.13 Interior Lighting (page 166).
	Refer to: 5.9 Seats (page 257).
	Refer to: 5.11 Airbag Supplemental Restraint System (SRS) (page 261).
Mini Bus	Refer to: 5.2 Hydraulic Lifting Equipment (page 239).
	Refer to: 4.12 Exterior Lighting (page 155).
	Refer to: 4.13 Interior Lighting (page 166).
	Refer to: 5.9 Seats (page 257).
	Refer to: 5.10 Glass, Frames and Mechanisms (page 259).
	Refer to: 5.13 Roof (page 265).
	Refer to: 5.11 Airbag Supplemental Restraint System (SRS) (page 261).

1.5 Conversion Homologation

The Vehicle Converter must observe any statutory rules and regulations. When the conversion needs a new approval the following information must be quoted.

- All dimensional, weight and center of gravity data.
- The fixing of the body to the donor vehicle.
- Operating conditions.

The responsible Technical Service may require additional information and/or testing.

NOTE: For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

For additional information on vehicle type approval

Refer to: 1.2 Commercial and Legal Aspects (page 8).

1.6 Electromagnetic Compatibility (EMC)

WARNINGS:

Your vehicle has been tested and certified to European legislation relating to electromagnetic compatibility (72/245/EEC, UN ECE Regulation 10). It is your responsibility to make sure that any equipment fitted complies with applicable local legislation. Make sure any equipment is fitted by an authorized dealer.

Radio Frequency (RF) transmitter equipment (for example: cellular telephones, amateur radio transmitters) may only be fitted to your vehicle if they comply with the parameters shown in the 'Frequency Overview' table. There are no special provisions or conditions for installations or use.

Do not mount any transceiver, microphones, speakers, or any other item in the deployment path of the airbag system.

Do not fasten antenna cables to original vehicle wiring, fuel pipes and brake pipes.

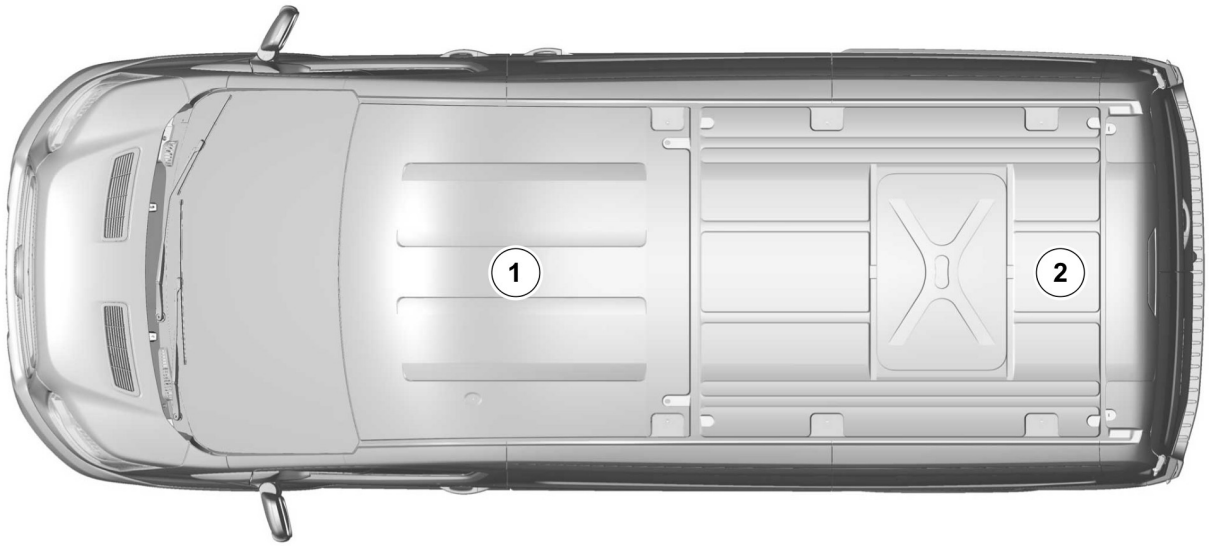
Keep antenna and power cables at least 100mm from any electronic modules and airbags.

NOTE: Only fit the antenna in the positions shown to the roof of your vehicle.

Frequency Overview

Frequency Band MHz	Maximum Output Power Watts (Peak RMS)	Antenna Position
1 - 30	50W	2
30 - 54	50W	1, 2
68 - 87.5	50W	1, 2
142 - 176	50W	1, 2
380 - 512	50W	1, 2
806 - 940	10W	1, 2
1200 - 1400	10W	1, 2
1710 - 1885	10W	1, 2
1885 - 2025	10W	1, 2

1.6.1 Permitted Antenna Location



E167532

NOTE: After the installation of RF transmitters, check for disturbances from and to all electrical equipment in the vehicle, both in the standby and transmit modes.

Check all electrical equipment:

- With ignition **ON.**
- With the engine running.
- During a road test at various speeds.

Check that electromagnetic fields generated inside the vehicle cabin by the transmitter installed do not exceed applicable human exposure requirements.

1.7 Vehicle Duty Cycle Guidelines

It is necessary to take into account the customer usage profile and the anticipated vehicle duty cycles of the modified vehicle in order to choose the appropriate specification of the base vehicle.

It is necessary to select the appropriate drive, engine, gear ratio, gross vehicle mass, gross train mass, axle plates and payloads of the base vehicle to match the customer requirements.

Where possible make sure that the base vehicle is ordered with any necessary plant fit options.

NOTE: For further information contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

A high numeric gear ratio is recommended for vehicles with customer requirements for:

- High payload.
- Trailer tow.
- Frequent stop-and-go cycles.
- High altitude and gradients.
- Terrain conditions such as found on building and construction sites.

1.7.1 Conversion Affect on Fuel Economy and Performance

Any conversion may affect the fuel consumption and performance depending on the aerodynamics and the weight added by the conversion. The published information for fuel consumption and performance of the base vehicle therefore may not be valid. It is advisable to control the weight, but without deteriorating other vehicle attributes and functions (especially those related to safety and durability).

1.7.2 Vehicle Ride and Handling Attributes

CAUTION: Do not exceed the axle plate, gross vehicle mass, trailer plate and gross trailer mass limits.

Due to the displacement of the center of gravity occurred by the conversion the ride and handling attributes may be different to the base vehicle.

NOTE: This vehicle should be evaluated for safe operation prior to sale.

1.8 End of Life Vehicle (ELV) Directive

The European End-of-Life Vehicle (ELV) directive requires that environmental and recycling aspects are integrated in the development process of new components and vehicles. This includes requirements with respect to:

- The overall recyclability (85%)/recoverability (95%) of vehicles.
- Limited use of hazardous substances including the elimination of prohibited substances such as lead, hexavalent chromium cadmium and mercury).
- Publication of dismantling information.
- Parts Marking according to the corresponding ISO Standards: ISO 1043-1, 1043-2 and 11469 for plastics and ISO 1629 for rubber materials.
- Increasing use of recycled materials.
- Producers meet all, or a significant part of, the costs to take back End-of-Life Vehicles.

In addition to the requirements resulting from the End-of-Life directive other environmental targets should be taken into consideration such as:

- Minimizing costs and environmental burden along the product life-cycle.
- Maximizing use of renewable materials e.g. natural fibers.
- Minimizing the presence of substances impacting vehicle interior air quality/clean compartment or allergenic reactions (please refer to 'Technischer Überwachungsverein TÜV TOXPROOF). This refers to aspects like smell, fogging, toxicity and allergy coming from material in the interior.
- Eliminate use of prohibited substances which are listed in the Global Automotive Declarable Substance List (GADSL) at http://www.gadsl.org

For continued legal compliance and environmental performance of all Ford products it is essential that any conversion of the vehicles is in compliance with the requirements listed above.

This is not a complete list of all legal requirements to be met by every converted vehicle.

NOTE: For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

1.9 Jacking

WARNINGS:

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.

You must use the specific jacking points.

CAUTION: Make sure that access to the spare wheel is maintained when converting the vehicle or relocating the spare wheel.

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

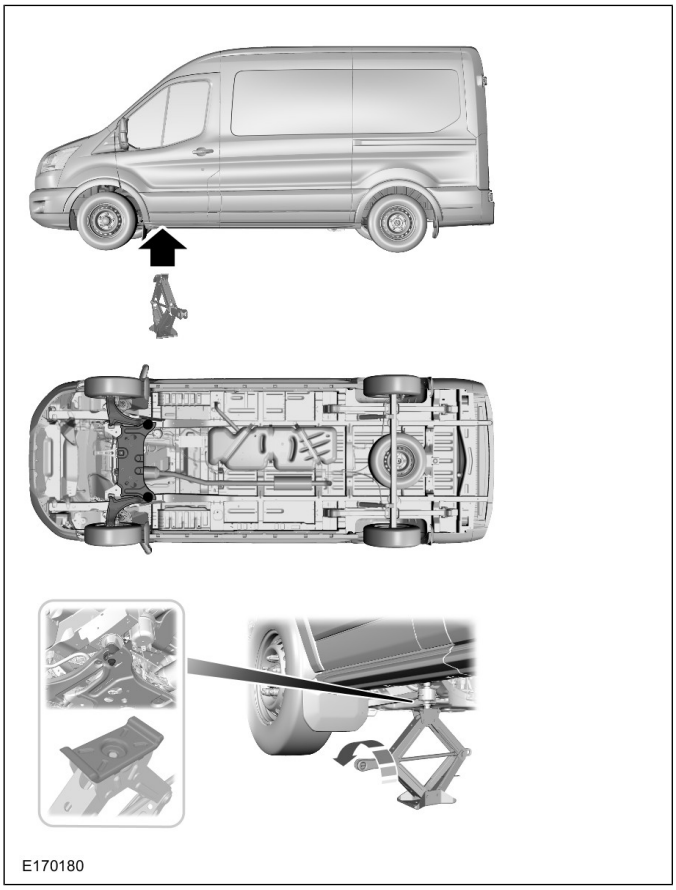
NOTE: Make sure that reinforcements are installed to maintain the integrity of the original body structure for/at jacking points.

NOTE: Any modifications to the vehicle must be noted in the owner's handbook or new descriptive literature included with the owner's documentation.

1.9.1 Front Jacking Points

NOTE: If your vehicle has rear air conditioning make sure the vehicle jack does not come in contact with the air conditioning lines.

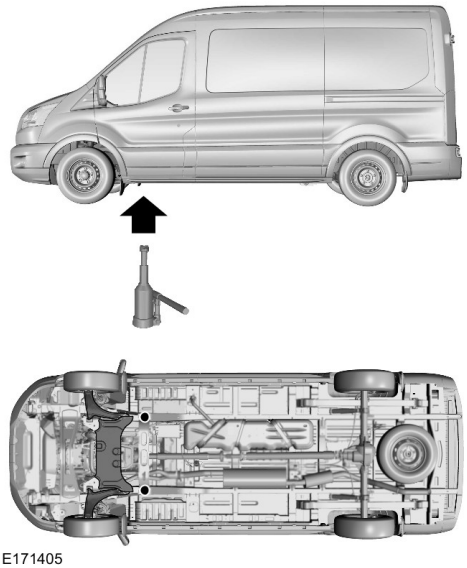
Front Wheel Drive vehicles and Rear Wheel Drive Vehicles up to T370



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Position the head of the vehicle jack under the front sub-frame rear mounting bolts.

Rear Wheel Drive Vehicles T410 and Over

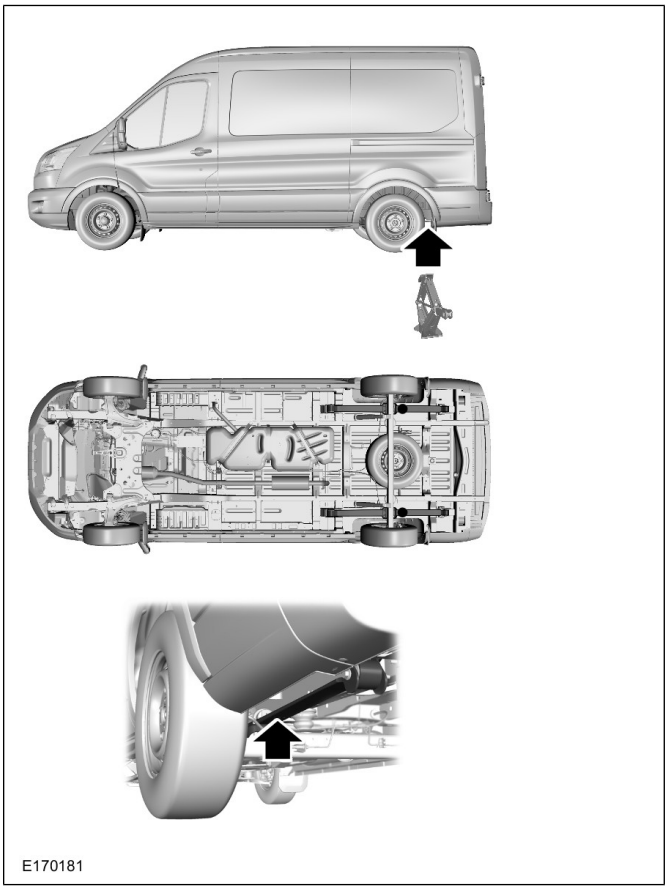


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Position the head of the vehicle jack under the protrusions at the rear of front sub-frame.

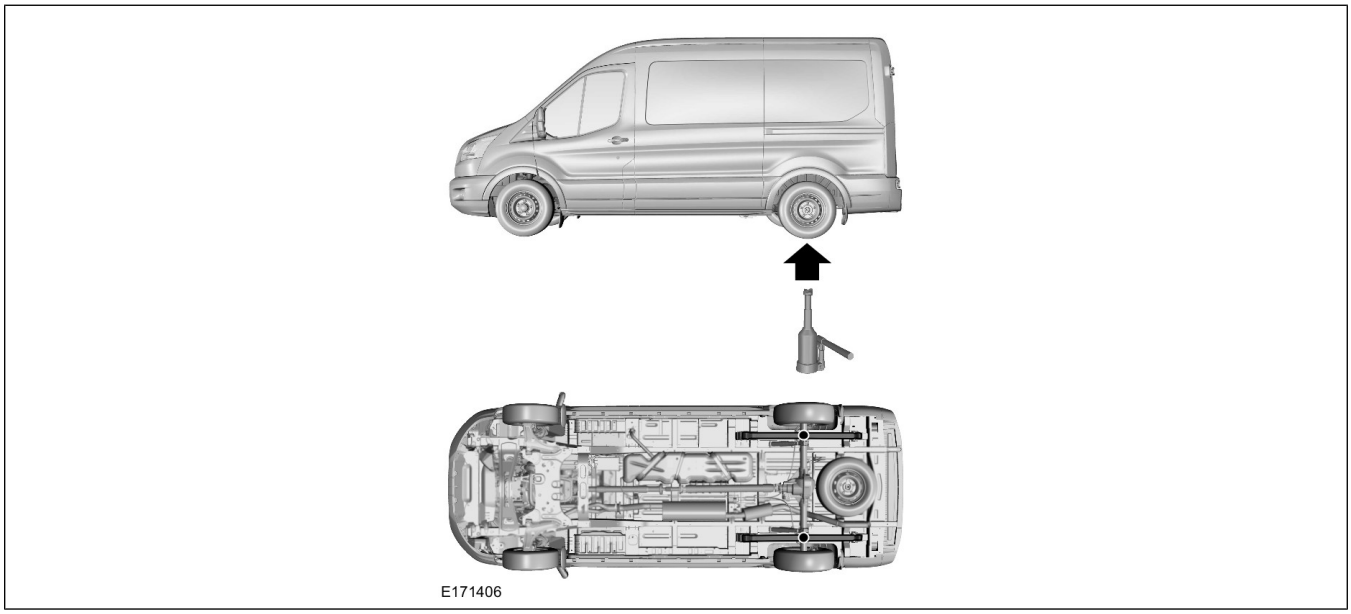
1.9.2 Rear Jacking Points

Front Wheel Drive Vehicles and Rear Wheel Drive Vehicles up to T370



Position the head of the vehicle jack under the rear leaf spring directly behind the rear wheel.

Rear Wheel Drive Vehicles T410 and Over



Position the head of the vehicle jack under the rear axle.

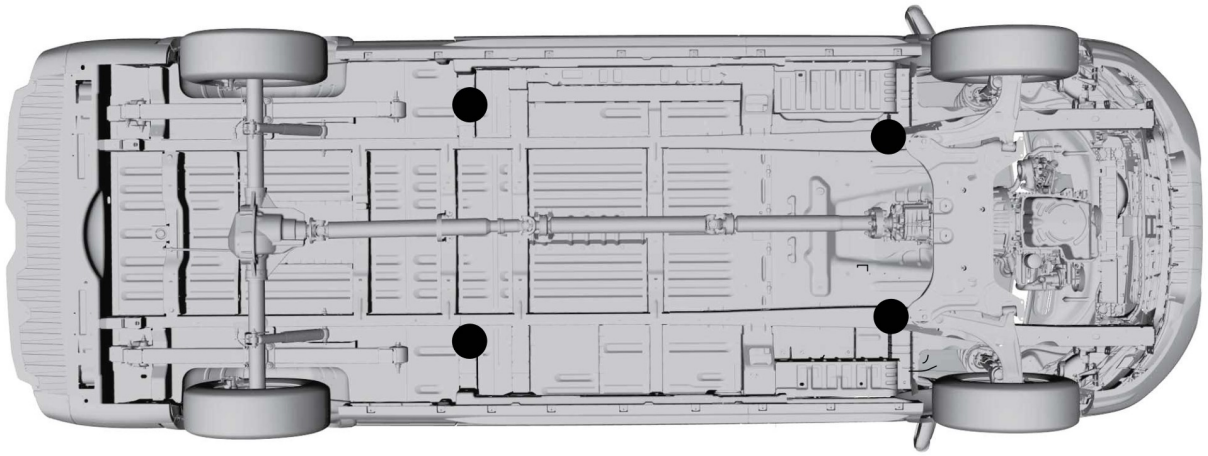
1.10 Lifting

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:

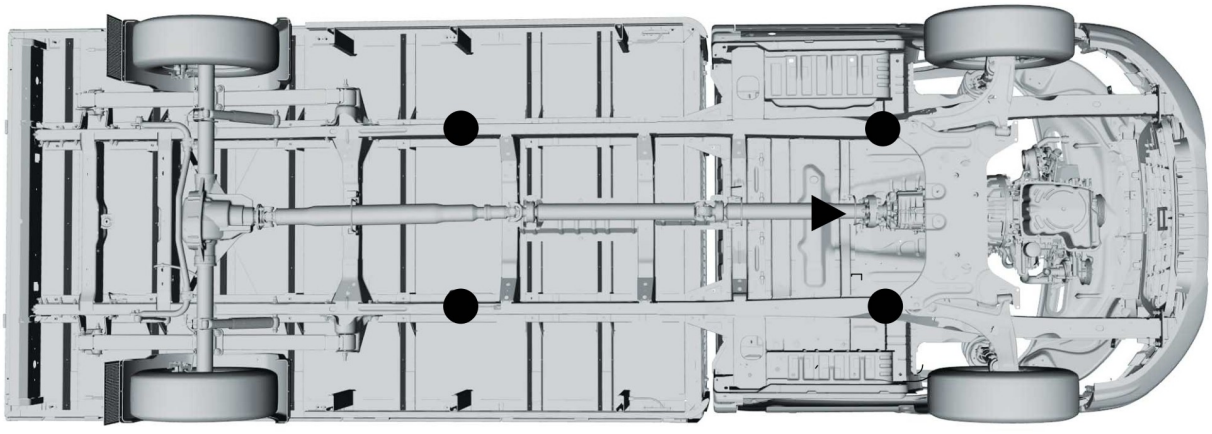
- **When lifting the vehicle with two post lift, vehicle lift arm adapters must be used under the lifting points.**
- **When lifting the vehicle with a two post lift, the maximum kerb weight must not be exceeded.**
- **It is important that only the correct lifting and support locations are used at all times.**

Lifting Points - Van, Bus and Kombi



E175927

Lifting Points - Chassis Cabs



E175928

1.11 Noise, Vibration and Harshness (NVH)

WARNING: Make sure that the modified vehicle complies with all relevant legal requirements.

CAUTION: The travel and function of pedals must not be restricted.

Changes to the powertrain, engine, transmission, exhaust, air intake system or tires may influence the exterior noise emission. Therefore the exterior noise level of the converted vehicle has to be verified.

The interior noise levels should not be deteriorated by the conversion. Reinforce panels and structures as appropriate to avoid vibrations. Consider the usage of sound deadening material on panels.

1.12 Vehicle Transportation Aids and Vehicle Storage

CAUTIONS:

Disconnect the battery if the vehicle is to be stored for more than 7 days.

Make sure that the protective covers are not removed from an incomplete vehicle until the conversion is started.

Make sure that components removed during conversion are kept clean and dry.

Make sure that components removed during conversion are refitted to the same vehicle.

In addition:

- The windscreen wipers should be lifted off the glass and set right up.
- All air intakes should be closed.
- Increase normal tire pressure by 0.5 bar.
- The hand brake system should not be used.
- Apply suitable wheel chock to prevent roll away.

A significant risk during storage is deterioration of vehicle bodywork, therefore, appropriate storage procedures must be observed, including periodic inspection and maintenance.

Claims arising from deterioration caused by incorrect storage, maintenance or handling are not the responsibility of Ford.

Vehicle Converters must determine their own procedures and precautions, particularly where vehicles are stored in the open as they are exposed to any number of airborne contaminants.

The following may be considered a sensible approach to storage:

Short Term Storage:

- Wherever possible vehicles should be stored in an enclosed, dry, well-ventilated area based on firm, well drained ground which is free of long grass or weeds and where possible protected from direct sunlight.
- Vehicles must not be parked near, under foliage or close to water as additional protection may be necessary for certain areas.

Long term storage:

- Battery to be disconnected, but not removed from the vehicle.
- The wiper blades should be removed and placed inside the vehicle. Make sure the wiper arms are suitably prevented from resting on the windscreen.
- Wheel trims (where fitted) removed and stored in the luggage compartment.
- Engage first gear and release the parking brake completely. Chock the wheels first if the vehicle is not on level ground.
- Set climate controls to the "open" position to provide ventilation, where possible.
- Where protective film has been applied in manufacture it must be left on the vehicle until prepared for delivery but must be removed after a maximum storage period of six months (film is date stamped to indicate required removal date).
- Make sure that all windows, doors, hood, lift gate, tailgate, luggage compartment lid, convertible top and roof opening panel are completely closed and the vehicle is locked.

The Pre Delivery Inspection (PDI) is the final opportunity to make sure a battery is fit for purpose prior the customer taking delivery of their new vehicle. The battery must be checked and appropriate action taken prior to the vehicle being handed over to the customer. Test results must be recorded on the PDI repair order.

Batteries. To make sure the battery is maintained correctly and to assist in preventing premature failure, it is necessary to check and recharge the battery monthly while a vehicle is not in use. Where a battery is left below its optimum charge level for any length of time, it may result in premature failure of the battery.

Action / Time in Storage	Monthly	Every 3 Months
Check Vehicle is clean	X	-
Remove external contamination	X	-
Check battery condition — Recharge if necessary	X	-
Visually check tires	X	-
Check interior for condensation	-	X
Run engine for 5 minutes minimum with air conditioning switched on, where applicable	-	X

Refer to: 4.4 Battery and Cables (page 102).

1.13.1 General Component Package Guidelines

WARNING: Do not modify, drill, cut or weld any suspension components, specifically the steering gear system, subframe or anti-roll bars, springs or shock absorbers including mounting brackets.

The Vehicle Converter has to ensure that sufficient clearance is maintained under all drive conditions to moving components such as axles, fans, steering, brake system etc.

The Vehicle Converter is responsible for all installed components during the conversion. The durability has to be confirmed by appropriate test procedures.

1.13.2 Driver Reach Zones

Controls and/or equipment required to be used while driving should be located within easy reach of the driver so as not to impair driver control.

1.13.3 Driver Field of View

WARNING: Make sure that the modified vehicle complies with all relevant legal requirements.

1.13.4 Conversion Affects on Parking Aids

WARNING: Ensure that monitors mounted in the cabin meet the interior package and safety requirements.

On conversions requiring a rear camera, the reverse signal may be taken as described in the electrical section, described in reversing lamps.

Refer to: 4.12 Exterior Lighting (page 155).

1.13.5 Aids for Vehicle Entry and Exit

Steps

WARNINGS:

Make sure that the modified vehicle complies with all relevant legal requirements.

If this modification alters the homologated dimensions, a new approval may be necessary.

CAUTION: Make sure that reinforcements are installed to maintain the integrity of the original body structure.

Power side steps can be ordered as an option on the base vehicle. Please check for availability.

Where additional steps are installed the required ground clearance line is to be maintained.

The Vehicle Converter must make sure that a movable step is set in the stored position when the vehicle is running. The step surface must be non-slip.

Grab Handles

WARNING: Make sure that the location of the no-drill zones are checked before drilling.

CAUTION: Make sure that reinforcements are installed to maintain the integrity of the original body structure.

Grab handles can be ordered as an option on the base vehicle. Please check for availability.

NOTE: For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

1.13.6 Front, Rear and Side Under-run Protection

WARNING: Check local legislation for legal requirements.

Front Under run Protection must be designed to directive ECE 93* or 2000/40 EC* or applicable local legislation.

Rear Under run Protection must be designed to directive ECE 58* or 70/221 EC* or applicable local legislation.

Side Under run Protection must be designed to directive ECE 73* or 89/297 EC* or applicable local legislation.

*As amended periodically

1.13.7 Vehicle Dimensions Key

Van, Bus, Kombi			
Wheelbase	**Overall Length (mm)**	**Overall Height (mm)**	
		H2	H3
L2 - 3300	5531	2490 - 2550	2729 - 2789
L3 - 3750	5981	2481 - 2547	2720 - 2786
L4 - 3750	6704	-	2746 - 2781

Transit Motorhome Chassis - H1		
Wheelbase	**Overall Length (mm)**	**Overall Height (mm)**
L2 - 3300	5321	2180
L3 - 3750	5771	2173
L4 - 3954	5975	2172

Wheelbase	**Overall Length (mm)**		**Overall Height (mm)**
	Without Float	**With Float**	
Single Chassis Cab - H1			
L1 - 3137	5205	5357	2192 - 2219
L2 - 3504	5572	5767	2176 - 2214
L3 - 3954	6022	6204	2183 - 2207
L4 - 3954	6579	6797	2183 - 2207
L5 - 4522	7577	7797	2195 - 2197
Double Chassis Cab - H1			
L2 - 3504	5572	5767	2203 - 2227
L3 - 3954	6022	6204	2203 - 2218
L4 - 3954	6404	6587	2208 - 2220
L5 - 4522	7394	7612	2198 - 2211

All dimensions are subject to manufacturing tolerances and refer to minimum specification models and do not include additional equipment.

Height dimensions show the range for the minimum to maximum weight range and are for guidance only.

Depending on the body style, Transit is available in 5 Wheelbases and 3 Roof Heights

Wheelbases:

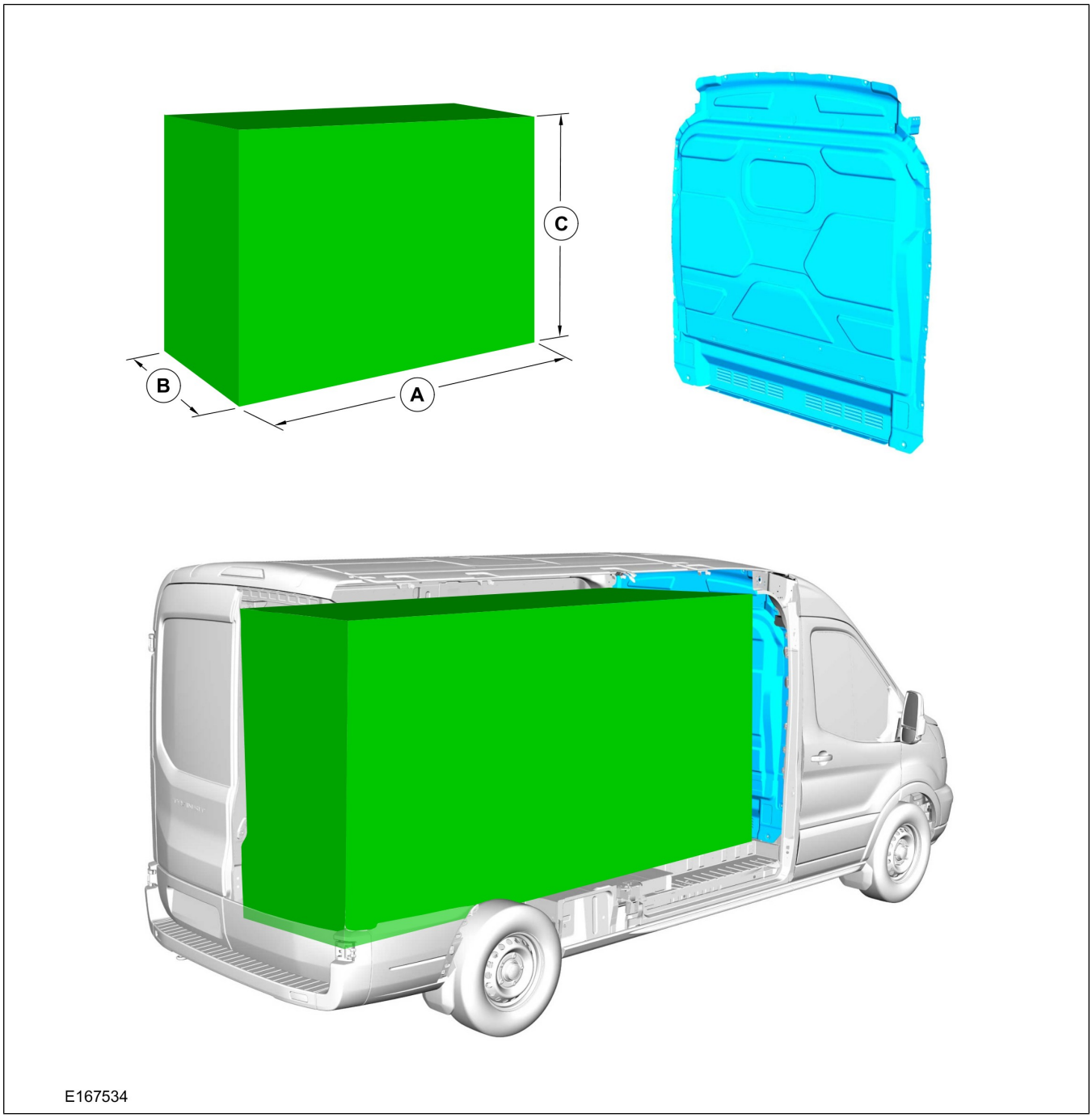
- Short Wheelbase (L1)
- Medium Wheelbase (L2)
- Long Wheelbase (L3)
- Long Wheelbase Extended Frame (L4)
- Extra Long Wheelbase Extended Frame (L5)

Roof Heights:

- Low (H1)
- Medium (H2)
- High (H3)

1.13.8 Recommended Main Load Area Dimensions

H2 - Medium Roof Height - Full Bulkhead - Fixed/Glazed

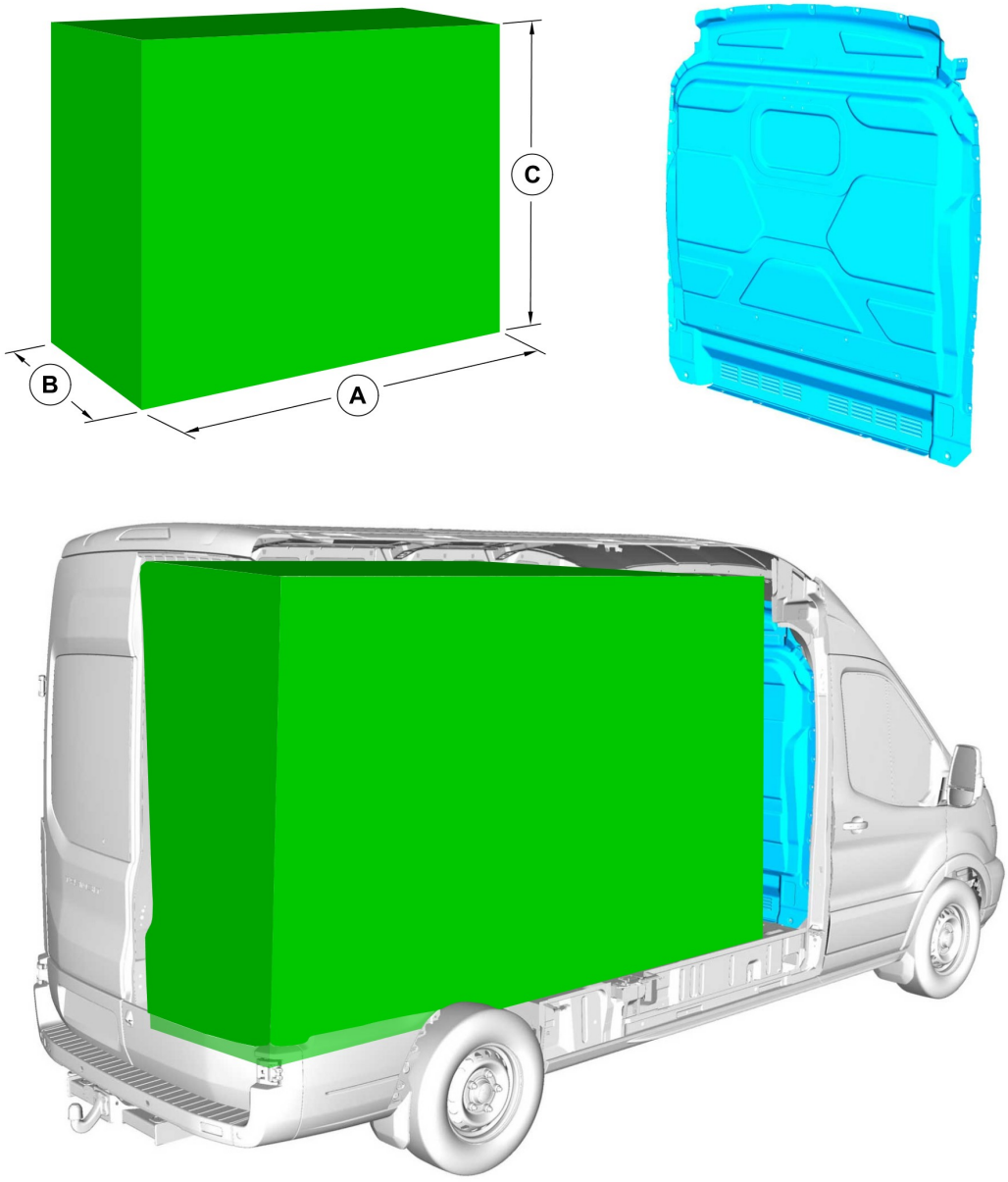


Vehicle	A (mm)	B (mm)	C (mm)
L2 - H2 FWD SRW	2872	1392	1700
L2 - H2 RWD SRW	2872	1392	1600
L3 - H2 FWD SRW	3322	1392	1700
L3 - H2 RWD SRW	3322	1392	1600

L2 = 3.3m Wheel Base, L3 = 3.75m Wheel Base, L4 = 3.75m Wheel Base

FWD = Front Wheel Drive, RWD = Rear Wheel Drive, SRW = Single Rear Wheel

H3 - High Roof Height - Full Bulkhead - Fixed/Glazed



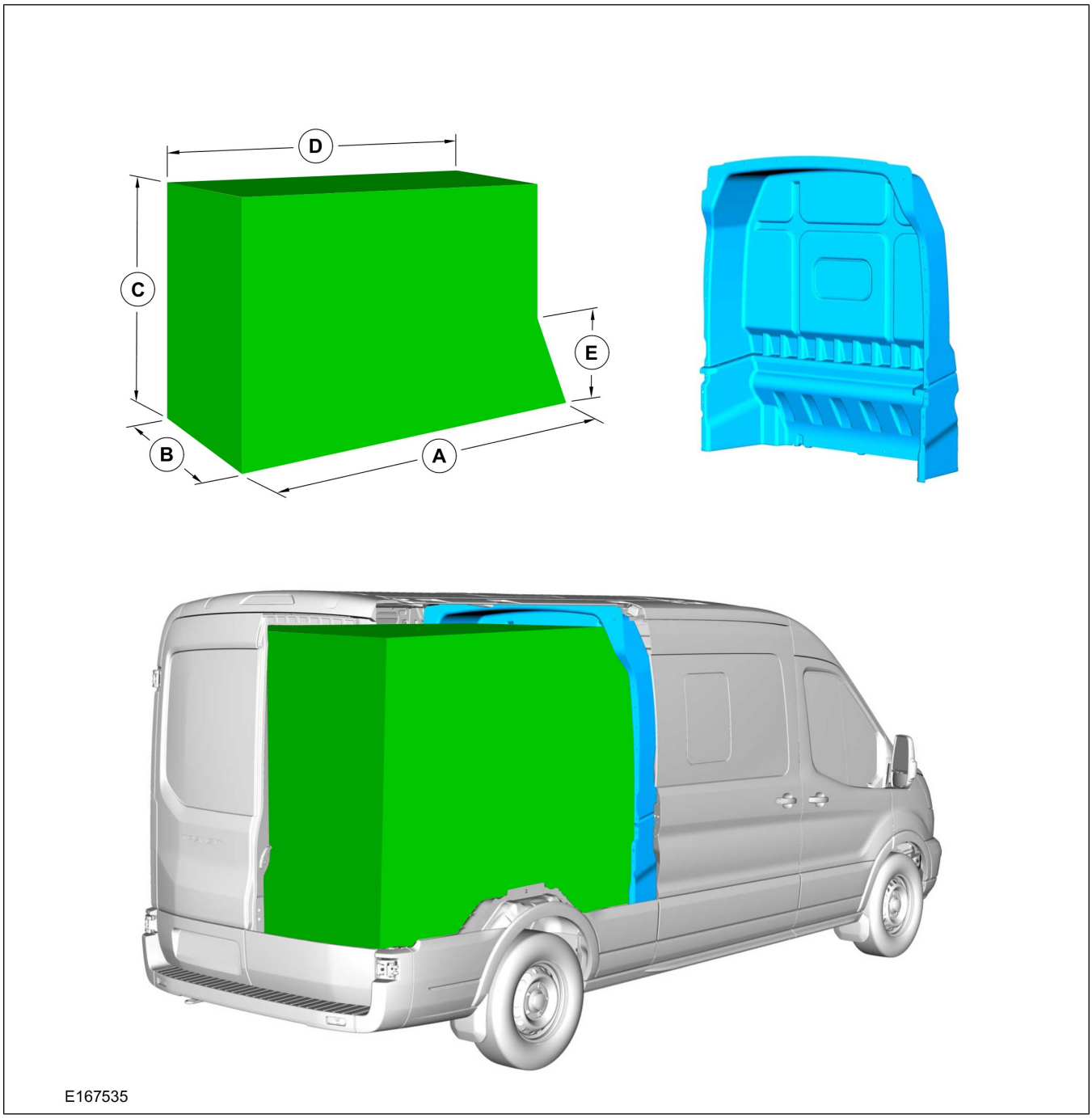
E167533

Vehicle	A (mm)	B (mm)	C (mm)
L2 - H3 FWD SRW	2877	1386	1925
L2 - H3 RWD SRW	2877	1386	1825
L3 - H3 FWD SRW	3327	1386	1925
L3 - H3 RWD SRW	3327	1386	1825
L4 - H3 RWD SRW	4050	1386	1825
L4 - H3 RWD DRW	4064	1154	1868

L2 = 3.3m Wheel Base, L3 = 3.75m Wheel Base, L4 = 3.75m Wheel Base

FWD = Front Wheel Drive, RWD = Rear Wheel Drive, SRW = Single Rear Wheel, DRW = Dual Rear Wheels

H2 - Medium Roof Height - Double Cab in Van Full Bulkhead - Fixed/Glazed

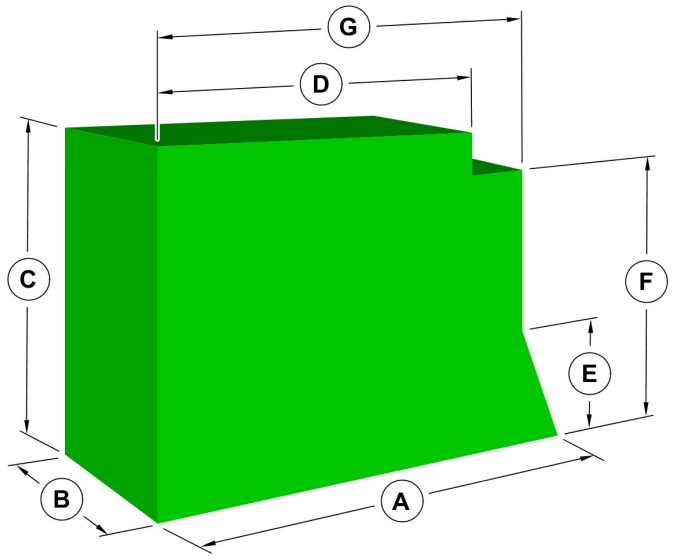


Vehicle	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)
L2 - H2 FWD	2038	1392	1818	1789	520
L2 - H2 RWD	2038	1392	1718	1789	520
L3 - H2 FWD	2488	1392	1818	2239	520
L3 - H2 RWD	2488	1392	1718	2239	520

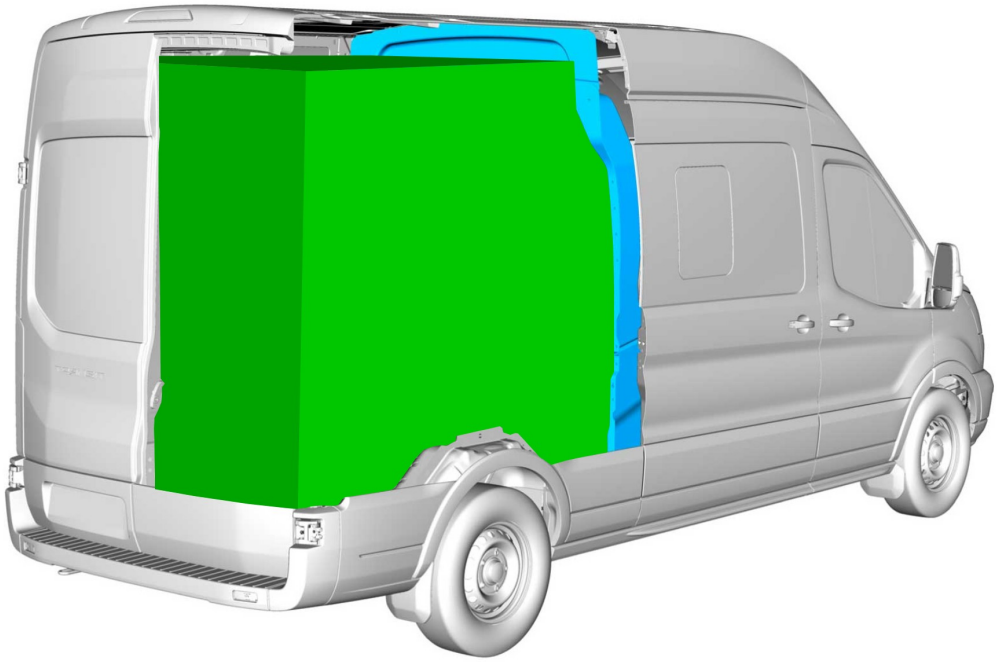
L2 = 3.3m Wheel Base, L3 = 3.75m Wheel Base

FWD = Front Wheel Drive, RWD = Rear Wheel Drive

H3 - High Roof Height - Double Cab in Van Full Bulkhead - Fixed/Glazed







E167536

Vehicle	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)
L2 - H3 FWD	2038	1392	2055	1439	520	1798	1788
L2 - H3 RWD	2038	1392	1955	1439	520	1698	1788
L3 - H3 FWD	2488	1392	2055	1889	520	1798	2238
L3 - H3 RWD	2488	1392	1955	1889	520	1698	2238
L4 - H3 RWD SRW	3211	1392	1955	2612	520	1698	2961
L4 - H3 RWD DRW	3211	1154	1955	2612	520	1698	2961

L2 = 3.3m Wheel Base, L3 = 3.75m Wheel Base

FWD = Front Wheel Drive, RWD = Rear Wheel Drive, SRW - Single Rear Wheel, DRW - Dual Rear Wheel

1.13.9 Chassis Cab Body

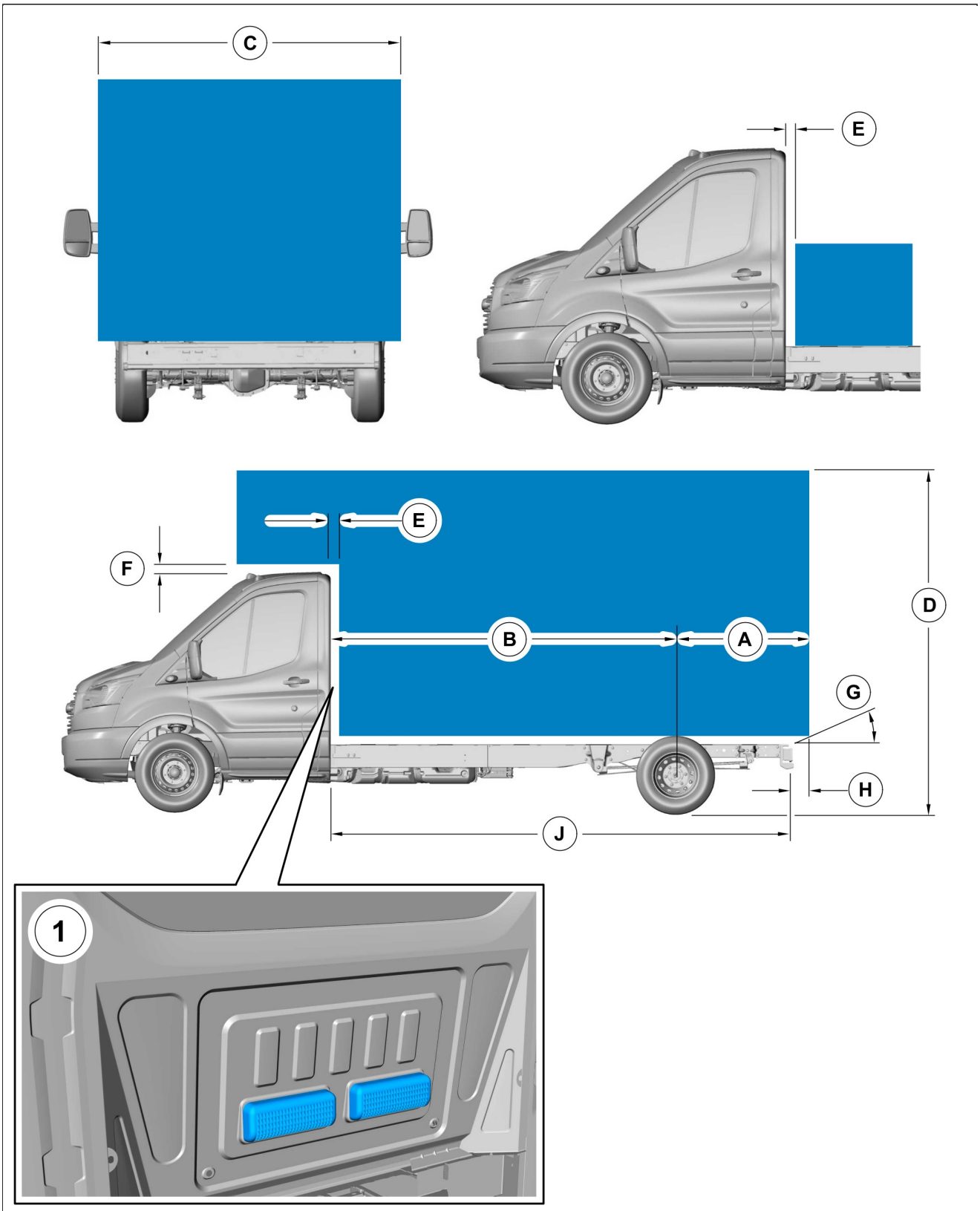
WARNINGS:

Do not modify the wheelbase or add any type of frame extension to vehicles fitted with ESC.

Do not allow Center of Gravity of the body payload to fall behind the rear axle center line.

NOTE: Extreme rear overhang may encourage unacceptable loading conditions, which could unload the front axle producing unacceptable handling and braking characteristics.

NOTE: When extending the length of the frame rearward of the rear axle, limit the overall rear overhang to a maximum of 50% of the wheelbase of the donor vehicle.



E175789

Description			L1	L2	L3	L4	L5
A	Maximum recommended rear overhang		Maximum 50% of the wheelbase considering CoG of (second unit) body and payload is not rearwards of rear axle centerline and considering the requirements of masses and dimensions regulation				
B	Back of cab to rear axle	Single Cab	1730mm	2097mm	2547mm	2547mm	3115
		Double Cab	-	1282	1732	1732	2300
C	Maximum external body width	Short Mirror Arms	2200mm				
		Long Mirror Arms	Maximum widths of up to 2400mm*				
D	Maximum recommended external overall height RWD and FWD		3300mm without exceeding the maximum CoG height. See Load Distribution section in this manual for CoG Position				
E	30mm minimum clearance between the back of the cab and the second unit body						
F	30mm						
G	Ensure local lighting legislation is maintained						
H	Under run bar and towing attachment legislation to be maintained						
J	Frame length behind back of cab (not including rear light cross member)	Single Cab	2775mm	3142mm	3592mm	4149mm	5147
		Double Cab	-	2327	2777	3159	4149

NOTE: The frontal area (Width x Height) should NOT exceed 6.4m².

CoG = Center of Gravity

All dimensions are subject to manufacturing tolerances and refer to minimum specification models and do not include additional equipment. The illustrations are for guidance only.

* The maximum width of a vehicle conversion may be restricted below 2400mm in order to comply with installation of Lighting Regulation ECE R48 which specifies widths restrictions for mandatory light components. Fitting optional Front Fog Lamps restricts the vehicle width to 2375mm. For non-European Union territories, please refer to local legislation. For Austrialia and New Zeland, please refer to ADR13 vehicle regulations.

1.14 Hardware—Specifications

Material Specification, Strength and Torque

Standard Hardware and Tightening Torques (Nm) Bolts/Studs: ISO 898-1, Nuts: ISO 898-2						
	Grade 4.8		Grade 8.8		Grade 10.9	
Thread Size	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
M4	1.1	1.4	2.4	3.4		
M5	2.2	2.7	4.9	6.7		
M6	3.7	4.7	8.5	11.5	11.0	15.0
M8			20.0	28.0	25.0	35.0
M10			41.0	55.0	50.0	70.0
M12			68.0	92.0	95.0	125.0
M14			113	153	150	200
M16			170.0	230.0	230.0	310.0
M18			252.0	317.0	317.5	399.4
M20			345.0	430.0	434.7	541.8
M22			470.0	590.0	592.2	743.4
M24			600.0	750.0	756.0	945.0

This torque chart is a recommendation and the converter is responsible for the optimal torque for a specific joint.

1.15 Load Distribution

1.15.1 Load Distribution

CAUTIONS:

Do not exceed the axle plated weights.

Do not exceed the gross vehicle weight.

In front wheel drive (FWD) vehicles, the front axle load must, in all load cases, exceed 38% of the actual gross vehicle weight.

In rear wheel drive (RWD) single rear wheel (SRW) vehicles, the front axle load must, in all load cases, exceed 36% of the actual gross vehicle weight.

In RWD dual rear wheel (DRW) vehicles, the front axle load must, in all load cases, exceed 30% of the actual gross vehicle weight.

NOTE: Overloading of the vehicle could result in unacceptable ground clearance.

NOTE: The center of mass of the payload should be located within the wheelbase of the vehicle.

NOTE: Avoid one-sided load distribution.

NOTE: Uneven load distribution could result in unacceptable handling and braking characteristics.

NOTE: Load distribution outside of the permitted range may result in unacceptable steering, handling and braking characteristics.

For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

1.15.2 Center of Gravity Position

The position of the center of gravity is changed when masses are added or removed from the vehicle. This may influence the steering characteristics, handling behavior and the brake performance.

Lateral Position

It is important to keep the Center of Gravity laterally within given limits.

Lateral Center of Gravity is determined by the vertical wheel forces difference right (front right mass added to rear right mass) to left (front left mass added to rear left mass).

WARNING: The difference right to left must not exceed 4% (absolute difference right to left / total weight in per cent).

Vertical Position - Center of Gravity Height

The Center of Gravity Height of the vehicle is determined by the mass of the base delivered vehicle and the added and removed masses. In physics this relation is described by the Steiner's theorem.

The Center of Gravity Height influences axle weights while braking. Center of Gravity height influences roll stability. Safety systems will work properly within the center of gravity boundaries specified in the following warnings:

WARNINGS:

The following table shows maximum vertical center of gravity (CG_v) heights by vehicle type. If the CG_v is equal to or less than the values stated and no modifications have been made to the components of the braking system, suspension and/or wheels and tires, the converted vehicle complies with ECE 13-H, ANNEX 9 standard or ADR 31/ADR 35 or applicable local legislation.

If the CG_v of the converted vehicle is above the values stated Ford Motor Company makes no representation as to conformity with ECE 13-H, ANNEX 9 standard or ADR 31/ADR 35 or applicable local legislation.

Vehicle	Drive	Wheelbase	Maximum Vertical Center of Gravity (CG_v) Height
Van/Kombi	FWD	All *	850mm
Van/Kombi	RWD	L2	850mm
Van/Kombi	RWD	L3 and L4	1000mm
M2 Bus	RWD	All**	1000mm
Single Chassis Cab	FWD	All	850mm
Single Chassis Cab	RWD	All	1000mm
Double Chassis Cab	FWD	All	850mm
Double Chassis Cab	RWD	All	1000mm
Transit Motorhome Chassis	FWD	All	960mm

* When converted a Van, Kombi N1, Kombi M1, Kombi Van N1, Kombi Van M1 and Double Cab in Van vehicles with a gross vehicle mass of less than 3300kg are excluded from conformity with ECE 13-H ANNEX 9 standard or ADR 31/ADR 35.

** Except M2 Bus RWD SRW 440 LWB EL (L4) which has a Maximum Vertical Centre of Gravity Height of 950mm

1.15.3 Center of Gravity Height Test Procedure

Measurement

Vehicle shall be loaded according to test specifications specified in ECE13-H ANNEX 9 (Vehicle Mass) or ADR 31/ADR 35 or applicable local legislation.

In order to check the center of gravity height the following described method is proposed.

For this test four scales are required. The test is possible with two scales but this requires more preparation and it results in lower accuracy.

Initially the vehicle weights needs to be measured in a horizontal position. Afterwards the front is lifted and weights measured again. The higher it is lifted the more accurate the results will be. The height is restricted by different possible touch conditions, between vehicle parts and roof, ground and environment.

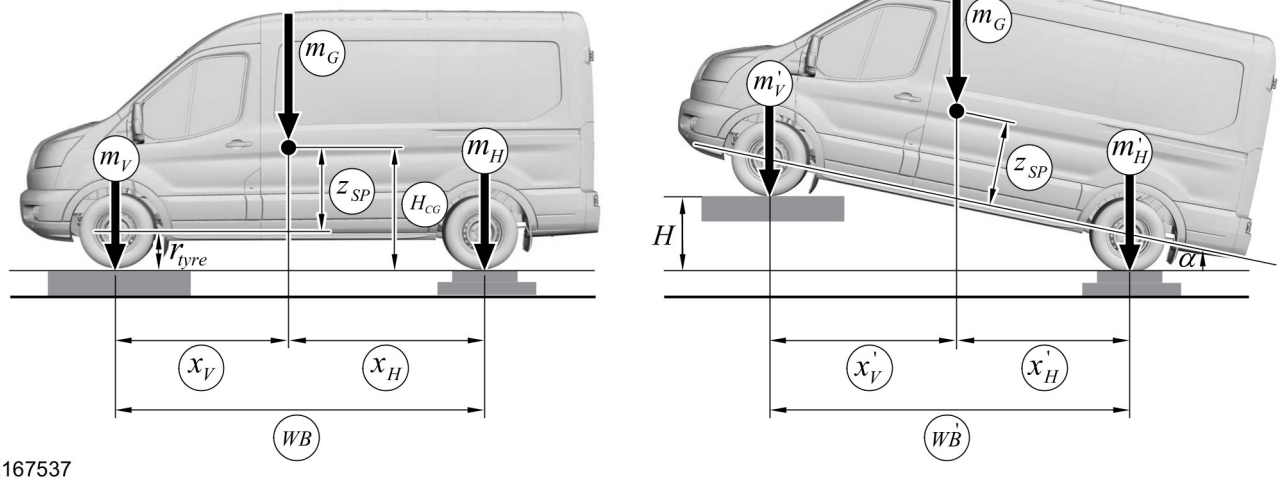
In order to improve measurements following preparations need to be done:

- Fix wheel travel, for example: solid shocks, or spring fixes.
- Increase tire pressure to maximum allowed value.
- It is important to remove all load, for example moving items, from the car or it should be properly fixed.
- Doors should be closed.

Before measuring the vehicle the engine must be switched off, after lifting it should be rolled freely in order to release tension in the tire and suspension.

Calculation

In order to estimate the resulting vertical center of gravity (CG_v) the axle load needs to be measured twice. First one is in the horizontal plane and the second measurement is after the front is lifted. To get a consistent result this test should be done 3 times independently with different heights. To improve accuracy the test is repeated with the rear end lifted.



E167537

Variables, to be measured, calculated or known			Measurement		
			1st	2nd	3rd
Wheelbase	WB	mm			
Front Axle Weight	m_V	kg			
Rear Axle Weight	m_H	kg			
Total Mass	$m_G = m_V + m_H$	kg			
INCLINED VEHICLE					
Front Axle Weight	m'_V	kg			
Rear Axle Weight	m'_H	kg			
Height (Lift)	H	mm			
Inclination Angle* see figure E146623		deg			
Center of Gravity Height Z** see figure E146624		mm			

***Inclination Angle:**

$$\alpha = \arcsin\left[\frac{H}{WB}\right].$$

E146623

****Center of Gravity Height Z:**

$$z_{SP} = \frac{m_H - m'_H}{m_G \cdot H} \cdot WB^2 \cdot \cos\alpha$$

$$z = H_{CG} = z_{SP} + r_{tyre}$$

E146624

1.15.4 Center of Gravity Height Calculation

Given or measured parameter	
Wheelbase	WB
Front axle weight	m_V
Rear axle weight	m_H
Front height	H

Calculated and auxiliary parameter	
Center of Gravity (CoG) height	Z_{SP}
Total vehicle mass	m_G
Distance front axle to CoG (horizontal)	X_V
Distance rear axle to CoG (horizontal)	X_H
Wheelbase (projected in horizontal)	RS'
Front axle weight	m'_V
Rear axle weight	m'_H
Distance front axle to CoG (projected in horizontal direction)	X'_V
Distance rear axle to CoG (projected in horizontal direction)	X'_H
Inclination angle	arc sin
Front part of 'distance rear axle to CoG (horizontal)'	X_{H1}
Rear part of 'distance rear axle to CoG (horizontal)'	X_{H2}

1.15.5 Formulas

- Masses and lengths. Total vehicle mass is the sum of front and rear axle weight:
- $m_G = m_V + m_H$

Taking the sum of moments equals zero law the distance Center of Gravity and wheel center can be calculated as:

$$x_V = \frac{m_H}{m_G} WB$$

$$x_H = \frac{m_V}{m_G} WB$$

E146626

In inclined system the main variable is the inclination angle which is the quotient of the lifting height and the wheelbase:

$$\sin \alpha = \frac{H}{WB}$$

E146627

Similar to the equation for the horizontal system the distance projected in to the ground plane can be determined using the sum of moments around front and rear wheel center:

$$x_V' = \frac{m_H'}{m_G} WB'$$

$$x_H' = \frac{m_V'}{m_G} WB'$$

E146628

Trigonometry leads to the projected wheelbase and analysis of the geometry as shown in the figure E145328 can be used to derive the auxiliary values below:

$$WB' = WB \cos\alpha$$

$$x_{H2} = \frac{x_H'}{\cos\alpha}$$

$$x_{H1} = x_H - x_{H2}$$

E146629

Using the rule of proportion leads to the Center of Gravity height formula:

$$\frac{x_{H1}}{z_{SP}} = \frac{H}{WB'}$$

$$z_{SP} = \frac{m_V - m_V'}{m_G \cdot H} \cdot WB^2 \cdot \cos\alpha \quad , \quad \alpha = \arcsin\left[\frac{H}{WB}\right]$$

or

$$z_{SP} = \frac{m_H' - m_H}{m_G \cdot H} \cdot WB^2 \cdot \cos\alpha \quad , \quad \alpha = \arcsin\left[\frac{H}{WB}\right]$$

E146630

1.16.1 Tow Bar Requirements

When a tow bar device is required, the vehicle converter should use a Ford approved tow bar.

CAUTION: Rear cargo doors may not be compatible with all tow bars and tow couplers, check before fitting.

NOTE: Base vehicles ordered without a tow bar or under run bar must order reinforcements and hardware. Contact your local Ford Dealer for details.

NOTE: Not all vehicles are suitable or approved to have tow bars fitted. See an authorized dealer for further information.

For further information on Towing a Trailer and Trailer Sway Control (TSC) refer to Owner's Manual.

For Trailer Tow Electric Wiring Kit without a tow bar please refer to Trailer Tow Electric (A055) in Wiring Installation and Routing Guides section in this manual.

For additional information in this manual:

Refer to: 1.9 Jacking (page 24).

Refer to: 4.1 Wiring Installation and Routing Guides (page 76).
Electrics for Tow bar.

1.16.2 Tow Bar Types

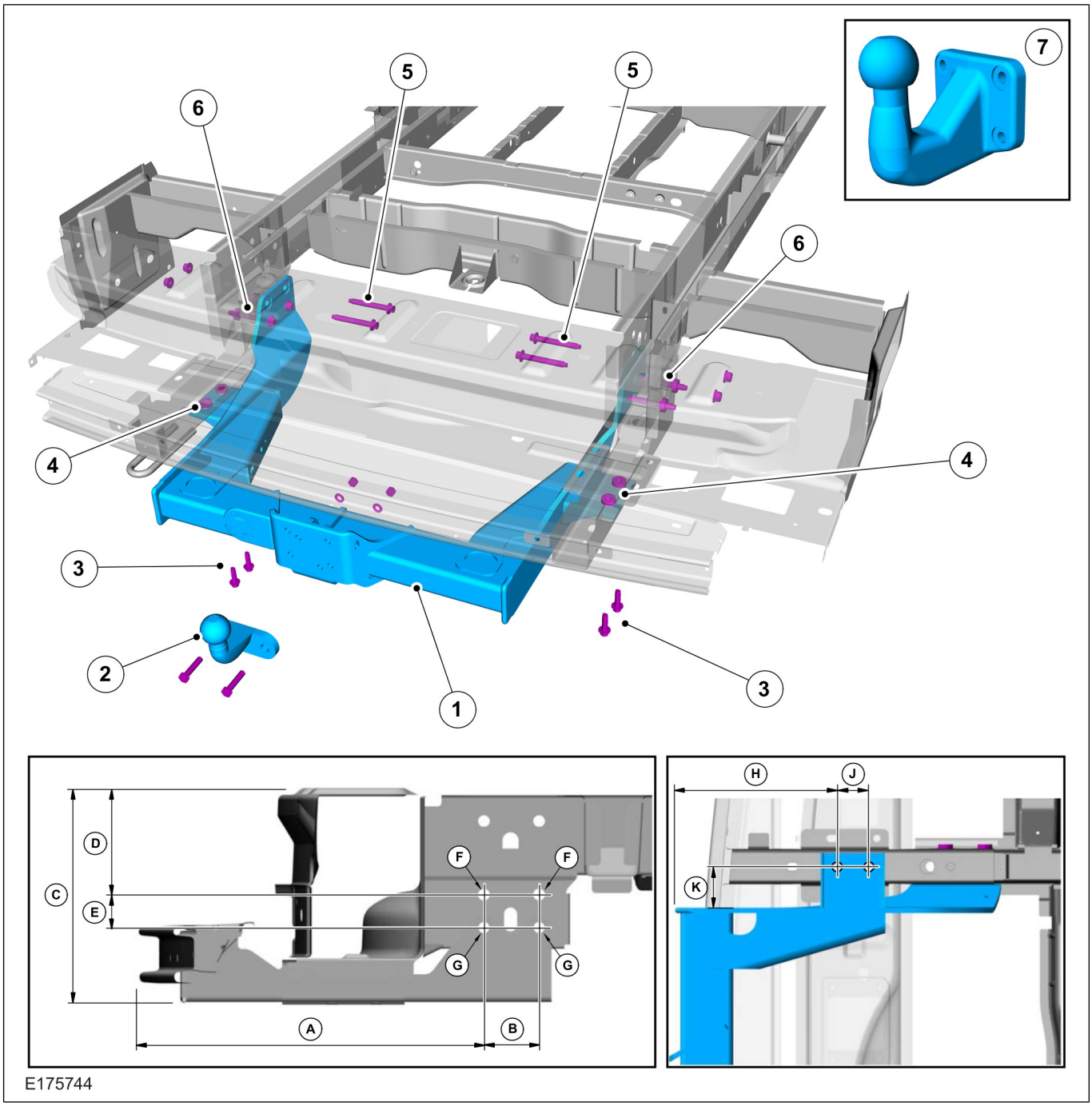
For tow bar devices fitted by the vehicle converter the following applies:

- Tow bar allowances must not exceed those of the standard vehicle.
- For attachment of the tow bar, under run bar and step see the following figures E175744, E167538, E167539 and E167540.
- Any modifications to the vehicle must be noted in the owner's handbook or new descriptive literature included with the owner's documentation.
- The maximum allowable tow ball static load is 112kg on a Van , Bus, Kombi and Chassis Cab with GVM up to 3.5 tonne
- The maximum allowable tow ball static load is 140kg on Van and Chassis Cab with GVM of 4.7tonne and 3.5 tonne HD (derated)
- Tow bar installations must meet the requirements of the EEC Directive 94/20 EC and /or ECE R55.
- Whenever frame drilling is necessary use tube reinforcement.

NOTE: When fitting a tow bar to Van, Bus and Kombi variants use all 12 fixing points as shown in E175744.

For any further details and advice please consult your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converters Advisory Service at VCAS@ford.com

Tow Bar Van, Bus and Kombi



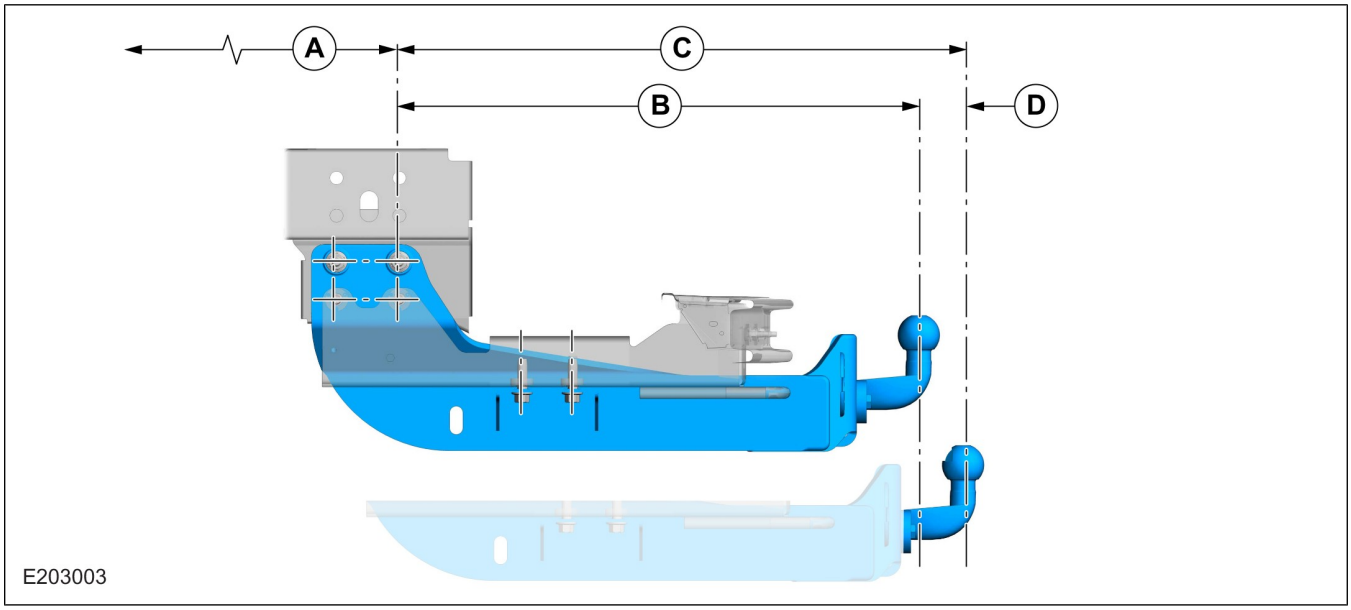
E175744

ITEM	DESCRIPTION						
1	Tow bar frame assembly						
2	Tow ball* 2.8 Tonne vehicle						
3	2x thread rolling bolts** each side, M12 x 40 - Torque 62.5Nm ±6.2						
4	2x unthreaded weld nuts inside the longitudinal member of the rear bumper						
5	2 new nuts and bolts (each side) in holes 'F' M12 x 90 - Torque 110Nm ±16.5						
6	Reuse 2x bolts (each side) in holes 'G' M12 x 100 Torque 103Nm ±15						
7	Tow ball 4.7 Tonne / 3.5 Tonne HD (derated) vehicle - use all 4 fixings hole						
A	514mm	D	135.8mm	G	12mm diameter	K	78.5mm
B	75mm	E	45mm	H	367.4mm	-	-
C	361.4mm	F	15mm diameter	J	60mm	-	-

* The low position two fixing holes should be used for attaching the tow ball to vehicles with 16 inch wheels and the mid position two fixing holes should be used for attaching the tow ball to vehicles with 15 inch wheels

** Use thread rolling bolt (Ford Part Number: W505286 – S442, M12x40 HF010) or equivalent.

Trailer Sway Control (TSC) Tow Ball Zone - Van, Bus, Kombi

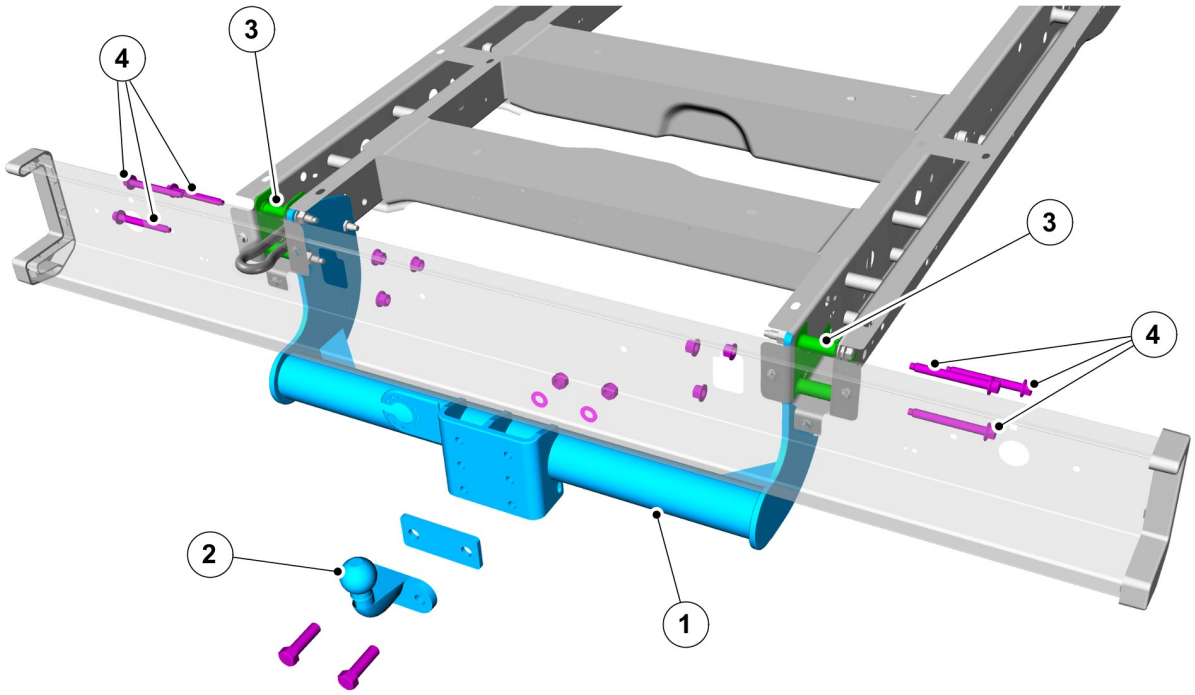


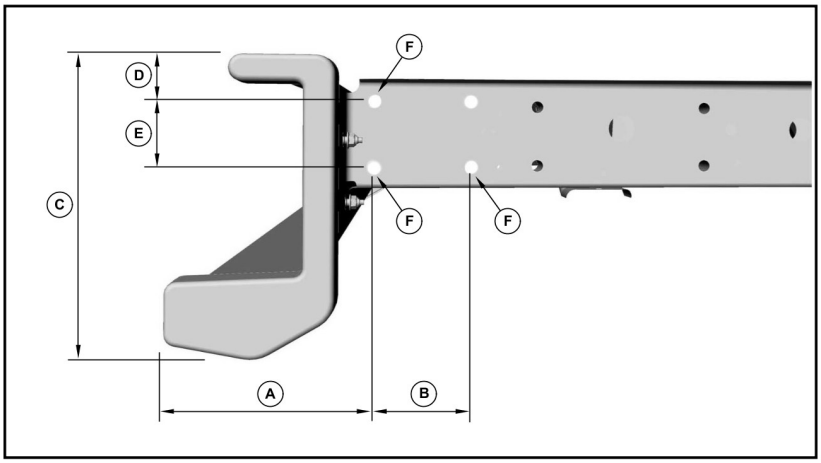
ITEM	DESCRIPTION
A*	MWB/LWB = 715mm, LWB-EL = 1439mm
B	629mm
C	666mm
D	37mm

To ensure functionality of TSC, please make sure that the tow ball is within zone 'D' as shown in figure E203003.

* From center of rear axle.

Tow Bar Chassis Cab 2.8 Tonne





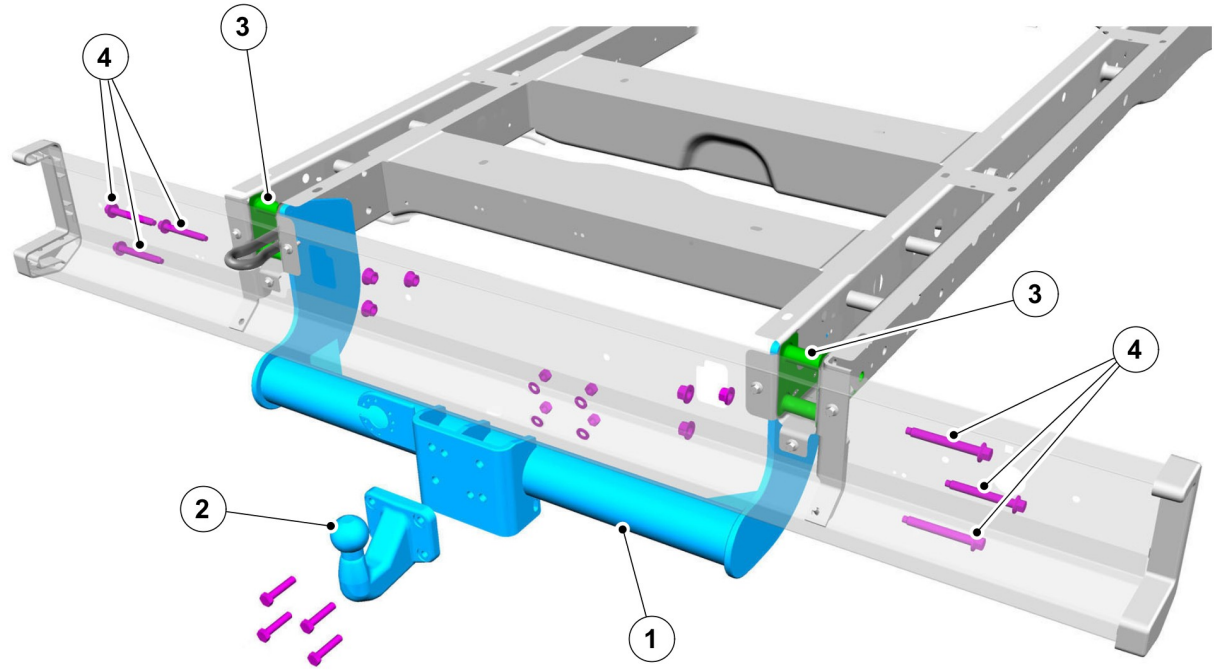
E167538

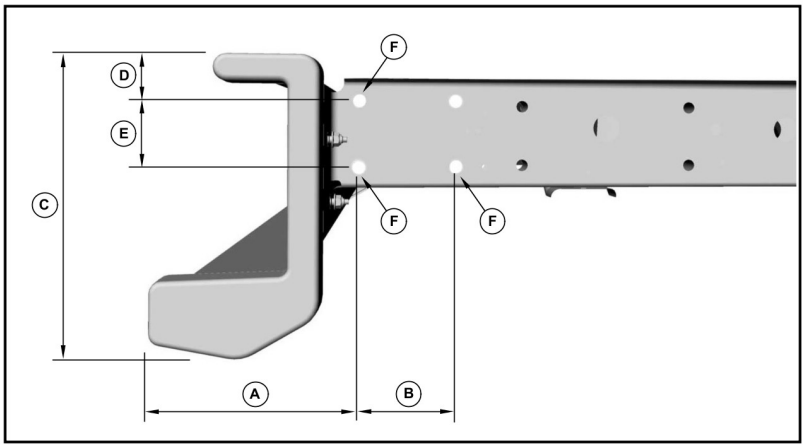
ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Tow bar frame assembly	B	106mm
2	Tow ball with 2x fixing bolts*	C	267mm
3	Reinforcement clamp plate**	D	22mm
4	Side member with 3x fixing nuts and bolts each side, M12 x 1.75 x 100 - Torque 103NM ±15	E	74mm
A	115mm	F	15mm Diameter

* The low two fixing positions should be used for attaching the tow ball to vehicles with 16 inch wheels and the mid two fixing positions should be used for attaching the tow ball to vehicles with 15 inch wheels

** Vehicles built before September 2014 will have two piece reinforcement clamp plate.

Tow Bar Chassis Cab 4.7 Tonne and 3.5 Tonne HD (derated)



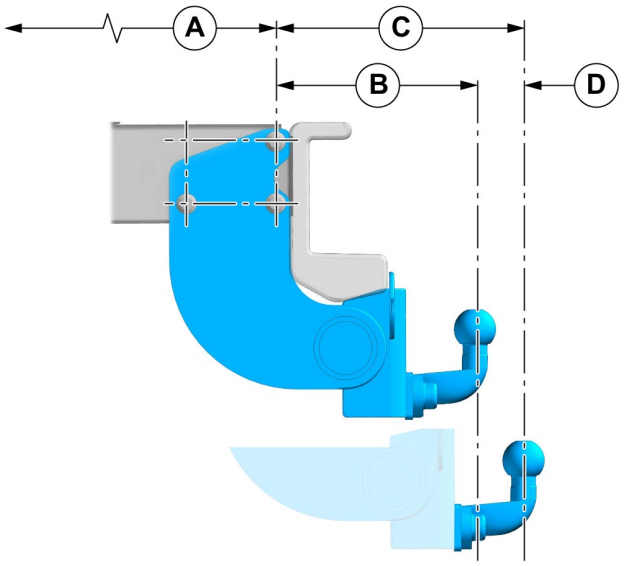


E167539

ITEM	DESCRIPTION		
1	Tow bar frame assembly		
2	Tow ball with 4x fixing bolts		
3	Reinforcement clamp plate*		
4	Side member with 3x fixing nuts and bolts each side, M12 x 1.75 x 100 - Torque 103NM ±15		
A	115mm	D	22mm
B	106mm	E	74mm
C	267mm	F	15mm Diameter

* Vehicles built before September 2014 will have two piece reinforcement clamp plates.

Trailer Sway Control (TSC) Tow Ball Zone - Chassis Cab Short Wheel Base



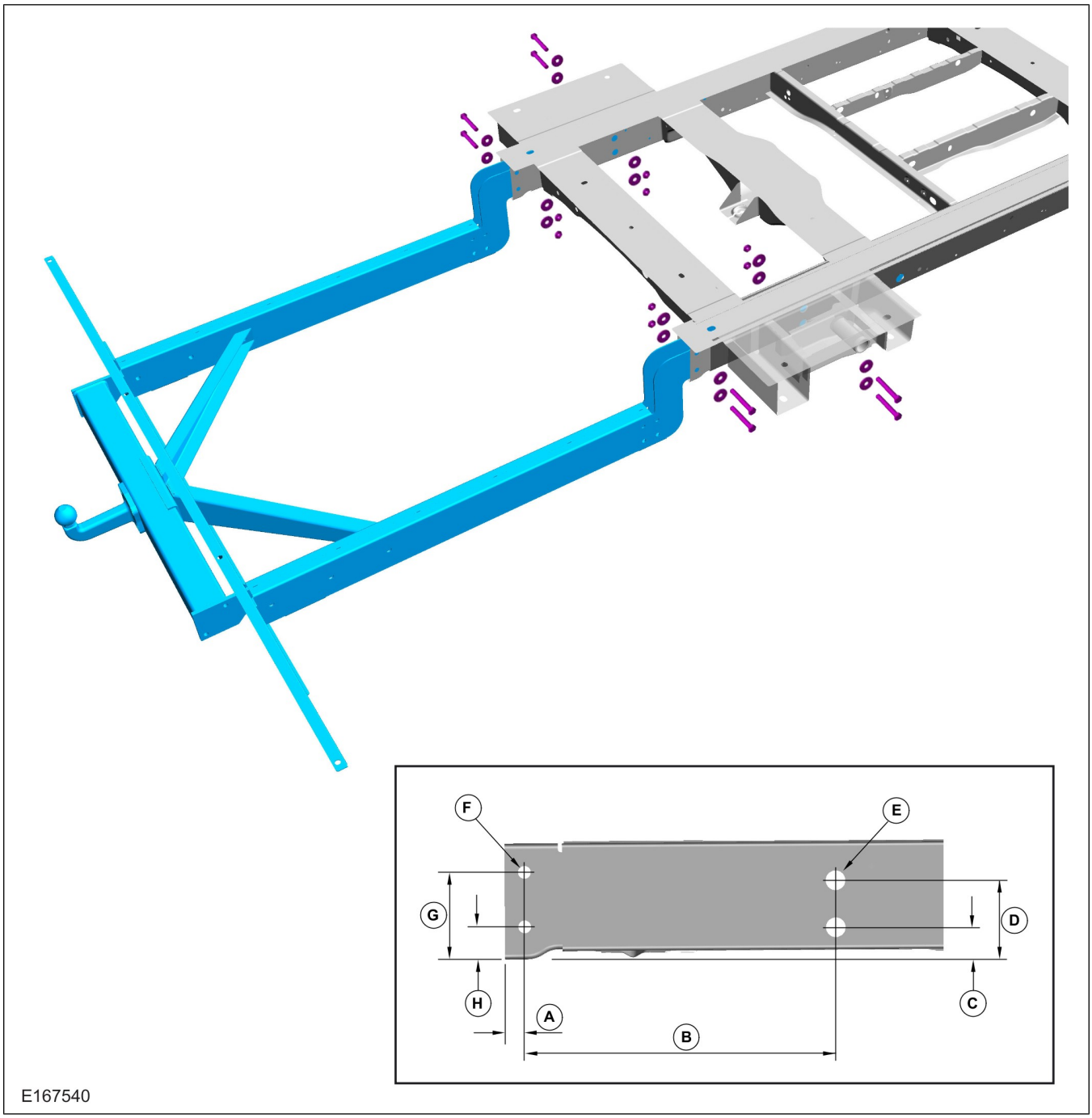
E203004

ITEM	DESCRIPTION
A*	941mm
B	222mm
C	257mm
D	35mm

WARNING: To ensure functionality of Trailer Sway Control (TSC), please make sure that the tow ball is within zone 'D' as shown in figure E203004.

* From center of rear axle.

Tow Bar Transit Motorhome Chassis



ITEM	DESCRIPTION
A	20mm
B	314mm
C	30mm
D	77.5mm
E	20mm Diameter
F	13mm Diameter
G	86mm
H	32mm

2.1 Suspension System

WARNING: Do not modify, drill, cut or weld any suspension components, specifically the steering gear system, subframe or anti-roll bars, springs or shock absorbers including mounting brackets.

CAUTION: Modifications to the suspension system can cause a deterioration of the vehicle handling characteristics and durability.

NOTE: For detailed information please contact the Vehicle Converter Advisory Service at VCAS@ford.com

2.2 Front Suspension

2.2.1 Springs and Spring Mounting

WARNING: Do not modify, drill, cut or weld any suspension components, specifically the steering gear system, subframe or anti-roll bars, springs or shock absorbers including mounting brackets.

CAUTIONS:

When carrying out welding work the springs must be covered to protect them against weld splatter.

Do not touch springs with welding electrodes or welding tongs.

Make sure that components loosened or removed and reinstalled are properly reassembled and the torque set in accordance with manufactures requirements.

NOTE: Do not modify the wheelbase or add any type of frame extension.

NOTE: Do not damage the surface or corrosion protection of the spring during disassembly and installation.

NOTE: For detailed information please contact the Vehicle Converter Advisory Service at VCAS@ford.com

2.3 Rear Suspension

2.3.1 Springs and Spring Mounting

WARNINGS:

Do not modify, drill, cut or weld any suspension components, specifically the steering gear system, sub-frame, springs or shock absorbers including mounting brackets.

The rear leaf springs are pre-stressed in manufacture and should not be altered for rate or height in any way during vehicle conversion. Adding or removing leaves may result in failure or reduced function of the spring as well as other vehicle related issues for which Ford Motor Company can not be held responsible.

CAUTIONS:

When carrying out welding work the springs must be covered to protect them against weld splatter.

Do not touch springs with welding electrodes or welding tongs.

Make sure that components loosened or removed and reinstalled are properly reassembled and the torque set in accordance with manufactures requirements.

NOTE: Do not modify the wheelbase or add any type of frame extension.

NOTE: Do not damage the surface or corrosion protection of the spring during disassembly and installation.

NOTE: Do not add any additional axles.

NOTE: For detailed information contact the Vehicle Converter Advisory Service at VCAS@ford.com

Rear Anti Roll Bar

The following vehicles have rear anti roll bars:

- All FWD Chassis Cabs
- All RWD vehicles with dual rear wheels (DRW)

2.4 Wheels and Tires

2.4.1 Wheel Clearance

The distance from the tire to the mudguard or wheel arch must be sufficient, even if snow or anti-skid chains are fitted and the suspension is fully compressed allowing for axle twist as well. Please consult the Vehicle Converter Advisory Service VCAS@ford.com for clearance requirements and data.

NOTE: Make sure that only approved wheels and/or permissible tire sizes are fitted.

NOTE: Ensure access to the wheel and wheel jack, and provide sufficient clearance in wheel arch to allow changing the wheels after conversion.

NOTE: Maintain access to the spare wheel winch on Chassis Cab and Motorhome Chassis, via the hole in the side rail, under all loading conditions.

For standard wheelhouse dimensions:

Refer to: 5.1 Body (page 214).
Integral Bodies and Conversions

2.4.2 Tire Manufacturers

Replacement tires should be of the same make, size, tread pattern and load rating as the Original Equipment Manufacturer. Under these conditions the original tire label should be satisfactory, however if the specified tires and/or inflation pressures are changed then a new label should be affixed over the original label.

2.4.3 Tire Pressure Monitoring Sensor (TPMS)

Ford TPMS is a direct system, using physical pressure sensors. TPMS is calibrated according to the correct tire pressure for the GVM of the vehicle. If the spare wheel is ordered on a base vehicle with TPMS, the tire will not be supplied with a TPMS sensor.

If you need to replace a road wheel and tire with the spare wheel, the system will continue to identify a defect. This is to remind you to repair and refit the damaged road wheel and tire to your vehicle. To restore the correct operation of the system, you must have the repaired road wheel and tire refitted to the vehicle.

NOTE: If fitting new tires, you must ensure that the TPMS sensors are fitted correctly as outlined in the service literature. For further information refer to the Owner's Manual or contact your Local Ford Dealer.

The TPMS receiver is located in the overhead shelf and points directly towards the rear doors. For additional information

Refer to: 4.16 Handles, Locks, Latches and Entry Systems (page 169).


E167541

2.4.4 Spare Wheel

When converting or relocating the spare wheel, access must be ensured.

2.4.5 Tire Repair Kit

Your vehicle may not have a spare tire. Therefore you will have a temporary mobility kit which will only repair one tire. The temporary mobility kit is made up of a compressor and separate sealant. The compressor will be located in the glove stowage compartment. If the passenger seat is removed please choose an appropriate storage space for the compressor to ensure easy access in case of puncture. The sealant will be located in the right hand side step well. If the vehicle is fitted with an outboard handbrake, it may also be necessary to choose an alternative storage space for the sealant. For more information and usage of the tire repair kit please refer to the Owner's Manual.

2.4.6 Jacking Kit

On right hand drive camper variants the customer is required to find a new location for the jack kit which will be supplied in a foam pod which houses all necessary components.

2.4.7 Painting Road Wheels

CAUTION: Do not paint wheel clamp surfaces in contact with other wheels, brake drum or disc, hub and holes, or surfaces under wheel nuts. Any further treatment in these areas may affect the wheel clamp performance and the vehicle safety.

- Mask the wheel when changing the color or repairing paint.

2.5 Driveshaft

2.5.1 Power Take Off

Gearbox add-on - Auxiliary Propeller Drive Shaft

CAUTIONS:

- **Make sure that an inhibitor is fitted to any modified vehicle that uses the prop-shaft to power auxiliary equipment.**
- **The only modification to the engine control system (throttle, powertrain control module and fuel pump) recommended by the manufacturer is the addition of an engine (RPM) controller.**
- **Do not weld or join onto any part of the axle assembly.**
- **The transmission oil temperature must not exceed 130°C during operation of the Power Take Off.**

Where power is to be taken from the prop-shaft for accessory drive, the engine controller can be used in the same way as for the Front End Accessory Drive (FEAD).

Refer to: 3.3 Accessory Drive (page 65).

Exceeding the recommended power take off ratings may result in the engine over heating.

If the driveshaft is modified, it must be balanced to a limit of 80gmm at 5000rpm and the installation must not have universal joint angles exceeding 4º. The gearbox output included angle must be no more than 1º.

2.6 Brake System

2.6.1 General

The Brake System must be fully functional when the vehicle conversion is completed. The vehicle brake operating modes must be checked, including warning system and parking brakes.

Brakes are certified to 71/320EEC and ECE R13H requirements as amended or ADR 31/ADR 35 or applicable local legislation.

WARNING: Do not restrict the airflow and cooling to the brake system.

CAUTION: Spoilers and wheel covers must not affect the brake cooling performance.

NOTE: Do not obstruct the view of the brake fluid reservoir level.

NOTE: The donor vehicle brake fluid reservoir is translucent so that it is possible to check the level of fluid without opening the reservoir which will reduce the risk of contamination. Do not move brake fluid reservoir.

The brake fluid reservoir must remain accessible for servicing and for adding brake fluid.

2.6.2 Kerb Mass Data

NOTE: For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

2.6.3 Brake Hoses General

CAUTION: Make sure that the front and rear brake hoses are not twisted and are correctly located away from body and chassis components.

Front and rear brake hoses must not rub, chafe or rest on body or chassis components. There must be clearance under all operating conditions, between full compression and extension and full lock to lock.

Brake lines must not be used to support or secure any other component.

2.6.4 Parking Brake

WARNINGS:

Do not modify the brakes.

Do not splice into the parking brake cable.

CAUTION: Make sure that a new parking brake cable is fitted if modification to the wheel base impacts the existing parking brake cable.

2.6.5 Hydraulic Brake—Front and Rear Brakes

WARNINGS:

Do not modify the brakes.

Do not modify the disc in flow and out flow of cooling air.

2.6.6 Anti-Lock Control — Stability Assist

WARNING: Do not modify any part of the braking system, including Anti Brake System (ABS), Traction Control System (TCS) and Electronic Stability Control (ESC), also known as Electronic Stability Program (ESP).

NOTE: For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

3.1 Engine

CAUTION: Make sure to follow the equipment suppliers instructions for safety, warranty and sometimes legal compliance.

For electrical supply to auxiliary equipment.

Refer to: 4.3 Charging System (page 95).

3.1.1 Engine Selection for Conversions

The vehicle converter is responsible for specifying the correct emissions engine to the latest E.E.C/E.U. Regulations or applicable local legislation depending on the completed vehicle category and weight. The final weight of a vehicle including the conversion, determines whether a vehicle needs a light-duty or heavy-duty emissions engine.

The weight is based on the Reference Mass defined as the mass in running order, less a 75kg allowance for the driver, add a 100kg uniform mass.

For guidance purposes only, if the Reference Mass used for completed vehicle type approval is:

- Not exceeding 2,840kg, a light-duty engine may be specified for N1 and N2 vehicles.
- Greater than 2,840kg, a heavy-duty engine needs to be specified. Note: Heavy-duty engines are recommended for M2 Bus Conversions.

NOTE: Only light duty emissions engines are available at EU6.1 emissions level for Transit vehicle conversions including Vans and Chassis Cabs.

3.1.2 Engine Power Curves

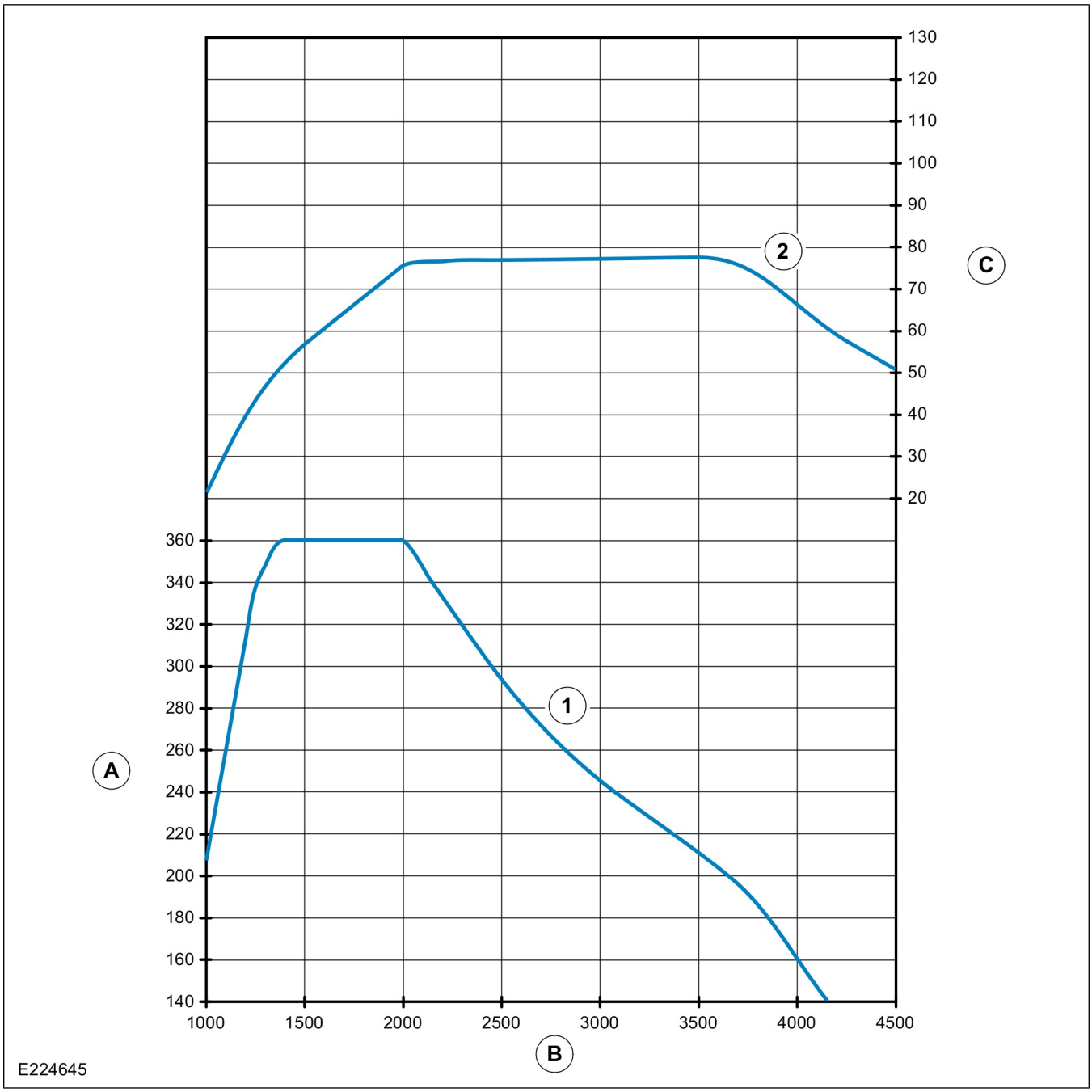
Front Wheel Drive (FWD)

- Common Rail 2.0L TDCi 77kW (105PS) Diesel Engine.
- Common Rail 2.0L TDCi 96kW (130PS) Diesel Engine.
- Common Rail 2.0L TDCi 125kW (170PS) Diesel Engine.

Rear Wheel Drive (RWD)

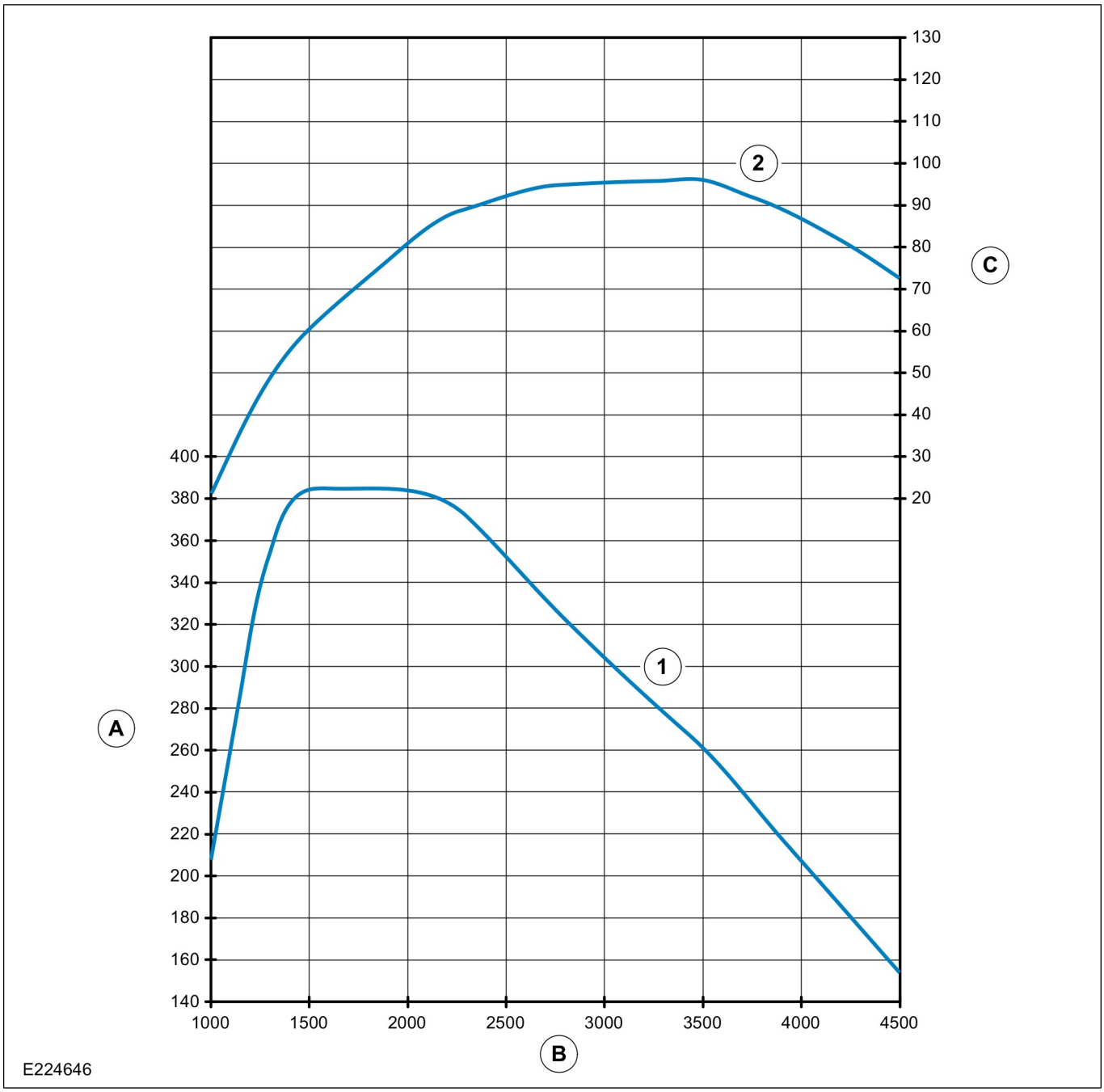
- Common Rail 2.0L TDCi 77kW (105PS) Diesel Engine.
- Common Rail 2.0L TDCi 94kW (130PS) Diesel Engine.
- Common Rail 2.0L TDCi 125kW (170PS) Diesel Engine.

FWD Common Rail 2.0L TDCi 77kW (105PS) Diesel Engine



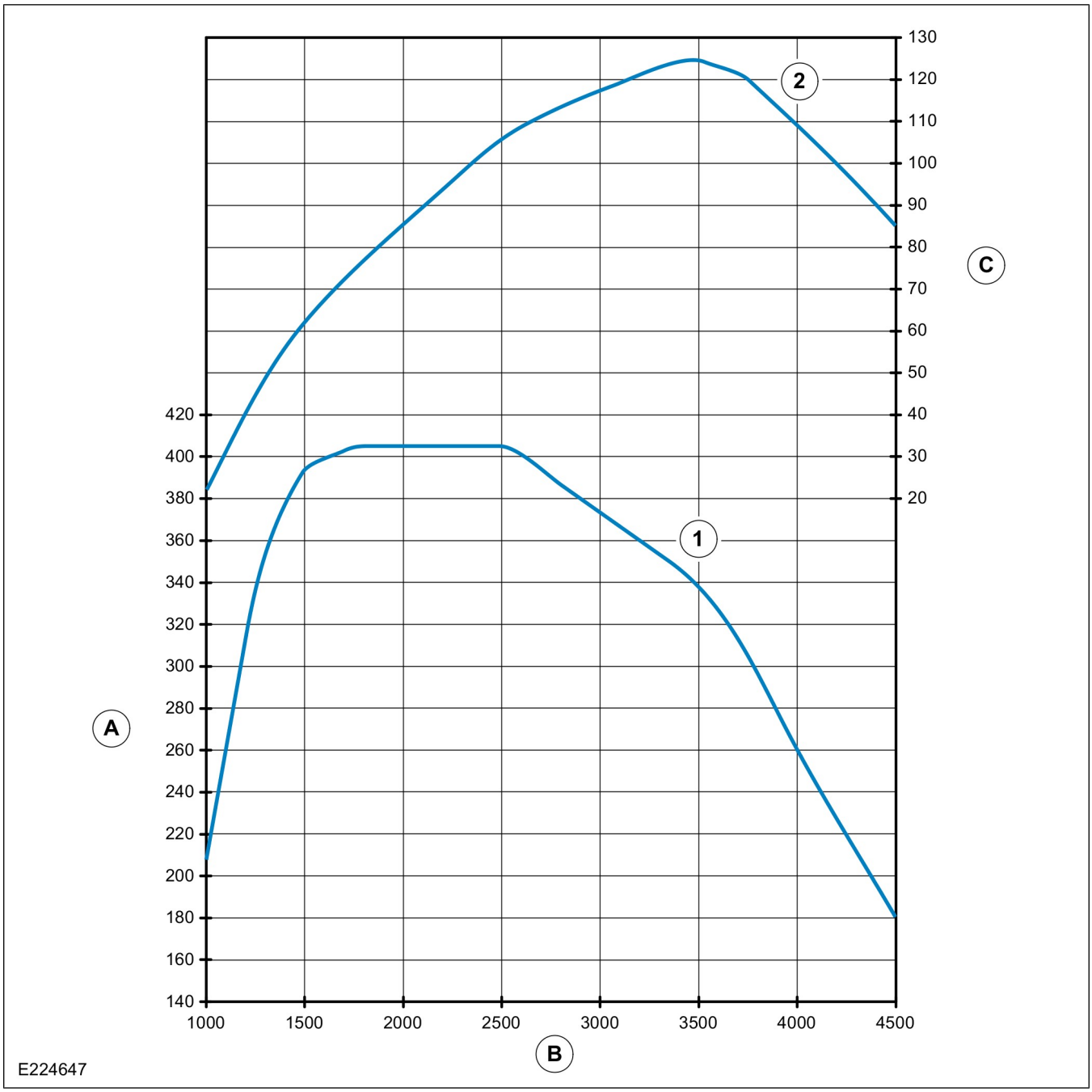
Item	Description
1	Torque Curve Nm — Max Torque = 360Nm at 1375-2000 1/min
2	Power Curve kW — Max Power = 77kW (105PS) at 3500 1/min
A	Nm
B	1/min
C	kW

FWD Common Rail 2.0L TDCi 96kW (130PS) Diesel Engine



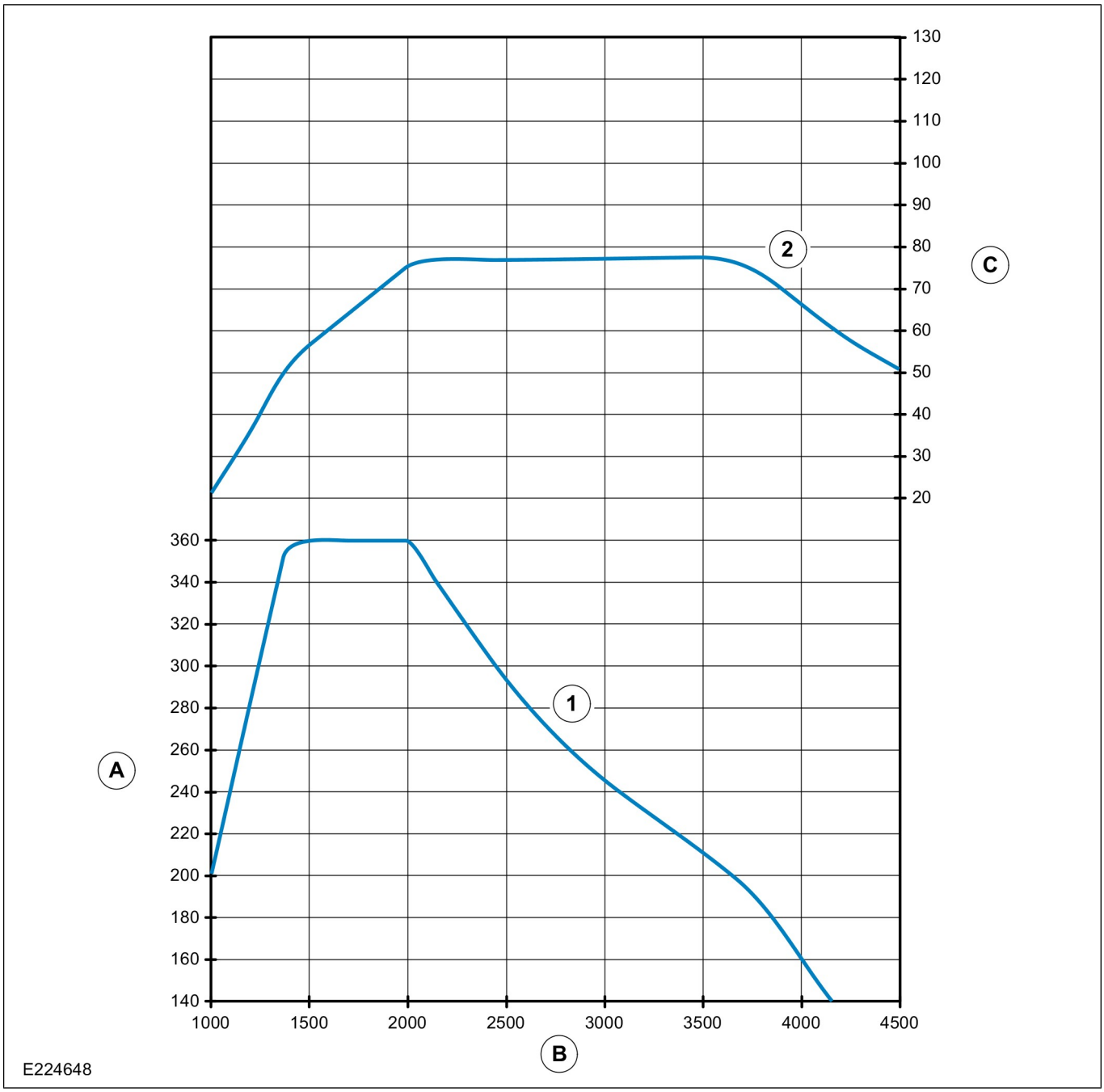
Item	Description
1	Torque Curve Nm — Max Torque = 385Nm at 1500-2000 1/min
2	Power Curve kW — Max Power = 96kW (130PS) at 3500 1/min
A	Nm
B	1/min
C	kW

FWD Common Rail 2.0L TDCi 125kW (170PS) Diesel Engine



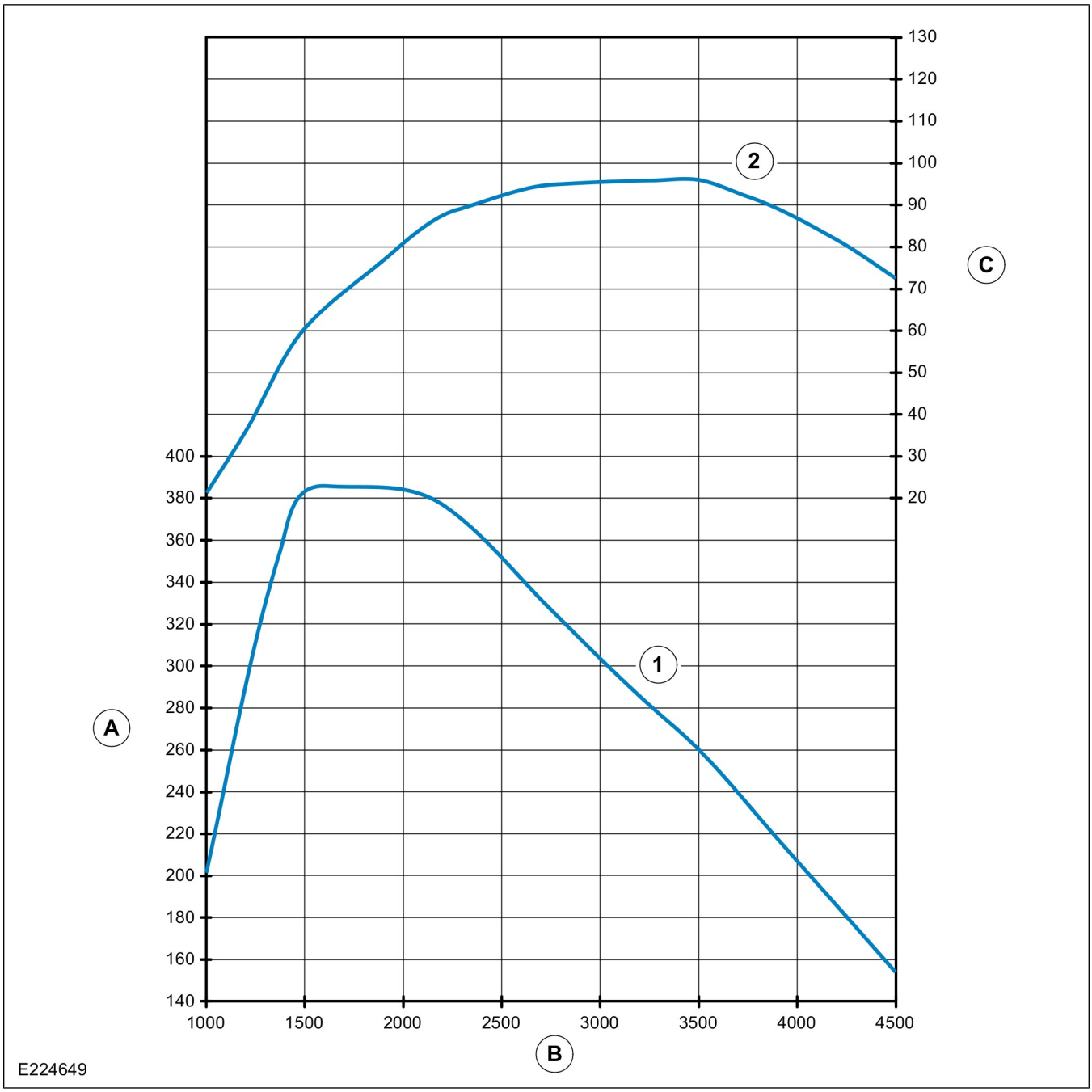
Item	Description
1	Torque Curve Nm — Max Torque = 405Nm at 1750-2500 1/min
2	Power Curve kW — Max Power = 125kW (170PS) at 3500 1/min
A	Nm
B	1/min
C	kW

RWD Common Rail 2.0L TDCi 105kW (105PS) Diesel Engine



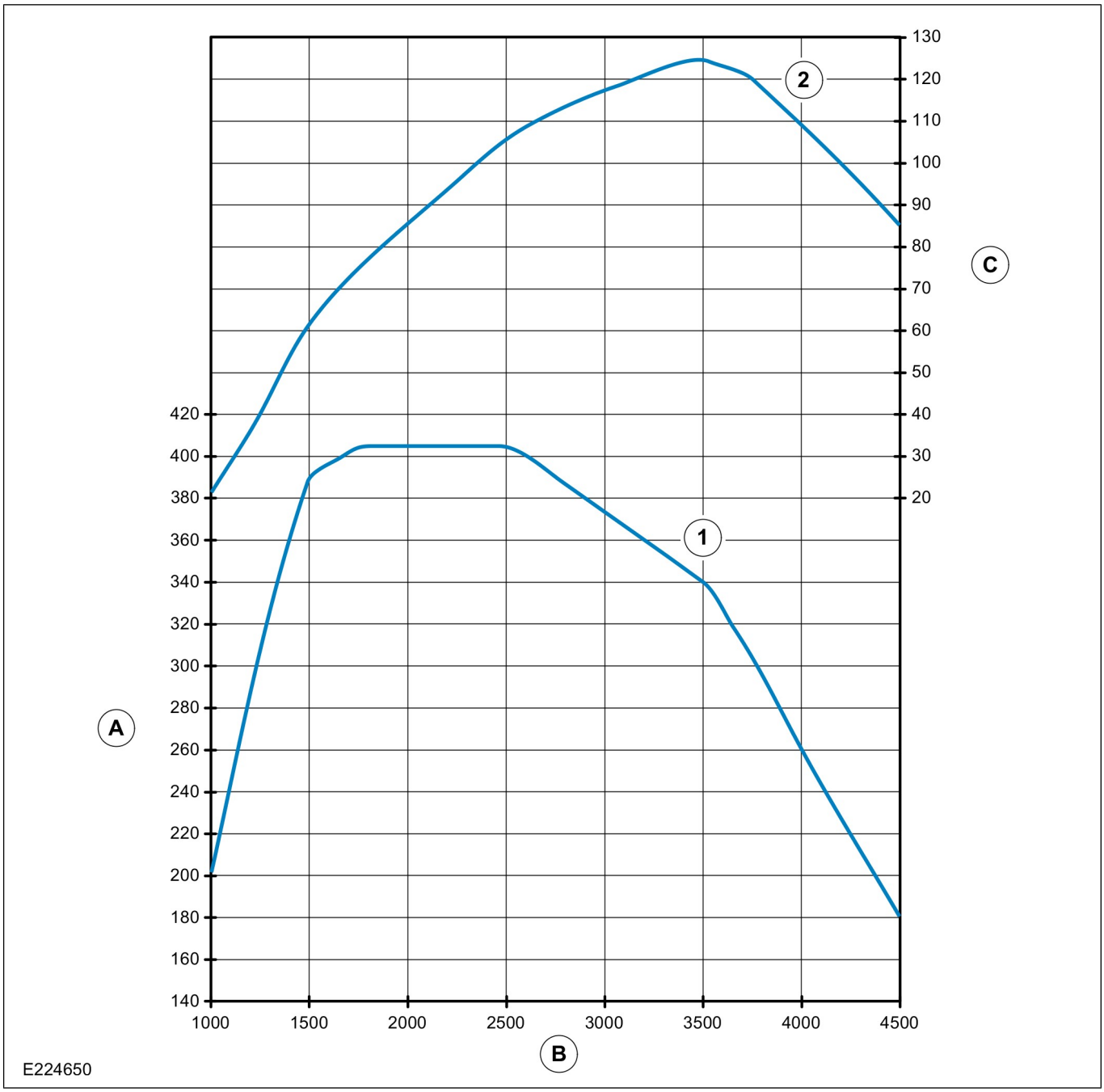
Item	Description
1	Torque Curve Nm — Max Torque = 360Nm at 1500-2000 1/min
2	Power Curve kW — Max Power = 77kW (105PS) at 3500 1/min
A	Nm
B	1/min
C	kW

RWD Common Rail 2.0L TDCi 96kW (130PS) Diesel Engine



Item	Description
1	Torque Curve Nm — Max Torque = 385Nm at 1500-2500 1/min
2	Power Curve kW — Max Power = 96kW (130PS) at 3500 1/min
A	Nm
B	1/min
C	kW

FWD Common Rail 2.0L TDCi 125kW (170PS) Diesel Engine



Item	Description
1	Torque Curve Nm — Max Torque = 405Nm at 1750-2500 1/min
2	Power Curve kW — Max Power = 125kW (170PS) at 3500 1/min
A	Nm
B	1/min
C	kW

3.2.1 Auxiliary Heater Systems

WARNINGS:

Ford coolant additives are necessary for the complete function of the system. Only use Ford approved or equivalent specification component, to withstand any detrimental effects on the materials.

Do not mount components in front of the grille or in an area of air flow around the engine, which could affect the engine cooling.

CAUTIONS:

Only make connections into the heater hose between the front cab heater and water pump return inlet.

Do not exceed the vehicle's original coolant volume (without auxiliary heater) by more than 10%.

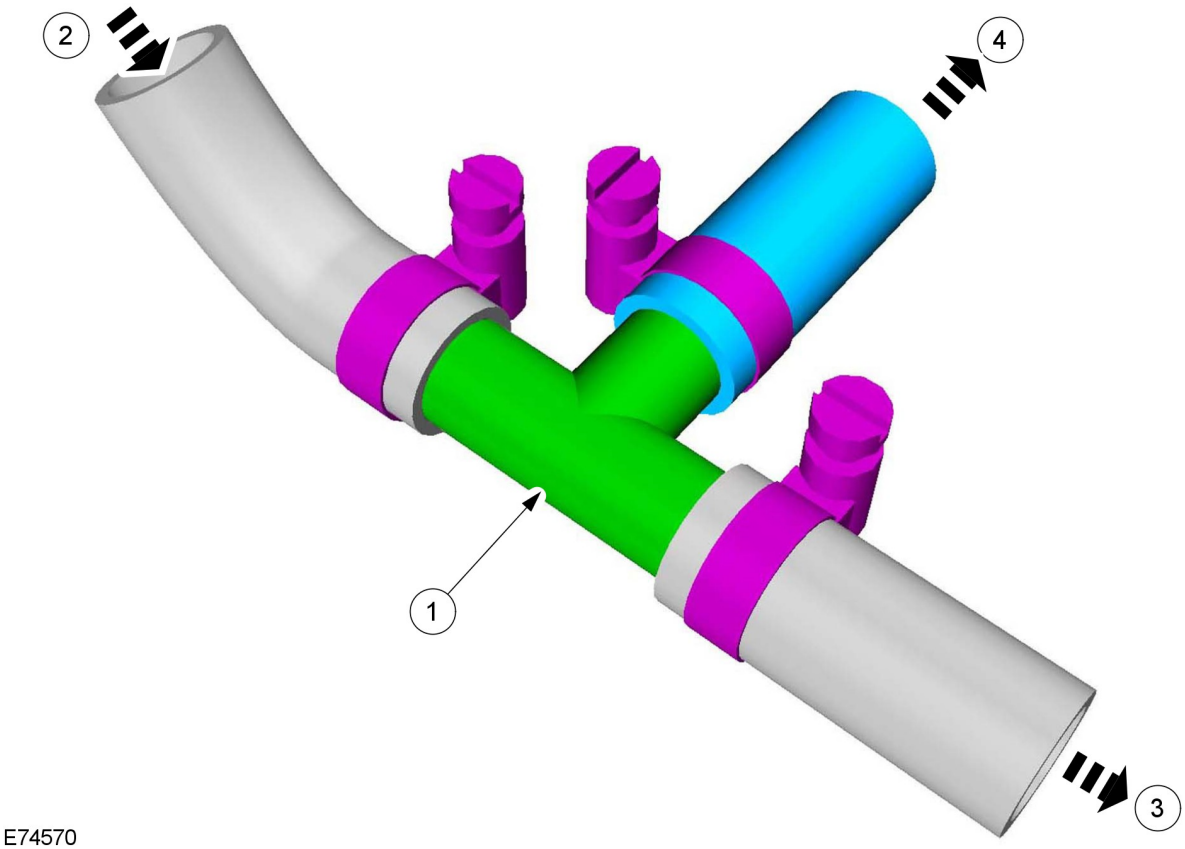
Maintain a coolant level between maximum and minimum line in cold condition after fill and de-aerating operations.

Only use the manufacturer recommended (or equivalent specification) coolant additives/anti-freeze. Do not mix coolant types.

- Coolant flow to cab heater must have priority over flow to auxiliary heater or hand wash facility.
- Coolant tube routing must be below the minimum line of the degas bottle.
- Use aluminum or plastic 'T' junction with swaged or beaded ends to prevent hose blow off. Reconnect original coolant tube as shown in view E74570 (in this section) with standard Ford water hose clip or suitable equivalent specification clip. Ensure interference fit between hose and 'T' joint.
- Tube routing must be secured to the body structure or suitable brackets avoiding electrical components or wires, hot or moving parts and brake or fuel system components.
- Hose must be heat sleeved with appropriate material if within 100mm of exhaust components (for example, manifold or exhaust gas recirculating).
- The vertical clearance between the critical cooling components (radiator, fan shroud and radiator brackets) and both the hood inner and outer (assembly) panels at design position shall not be less than 15mm.
- There shall be a minimum clearance of 10mm between the engine assembly and flexible components (for example, hoses or wiring harnesses) affixed to front end sheet metal hardware, under a maximum engine torque roll condition.

NOTE: For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory service at VCAS@ford.com

Water Hoses for Auxiliary Heating System



Item	Description
1	Connector (aluminum or plastic)
2	Heater hose (maintain heater fluid)
3	Original flow
4	To ancillary equipment

3.2.2 Auxiliary Heater Installation

Ensure that the exhaust gas from any auxiliary heating system can not be re-circulated into the vehicle. The exhaust gases must not pass into the engine intake system or the air intake for the passenger compartment ventilation. The heating system should be installed outside the passenger compartment. The location of the heating system should not be in close proximity to movable components. Any body reworks which damage the paint must be fully protected against corrosion.

Refer to: 5.14 Corrosion Prevention (page 268).

NOTE: The installation must be in line with the appropriate legal requirements.

3.2.3 Air Flow Restrictions

WARNING: Do not mount components in front of the grille or in an area of air flow around the engine, which could affect the engine cooling performance.

CAUTION: Over heating within the engine compartment can seriously compromise component robustness.

NOTE: Please assume under hood environment is about 130°C when selecting appropriate materials

NOTE: For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

3.3.1 Front End Accessory Drives — General Information

When the correct belt is used, tensioning is and remains fully automatic for the life of the belt.

CAUTIONS:

- **Only use the manufacturers recommended (or equivalent specification) components.**
- **Make sure that the ancillary pulley diameter is less than the crankshaft pulley diameter.**
- **Front End Accessory Drive shields must be maintained at all times. If shields are removed, for example when attaching an ancillary unit, they must be replaced so that it is protected appropriately.**

NOTE: No devices can be taken off the crank damper as this is a tuned device for system resonance.

NOTE: The shields are there to protect the Front End Accessory Drive system from STONE ingress and also protect people from rotating parts under Start-Stop function.

NOTE: For further information on systems requiring a unique belt please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

The Eigen frequency of the bracket with auxiliary unit should be above the maximum excitation frequency of the main excitation order of the individual engine at engine top speed. On 4-cylinder inline engines, this is the second engine order.

- **CAUTION: Do not fit an additional front end accessory drive to a vehicle already equipped with an air conditioning compressor.**

When engineering and installing a new front end accessory drive, i.e. belt drive of the crankshaft pulley, the longitudinal alignment must be within +/- 0.25mm and angular within +/- 0.33º.

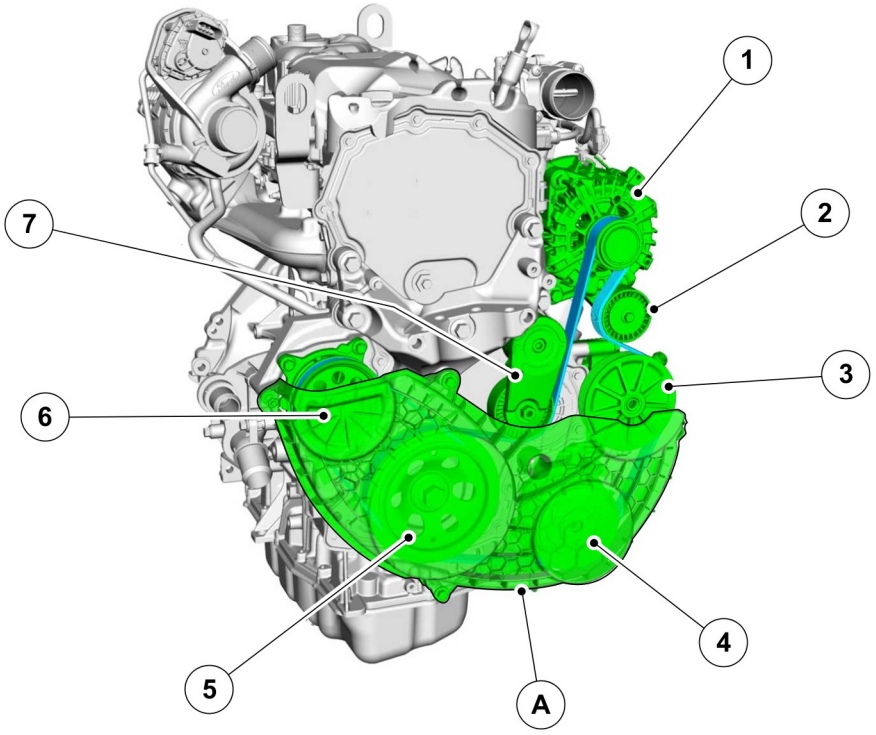
For most front end accessory drive applications the longer, standard option, air -conditioning belt can replace the standard belt and pulley layout.

The maximum power that is available for front end accessory drive applications at any engine speed is 6kW (in lieu of the 26Nm air conditioning compressor). For additional information please contact the Vehicle Converters Advisory Service, VCAS@ford.com

Abbreviations

- FWD = Front Wheel Drive
- RWD = Rear Wheel Drive

FWD 2.0L Diesel Engine - with Air Conditioning

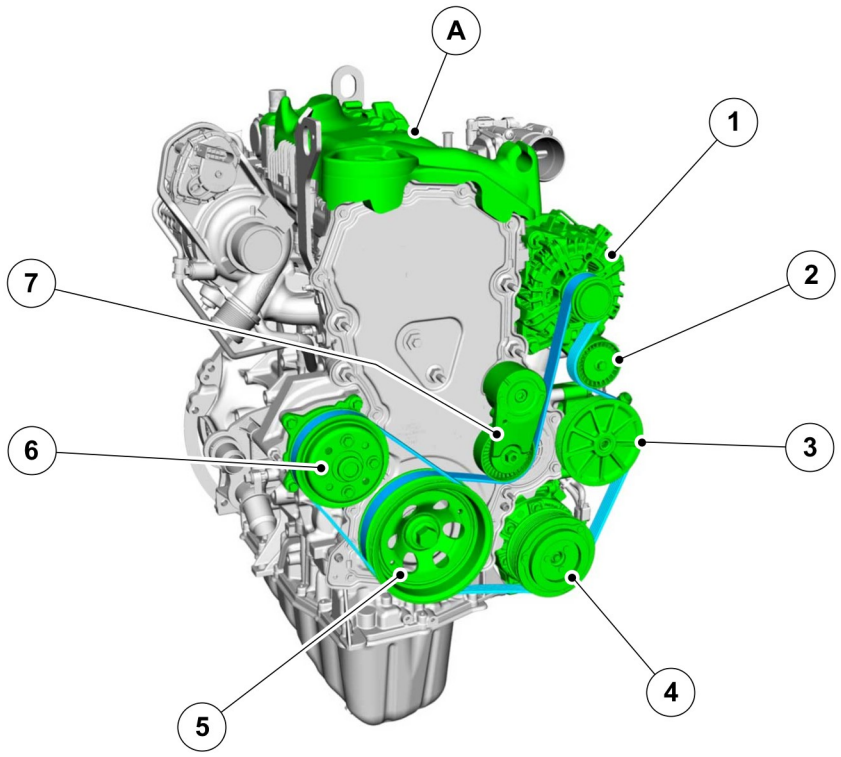


E224688

Pulley, Belt Layout and Protective Shield on FWD 2.0L Diesel Engine - with Air Conditioning

Item	Description
1	Alternator
2	Idler
3	HPAS Pump
4	AC Compressor
5	Crankshaft Pulley
6	Water Pump
7	Tensioner
A	Front End Accessory Drive Shield

RWD 2.0L Diesel Engine - with Air Conditioning



E224687

RWD Pulley, Belt Layout, Engine Top Cover on 2.0L Diesel Engine - with Air Conditioning

Item	Description
1	Alternator
2	Idler
3	HPAS Pump
4	AC Compressor
5	Crankshaft Pulley
6	Water Pump
7	Tensioner
A	Engine Top Cover

3.4 Clutch

The manufacturer does not offer the option of a reinforced clutch system. The axle ratio available is dependent on the weight of the specified donor vehicle.

It is necessary to select the appropriate drive, engine, gear ratio, gross vehicle mass, gross train mass, axle plates and payloads of the base vehicle to match the customers order.

3.5 Manual Transmission

The following manual transmissions are available for diesel engines, depending on the drive:

Front Wheel Drive (FWD) vehicles

— VMT6 Transmission

Rear Wheel Drive (RWD) vehicles

— MT82 Transmission

WARNING: Do not reroute external transmission gear shift cables.

NOTE: All transmissions are tachograph compatible.

Please also see BEMM Weight Charts for axle ratios, available to download or view via www.etis.ford.com/fordservice/

VMT6 - 6 Speed Manual FWD Transmission

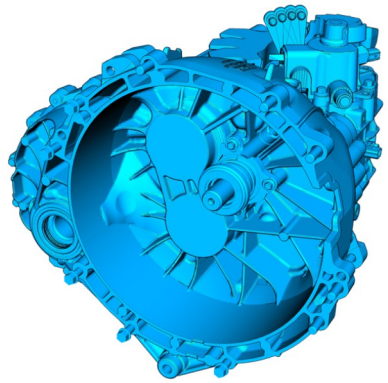
Gear	Base Transmission Ratio	Overall Transmission Ratio			
		4.71 Final Drive	4.19 Final Drive	3.94 Final Drive	4.43 Final Drive
1st	3.727	17.569	15.609	14.677	16.507
2nd	1.952	9.202	8.175	7.687	8.645
3rd	1.121	5.284	4.695	4.414	4.965
4th	0.780	3.677	3.267	3.072	3.455
5th	0.844	2.785	2.570	2.417	2.754
6th	0.683	2.254	2.080	1.956	2.229
Reverse	1.423	17.503	16.150	15.190	17.306

MT82 - 6 Speed Manual RWD and AWD Transmission

Gear	RWD Gear Set A	
	Base Transmission Ratio	Overall Transmission Ratio 4.10 Final Drive
1st	5.441	22.308
2nd	2.839	11.640
3rd	1.721	7.056
4th	1.223	5.014
5th	1.000	4.100
6th	0.794	3.255
Reverse	4.935	20.234

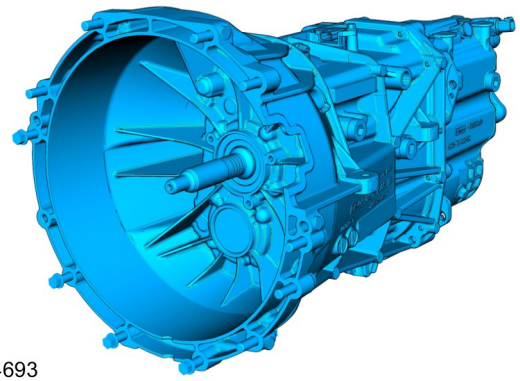
Gear	RWD Gear Set E				
	Base Transmission Ratio	Overall Transmission Ratio			
		3.15 Final Drive	3.31 Final Drive	3.55 Final Drive	3.73 Final Drive
1st	5.701	17.958	18.870	20.239	21.265
2nd	2.974	9.368	9.844	10.558	11.093
3rd	1.803	5.679	5.968	6.401	6.725
4th	1.282	4.038	4.243	4.551	4.782
5th	1.000	3.150	3.310	3.550	3.730
6th	0.776	2.444	2.569	2.755	2.894
Reverse	5.170	16.286	17.113	18.354	19.284

VMT6 - 6 Speed Manual FWD Transmission



E224692

MT82 - 6 Speed Manual RWD Transmission



E224693

3.6.1 Extensions and Optional Exhausts

CAUTIONS:

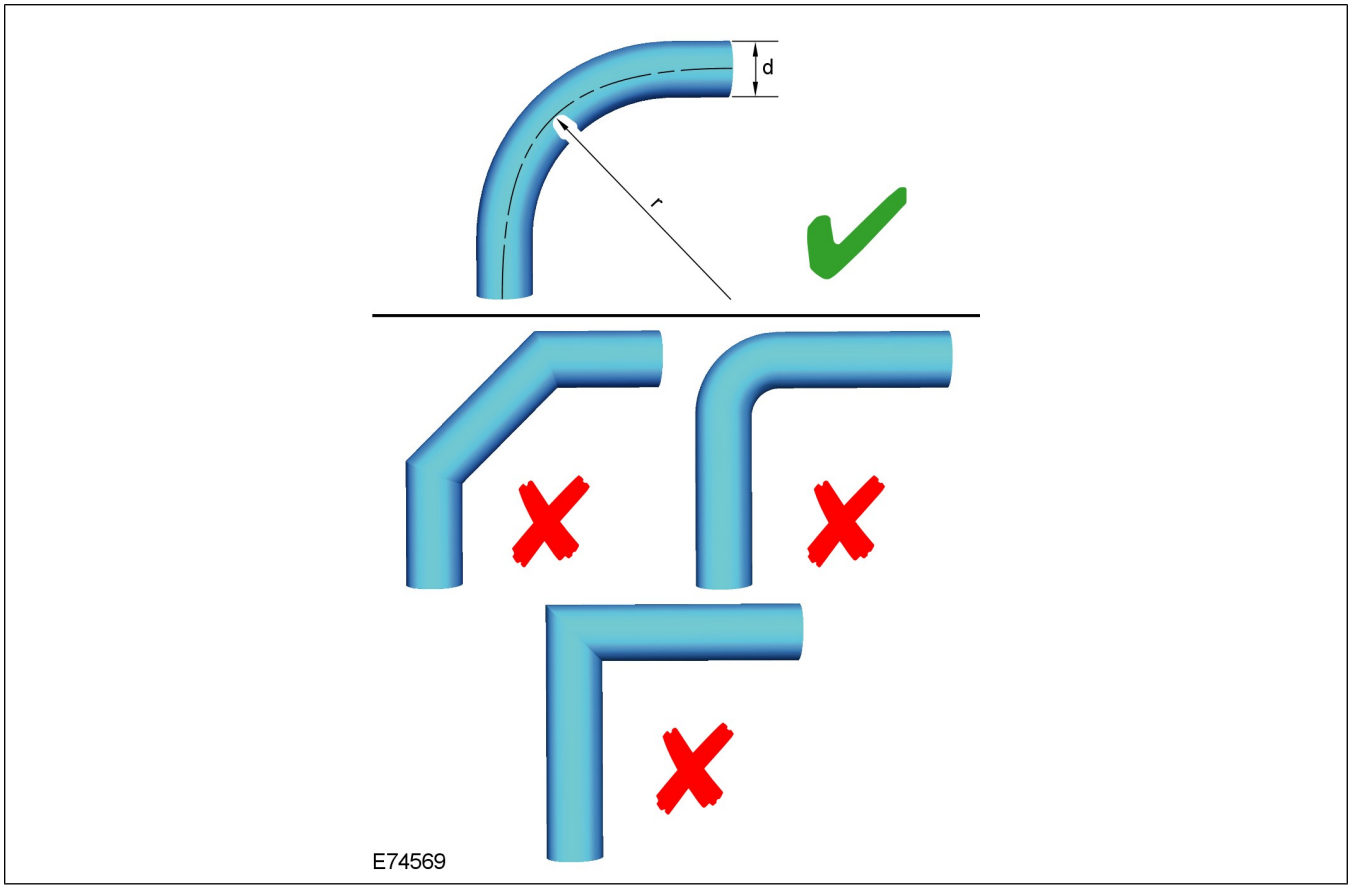
Non-standard systems must be tested for engine back pressure and all legal compliance (noise and emissions).

Make sure that for any pipes that require bending, the radius of the bend is minimum 2.5 x tube diameter.

Make sure that sufficient clearance is maintained for all driving conditions to all hot and moving components.

NOTE: Where possible all pipe connections should be designed so that the gas flows from smaller to larger diameter pipes.

Exhaust Pipe Design Principles



Item	Description
d	diameter
r	radius = 2.5d

3.6.2 Exhaust Pipes and Supports

CAUTIONS:

Maintain the original set-up and heat shields.

Do not position any components closer than 150mm nominal (100mm minimum) clearance to the downpipe, the catalytic converter, the diesel particulate filter, the selective catalyst reduction and any part of the exhaust system.

3.6.3 Exhaust Heat Shields

Exhaust Heat Shields

- Catalytic converters, in particular, operate at high temperatures.
- Ensure existing shields are maintained.
- Add further shields over exhaust system as necessary to avoid fire risk.

Standard Exhaust Heat Shields

CAUTION: Standard heat shields are available from your local dealer and can easily be fitted. Additional heat shields may be required over the modified exhaust system, particularly in areas of close proximity to the floor.

NOTE: For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

3.6.4 Diesel Particulate Filter (DPF)

The DPF forms part of the emissions reduction systems fitted to your vehicle. It filters harmful diesel particulates (soot) from the exhaust gas. For further information

Refer to: 4.8 Electronic Engine Controls (page 135).
DPF & RPM Speed Control.

Regeneration

WARNING: Do not park or idle your vehicle over dry leaves, dry grass or other combustible material. The DPF regeneration process creates very high exhaust gas temperatures. The exhaust will radiate a considerable amount of heat during and after DPF regeneration and after you have switched the engine off. This is a potential fire hazard.

Unlike a normal filter which requires periodic replacement, the DPF has been designed to regenerate, or clean itself to maintain operating efficiency. The regeneration process takes place automatically. However, some driving conditions mean that you may need to support the regeneration process.

If you drive only short distances or your journeys contain frequent stopping and starting, occasional trips with the following conditions could assist the regeneration process:

- Drive your vehicle, preferably on a main road or motor way, for up to 20 minutes avoiding prolonged idling, but always observing speed limits and road conditions.
- Do not switch off the ignition.
- Use a lower gear than normal to maintain a higher engine speed during this journey, where appropriate.

3.6.5 Vehicle Exhaust Systems — Vans with Full Bulkheads

Vehicle exhaust systems for vans with bulkheads are available in two lengths; a short length exhaust finishing approximately in the center of the vehicle, which is standard fit, and a long exhaust finishing at the rear of the vehicle. If you are undertaking any modification to the load compartment of the vehicle ensure that the most suitable length of exhaust is used to avoid exhaust gas ingress into the vehicle.

3.7 Fuel System

WARNINGS:

Do not cut into the original fuel supply lines.

Make sure that the modified vehicle complies with all relevant legal requirements.

NOTE: Auxiliary Fuel line comes with Fuel Fired Heater as an orderable option. The Auxiliary Fuel line is available as a service item.

For vehicles without auxiliary fuel line that require a fuel supply for applications (for example: auxiliary heater or fuel fired hand wash facility) it is advisable to use the auxiliary fuel supply port on the top of the fuel sender unit located on the top of the fuel tank as shown in figure E224457.

NOTE: To fit the auxiliary fuel line, the fuel tank will need to be lowered, see following process:

To lower fuel tank:

- Drain tank.
- Disconnect fuel lines between fuel tank and urea tank.
- Plug lines to prevent residual fuel from draining/spilling.
- Remove filler pipe from tank.
- Remove bolts securing the three tank straps.
- Lower the fuel tank to gain access to the top, see Figure E224457 for fitting auxiliary fuel line.

To refit fuel tank:

- Lift fuel tank ensuring not to trap fuel lines and electrical wires.
- Refit straps, torque bolts to 47.5Nm +/- 7.2Nm.
- Refit filler pipe to tank spud securing hose clip torque to 3.7Nm +/- 0.6Nm.
- Remove plugs and reconnect fuel lines.

CAUTIONS:

Make sure that sufficient clearance is maintained for all driving conditions to all hot and moving components.

Make sure that when the port is cut that it is smooth with no sharp edges or burrs.

NOTE: The tube and/or line must be routed independently and secured to the body structure or to suitable brackets.

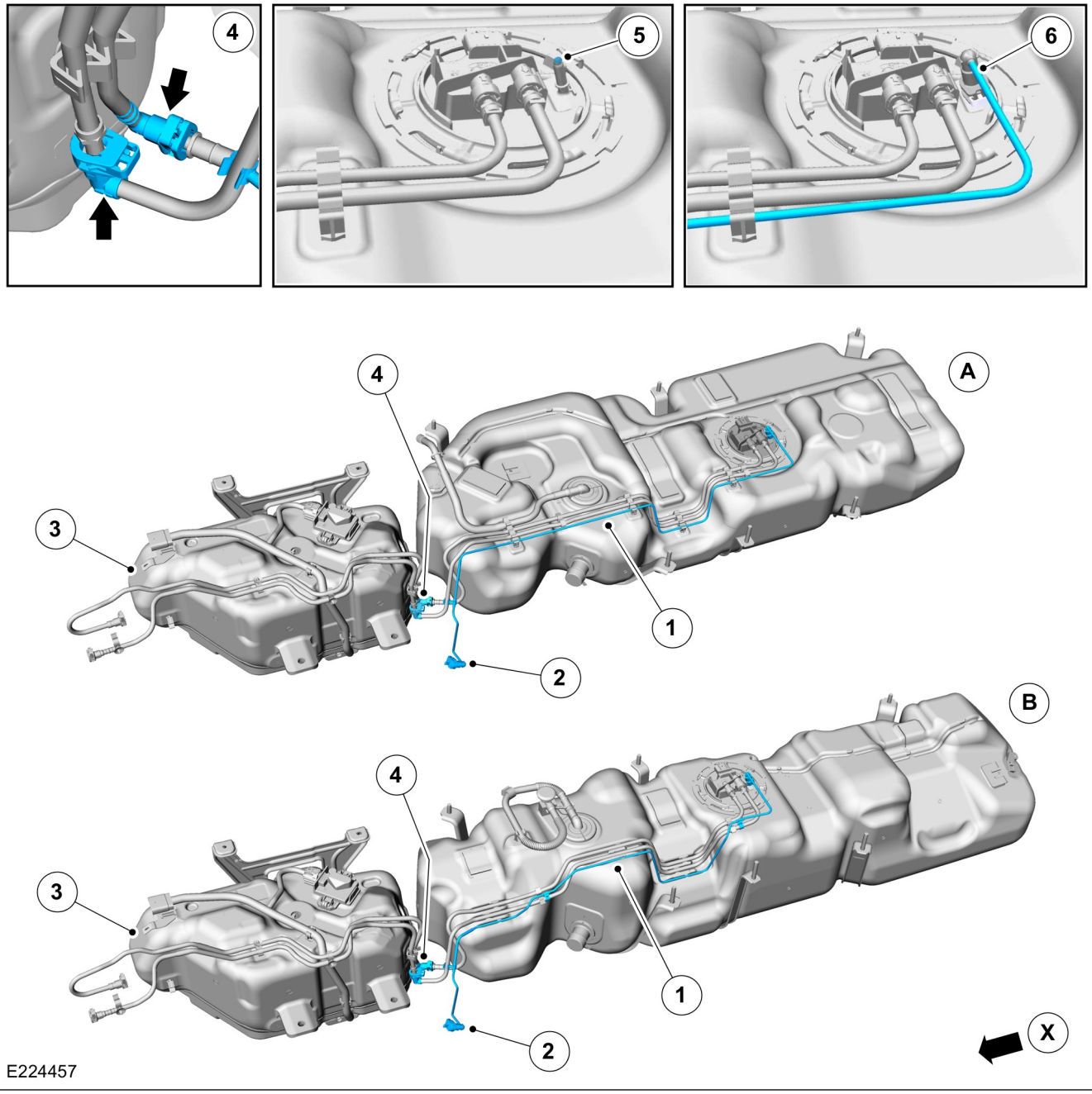
NOTE: Ensure that a suitable fuel shut-off is fitted in any unique system.

NOTE: Do not fasten anything to existing electrical components, wires or fuel lines.

For additional information

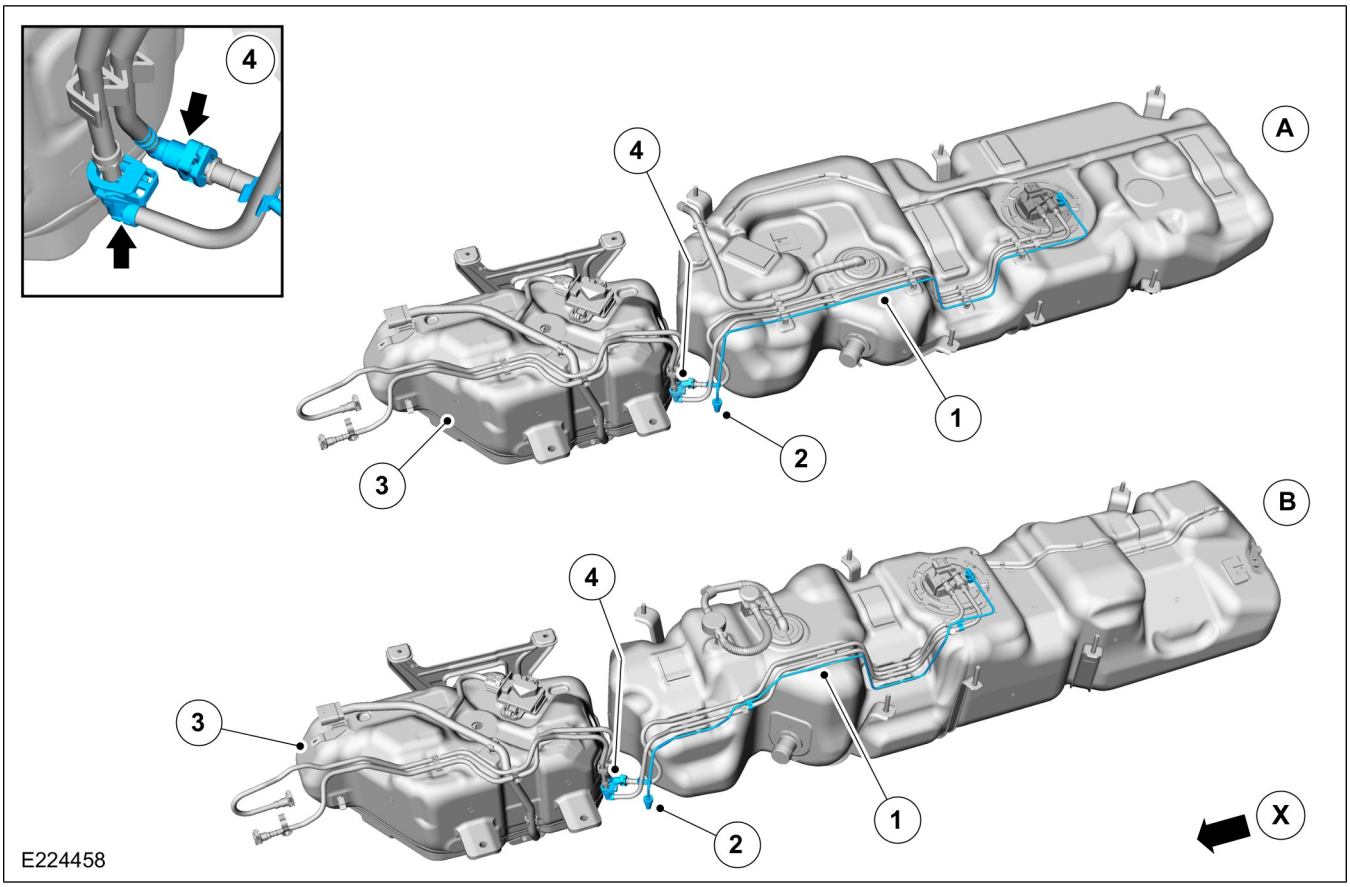
Refer to: 5.1 Body (page 214).
Floor 'Precautionary Drill Zones' Fuel Tank with UREA.

Auxiliary Fuel Line Supply Port Option - For all vehicles except Campers



Item	Description
A	FWD 80L Standard Fuel Tank Van, Bus and Kombi
B	RWD 80L Standard Fuel Tank/95L Optional Fuel Tank Van, Bus, Kombi and all Chassis Cabs
1	Auxiliary fuel line, part number FWD GK21-9N126-A*, RWD GK31-9N126-A*
2	Auxiliary fuel line has a female connector TI LOCC QC 7.89 fitted as standard. It is recommended to use a 7.89 male adapter mating part (manufacturer TI Automotive GmbH). For further information please contact VCAS@ford.com
3	UREA Tank/AdBlue® Tank
4	Disconnect fuel lines between Fuel Tank and UREA Tank
5	Cut off top of port of diesel delivery module flange leaving 19.64 +/- 0.12mm and carefully insert heater tube, part number FWD BK21-9T308-A*, RWD BK31-9T308-A*
6	Fix quick fit connector of fuel line to heater tube
x	Drive Direction

Auxiliary Fuel Line - For Camper vehicles



Item	Description
A	FWD 80L Standard Fuel Tank
B	RWD 80L Standard/95L Optional Fuel Tank - Van, Bus, Kombi and all Chassis Cabs
1	Auxiliary fuel line, part number FWD GK31-9N126-B*, RWD GK31-9N126-C*
2	Auxiliary fuel line has a male end adapter TI LOCC QC 7.89 fitted as standard with a female fuel spillage block connector. It is recommended to use a 7.89 female connector mating part (manufacturer TI Automotive GmbH), after female fuel spillage block connector is removed. For further information please contact VCAS@ford.com
3	UREA Tank/AdBlue® Tank
4	Disconnect fuel lines between Fuel Tank and UREA Tank
X	Drive Direction

4.1 Wiring Installation and Routing Guides

4.1.1 Wiring Harness Information

NOTE: Ford Motor Company has no control over the modification or installation process of the electrical content of auxiliary systems and therefore can take no responsibility for such installations.

The following provides an installation guide for any electrical modifications or additional systems being added to the vehicle. The aim is to maintain robust integration of auxiliary systems without compromising existing systems, in areas such as splicing techniques into existing wiring, module package location and EMC issues. It is also expected that the vehicle converter will test their installation and comply to all legal and homologation requirements.

4.1.2 General Wiring and Routing

Temperature requirements: Wiring systems in the vehicle interior are expected to function over the temperature ranges of – 40ºC to 85 ºC for exposure and – 40ºC to 75ºC for function. For engine compartment and underbody, the minimum temperature is - 40ºC, while the maximum exposure and operational temperatures are +125ºC for exposure and 105ºC for operational.

Make sure that the insulation is compatible with any fluids it may encounter , for example: gasoline, oil, antifreeze, brake fluid, transmission fluid and power steering fluid.

If a connector will be located in a hostile environment or wet area use a sealed connector. 'Hostile environment' areas include the engine compartment, wheel wells, underbody and doors.

Do not route wires near weld points or weld flashes. A minimum of 15mm clearance to any sheet metal welds under static and dynamic conditions is required. However, it is best to avoid routing near weld points or weld flashes at all times.

In general, the distance between retention points for wiring not contained in a rigid shield should be less than 300mm.

A minimum 25mm clearance is recommended from all sharp edges and a minimum 35mm clearance of all moving parts of the parking brake assembly. If these clearances can not be met, protect the wires with a convolute.

For conversions with walkthroughs, it is recommended to provide appropriate protection on the floor in the walkway.

4.1.3 Connector Pin Out Practices

When designing a harness to component connection, it is best practice to put the female terminals in the harness side connection and the male terminals in the component side. When determining connector pin outs, make sure that power and ground circuits are not in close proximity, adjacent, to one another. A minimum separation of 5 mm between power and ground circuits is required.

WARNING: Do not use connectors which cut through the outer covering and into the core wire.

CAUTION: Only use Ford approved connectors

Cutting into vehicle wiring is not permitted because:

- The base vehicle specification is unsuitable for incremental loads except in conjunction with Special Vehicle Option Auxiliary Fuse Panel.
- Long term risk of a faulty connection developing.
- Potential fire risk from over-loading.

All connections into existing wiring must be permanently insulated. Exterior connections must be water-proof.

When designing electrical circuits, or making alterations, the following must be considered:

- Current rating of wiring, see table 'Current Rating of Wire Sizes' in this section.
- Any voltage drop in the circuit should not lower the terminal voltage at consumption point to below 95% of battery voltage.
- Do not cut into the original harness.
- Additional earth returns should be included to support new equipment.
- A supplementary circuit diagram and accompanying instructions should be added to the Owner's information or a separate manual supplied with the vehicle for each unique component.

NOTE: For further information please contact your local National Sales Company representative, or local Ford Dealer.

Where wires are required to be extended, break in points and only Ford approved connectors should be used.

Ford approved jumper harnesses should be used.

4.1.4 Unused Connectors

The harnesses may have a number of unused connectors, which are dedicated to other features and options, for example heated seats, but are **not** always present depending on level of harness fitted. Ford **do not** recommend the use of these connectors for any other purpose than that intended by design.

4.1.5 Grounding

Drill point screws are not to be used for any ground attachments:

- Do not ground to moving structures, for example: doors, deck lids, lift gates, as the ground return path through the hinges is not reliable.
- Do not place more than 2 eyelet terminals under a single ground screw.
- Do not place electrical component attachments or ground screws adjacent to vehicle fuel tanks or fuel lines.

4.1.6 Prevention of Squeaks and Rattles

Wiring should be positively retained every 150 to 250mm. All connectors should be positively retained. Use tapes which do not squeak against metal or plastic.

4.1.7 Water Leakage Prevention

Make sure that drip loops are provided to prevent water leakage into the vehicle interior, passenger and cargo compartments, using wiring assemblies that pass from outside into the vehicle interior. The drip loop is a section of wiring that is deliberately formed and routed BELOW the point of entry into the vehicle, so that gravity assists in forming water droplets that escape from the lowest part of the wiring.

Wiring from door to passenger compartment, should be made such that the door entry point is below the passenger compartment entry point, which creates a type of drip loop.

4.1.8 Wiring Splicing Procedures

TYCO-RAYCHEM crimp splices



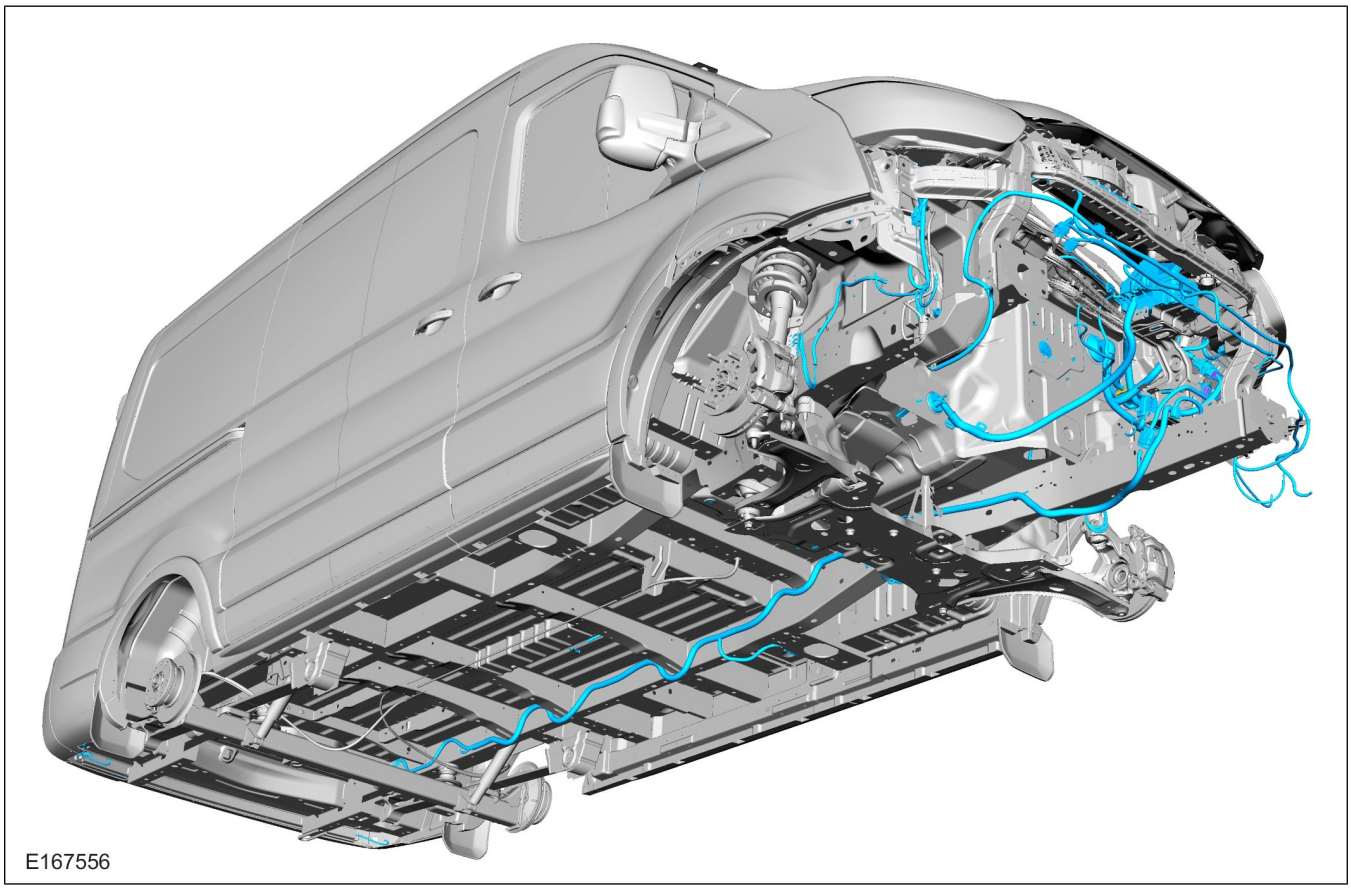
E131081

Ford Motor Company strongly advises against the use of wire splicing due to the variable and unpredictable nature of making robust, durable and reliable connections. However, if it is deemed that a wire splice is absolutely unavoidable, it must be made with **DuraSeal Heat-Shrinkable, Environmentally Sealed, Nylon-Insulated Crimp Splices** (manufactured by TYCO-RAYCHEM). For example the D406 series. As a further process to improve the splice integrity, the splice should be further sealed with a suitable heat shrink tubing. See Figure E131081.

4.1.9 Wiring Specification

	Conductor Resitance mOhm/m					
	Maximum			Minimum		
ISO Conductor Size mm² CSA	Plain Copper	Tinned Plated Copper	Nickel Plated Copper	Plain Copper	Tinned Plated Copper	Nickel Plated Copper
0.13	136	140	142	-	-	-
0.22	84.8	86.5	87.9	-	-	-
0.35	54.4	55.5	56.8	-	-	-
0.5	37.1	38.2	38.6	-	-	-
0.75	24.7	25.4	25.7	22.7	23.3	23.6
1	18.5	19.1	19.3	17.0	17.6	17.7
1.5	12.7	13.0	13.2	11.7	11.9	12.1
2.0	9.42	9.69	9.82	8.66	8.91	9.03
2.5	7.60	7.82	7.92	6.99	7.19	7.28
3	6.15	6.36	6.41	5.66	5.85	5.89
4	4.71	4.85	4.91	4.33	4.46	4.52
5	3.94	4.02	4.11	3.62	3.70	3.78
6	3.14	3.23	3.27	2.89	2.97	3.01
8	2.38	2.52	2.60	2.19	2.32	2.39
10	1.82	1.85	1.90	1.68	1.70	1.75
12	1.52	1.60	1.66	1.40	1.47	1.53
16	1.16	1.18	1.21	1.07	1.09	1.12
20	0.955	0.999	1.03	0.870	0.919	0.948
25	0.743	0.757	0.774	0.688	0.701	0.716
30	0.647	0.684	0.706	0.595	0.629	0.650
35	0.527	0.538	0.549	0.489	0.500	0.510
40	0.473	0.500	0.516	0.435	0.460	0.475
50	0.368	0.375	0.383	0.343	0.350	0.357
60	0.315	0.333	0.344	0.290	0.306	0.316
70	0.259	0.264	0.270	0.243	0.248	0.254
95	0.196	0.200	0.204	0.185	0.189	0.193
120	0.153	0.159	0.159	0.146	0.149	0.152

When designing wire installations for additional equipment use the cable size recommended by the equipment manufacturer or select a suitable size from the 'Current Rating of Wire Sizes' table.


E167556

Electromagnetic Compatibility (EMC) Awareness

The installation and routing of Ford wiring, (example of wiring shown in figure E167556), have been fully-validated and have passed the requisite EMC tests. Ford Motor Company, however, are not responsible for the vehicle's EMC immunity when non-Ford-approved systems are installed.

WARNING: Do not route other wiring near/close to electrical cables with the Anti-Lock Brake System and Traction Control System cables because of extraneous signal risk. It is generally not recommended to hang extra wiring off existing looms or pipes.

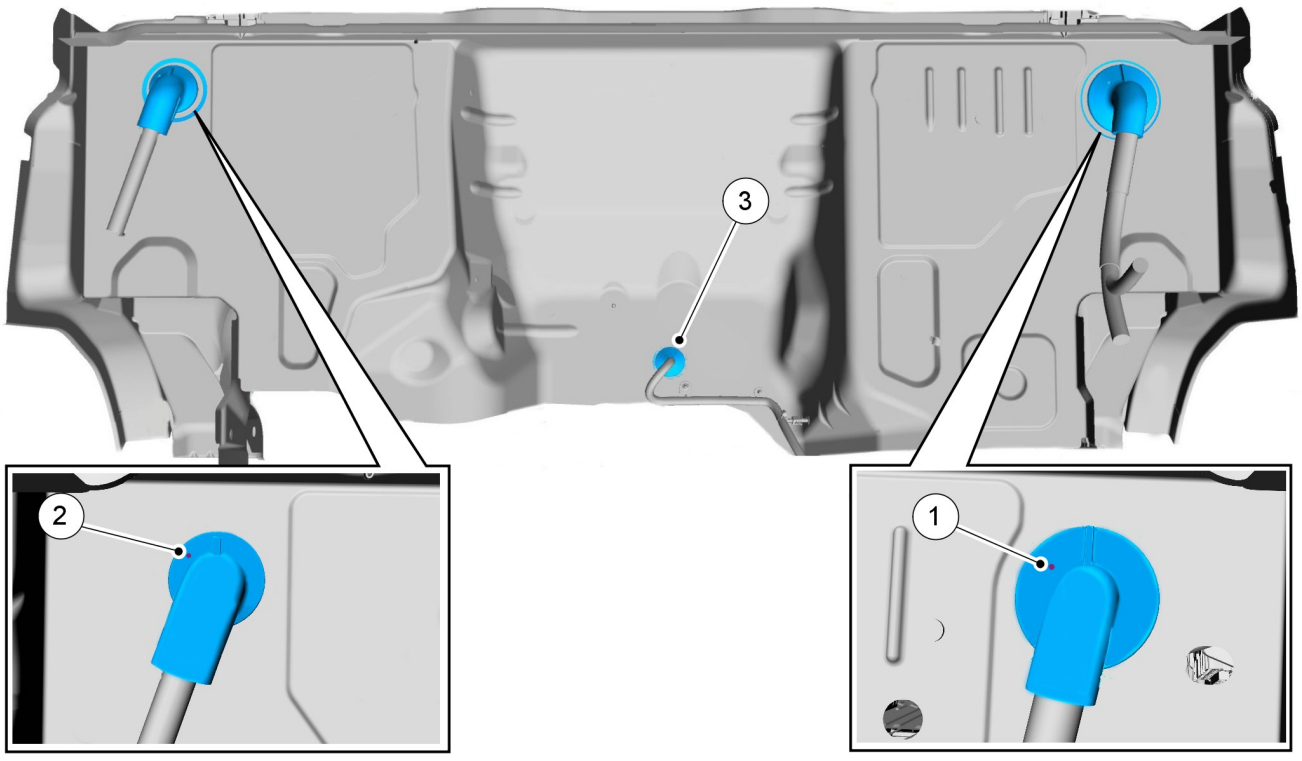
Wiring must be suitably fixed without any detrimental effect on other wiring.

Single or bunched looms must maintain the following clearances:

- 10mm from static components (unless clamped to it).
- 250mm from exhaust system.
- 30mm from rotating or moving components.

4.1.11 Wiring Through Sheet Metal

Front Wheel Drive Dash Panel (Left Hand Drive Shown)



E145360

Item	Description
1	Dash Grommet Left Hand Side
2	Dash Grommet Right Hand Side
3	This location is available on Rear Wheel Drive vehicles and Front Wheel Drive without Tachograph

WARNING: Harnesses passing through sheet metal must be through protective grommets that also ensure a watertight seal. A windscreen type sealer should be used. Adhesive or tape is not acceptable.

NOTE: Holes must permit the appropriate connector to pass through.

NOTE: The maximum size of additional wire bundle diameter is 6mm

There are three locations in the dash panel which have been identified for additional holes to route wires through. See figure E145360 (view from engine bay) for locations. The number of suitable locations will depend on the vehicle specification.

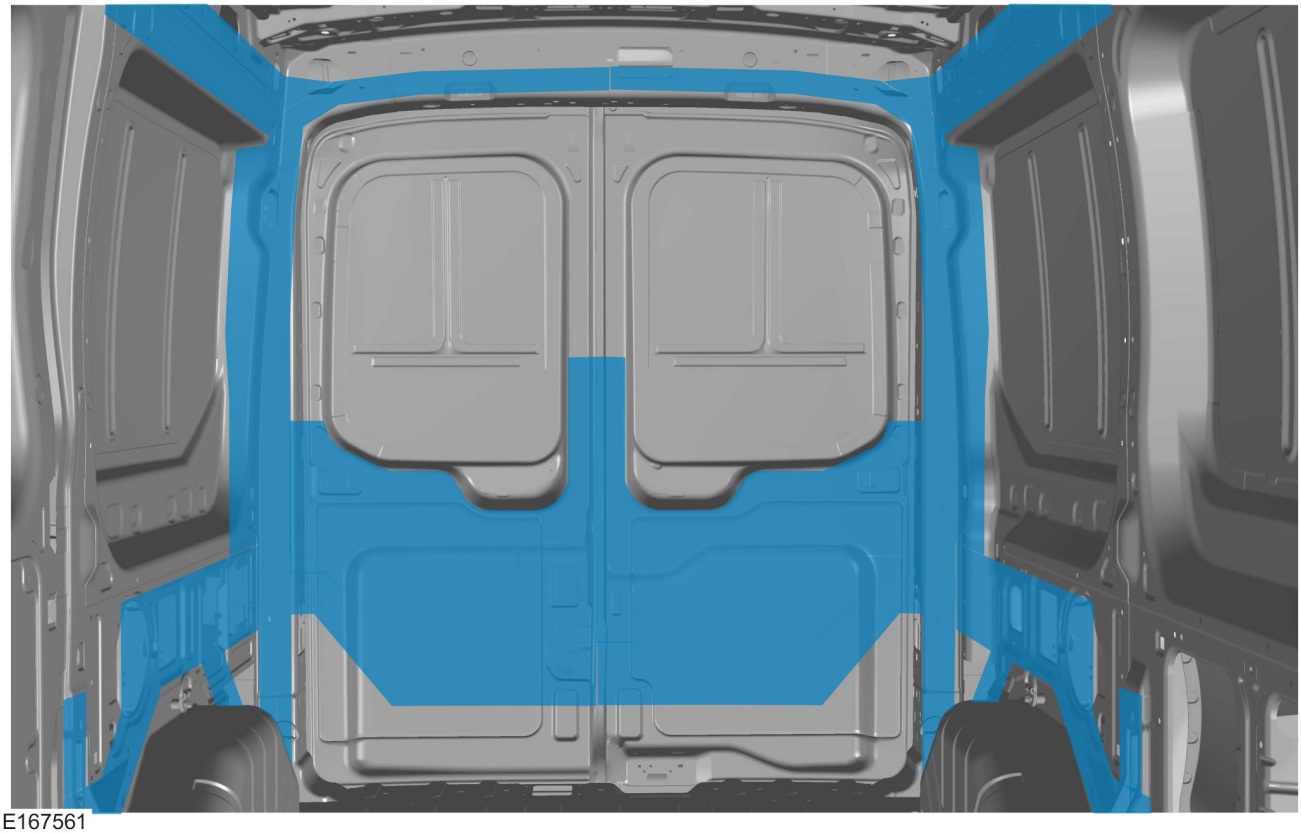
The grommets in locations 1 and 2, shown in figure E145360, are molded directly to wire bundles in polyurethane foam material. It is not possible to feed extra wires through with the wire bundle. The grommets have an 'indent' molded into the surface face, engine bay side, which show the positions where an additional hole can be made using the following procedure:

- Check that the immediate surrounding area is free from obstructions and/or components to prevent damage to critical systems.
- Use a suitable tool, for example: a drill or spike bit.
- Insert the drill or spike bit, horizontal and parallel, through the indent of the grommet , making sure not to extend further than 25mm through the grommet surface, this will help eliminate any possible damage to items on the passenger side of the grommet.

Ford released hardware is available to support further installations to the vehicle. Only this hardware and released parts are to be used for this.

4.1.12 No Drill Zones — Rear Cargo Area

Precautionary Drill Zones L2/H2 — Rear Cargo Doors



E167561

CAUTION: Do not drill into the vehicle before checking the precautionary drill zones and electrical wire routing.

The areas marked in blue on figures E167561 - E167565 show the Precautionary Drill zones for the rear cargo area where there is wire routing and is to be avoided, (for example: when installing cladding and racking). The same care should also be taken when using self tapping screws. Not all derivatives are shown but the routing is the same for roof line and wheel base with regards to B, C and D pillars or roof bows and doors. Other non electrical systems may also be present, for example: fuel tank under floor so it is important to check before drilling. For additional information refer to the following links.

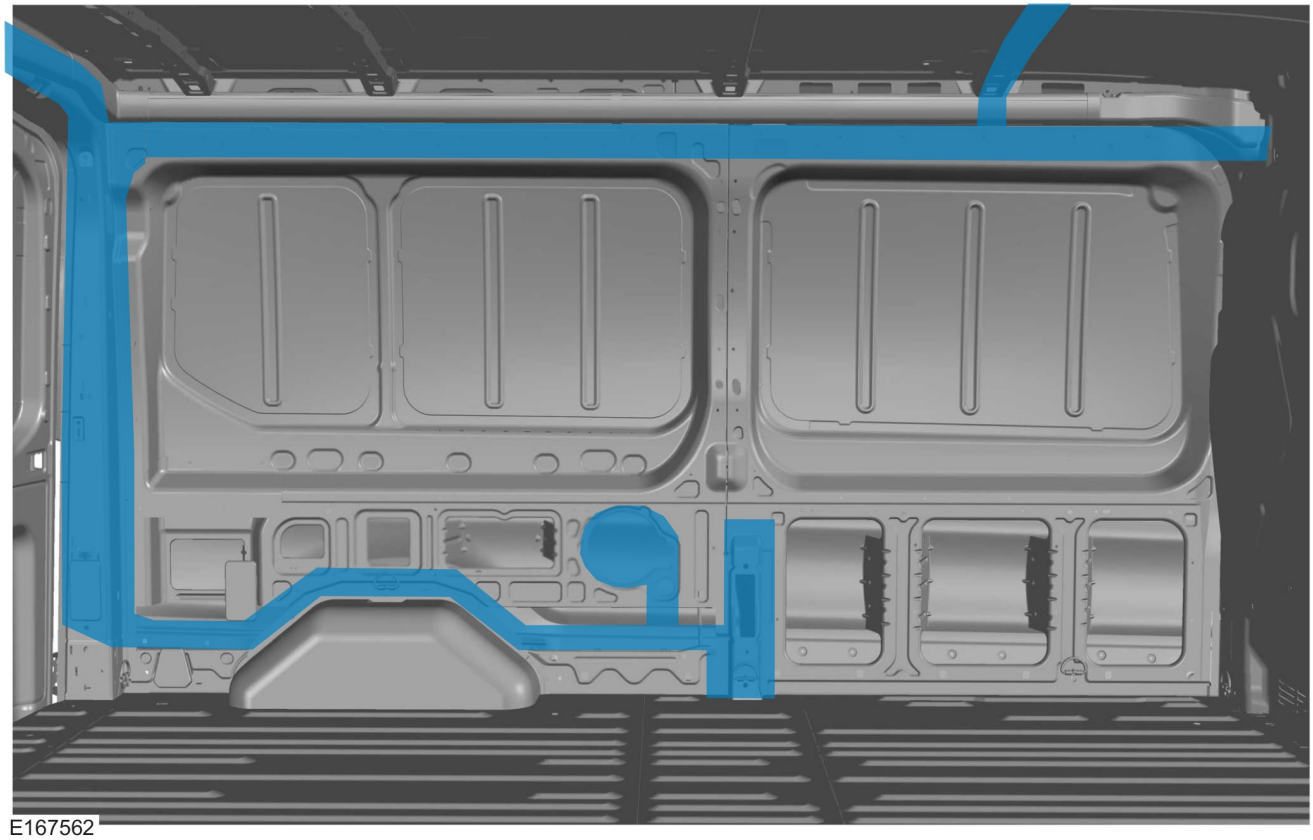
Refer to: 5.1 Body (page 214).

Precautionary Drill Zones
Refer to: 5.4 (page 246).
Load Compartment Tie Downs
Refer to: 5.3 Racking Systems (page 243).
Refer to: 5.6 Body Closures (page 249).
No Drill Zones - Closures

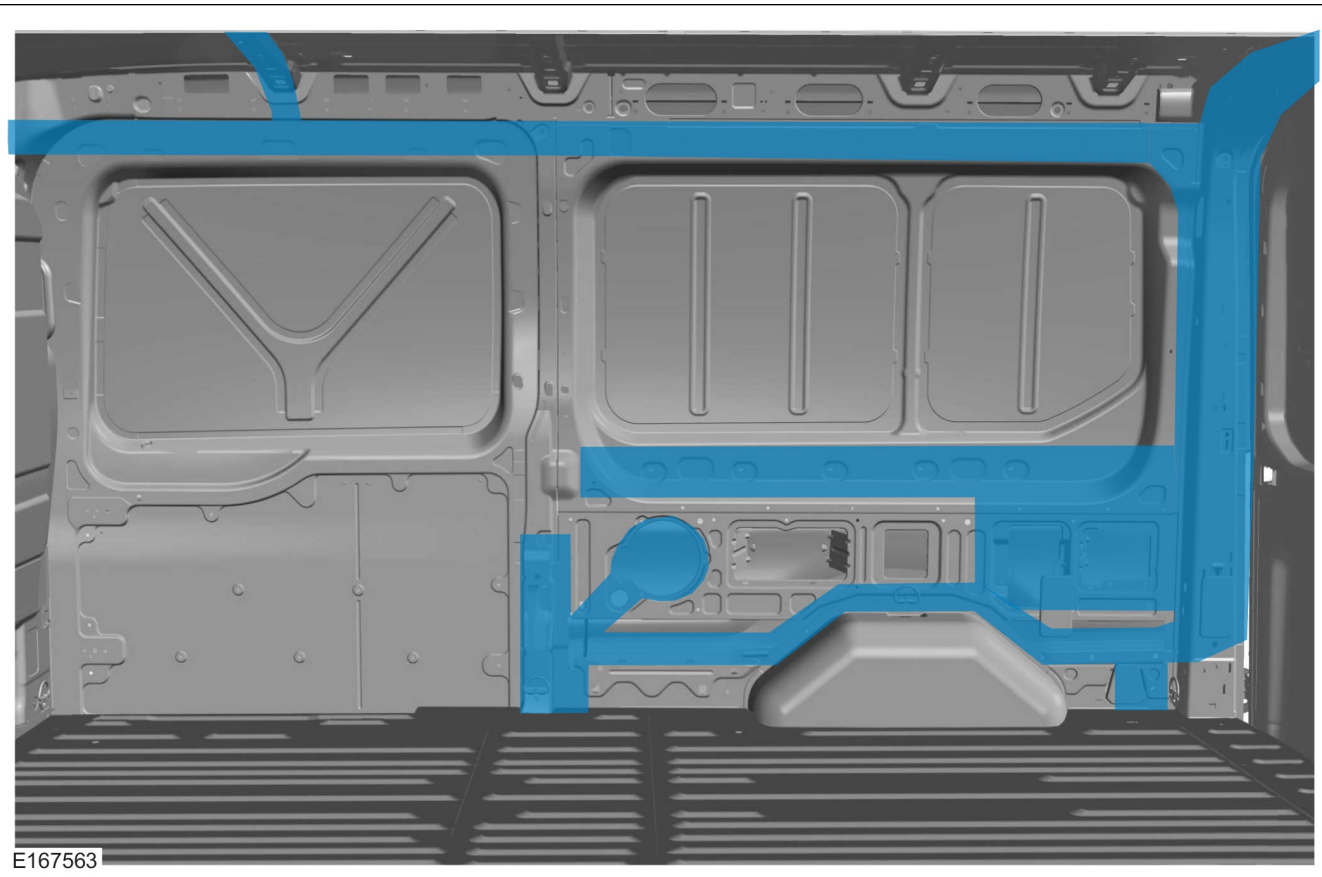
For vehicle wheelbase and Roof height

Refer to: 1.13 Package and Ergonomics (page 29).
'Vehicle Dimension Key' in this manual

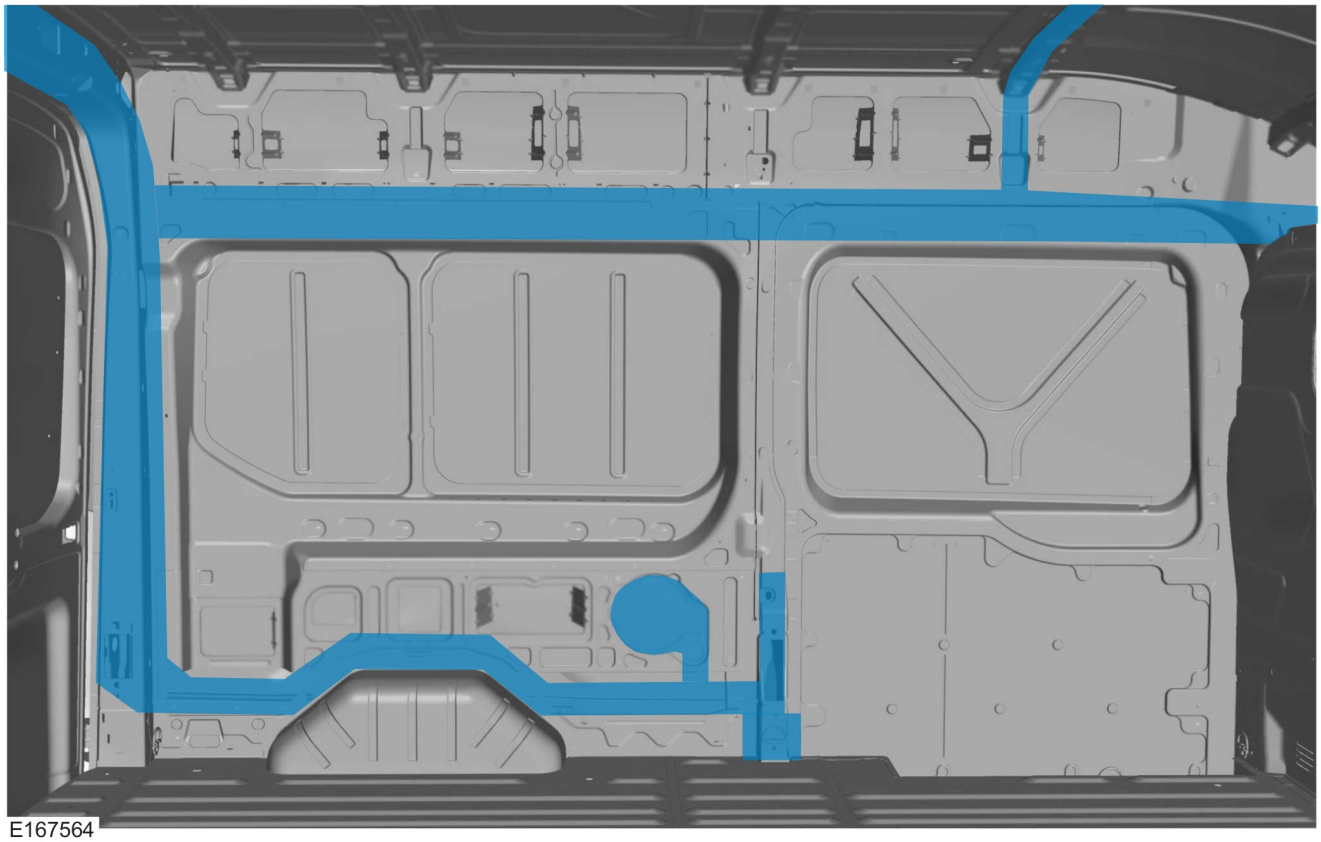
Precautionary Drill Zones L3/H2 — Left Hand Side


E167562

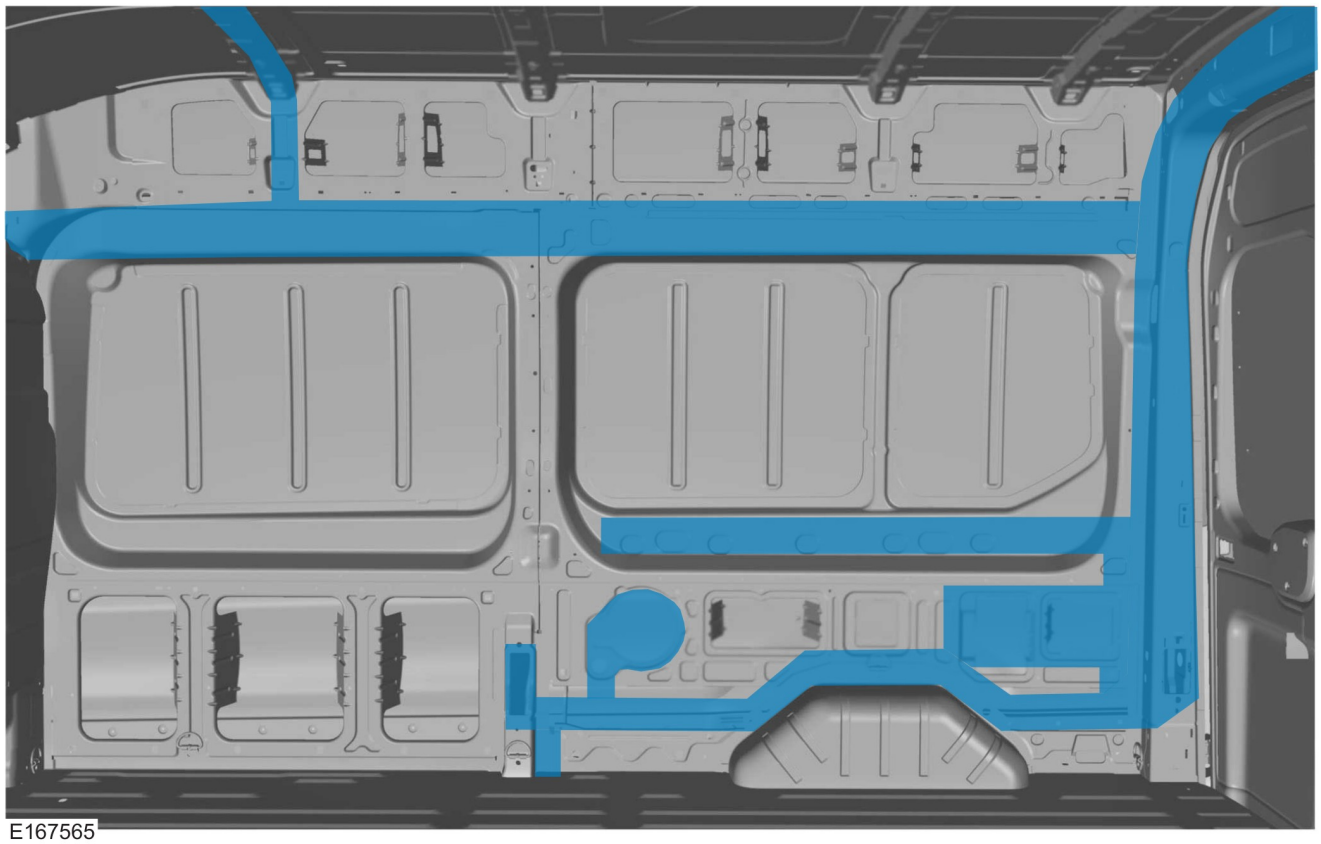
Precautionary Drill Zones L3/H2 - Right Hand Side


E167563

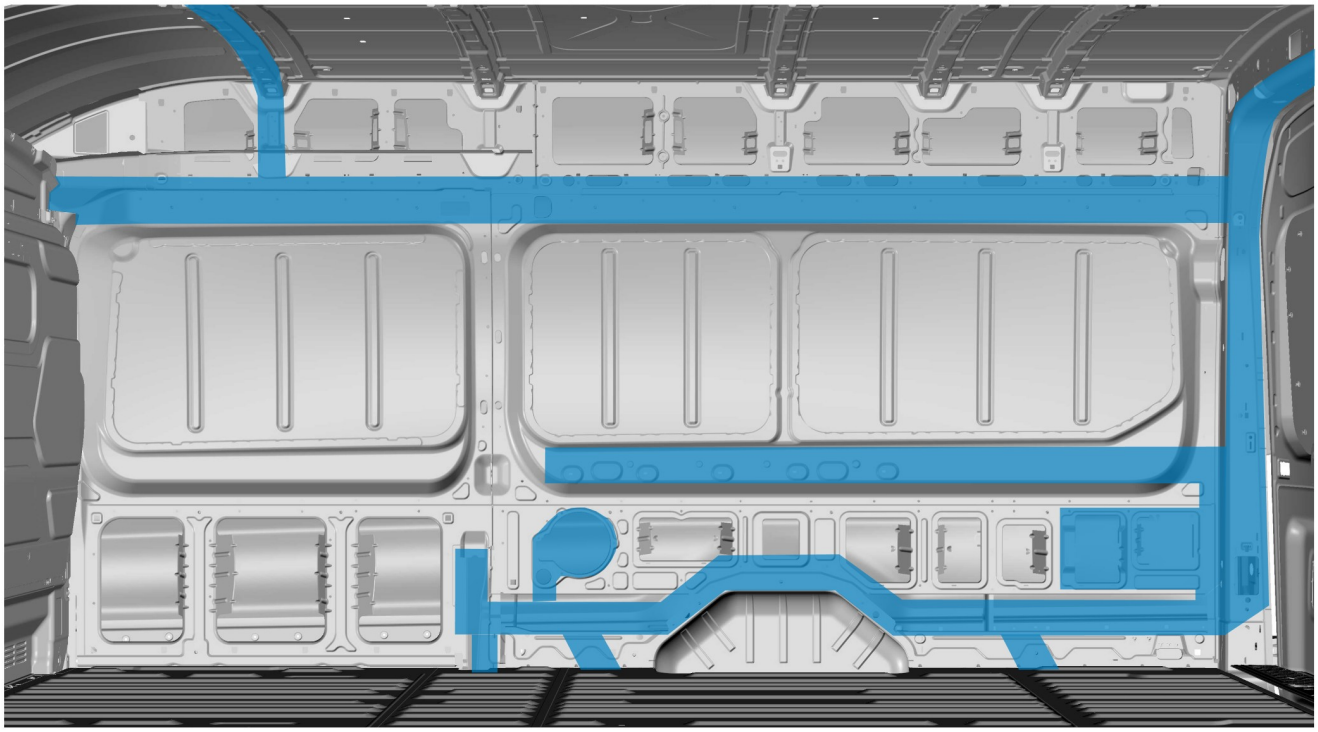
Precautionary Drill Zones L3/H3 - Left Hand Side


E167564

Precautionary Drill Zones L3/H3 - Right Hand Side


E167565

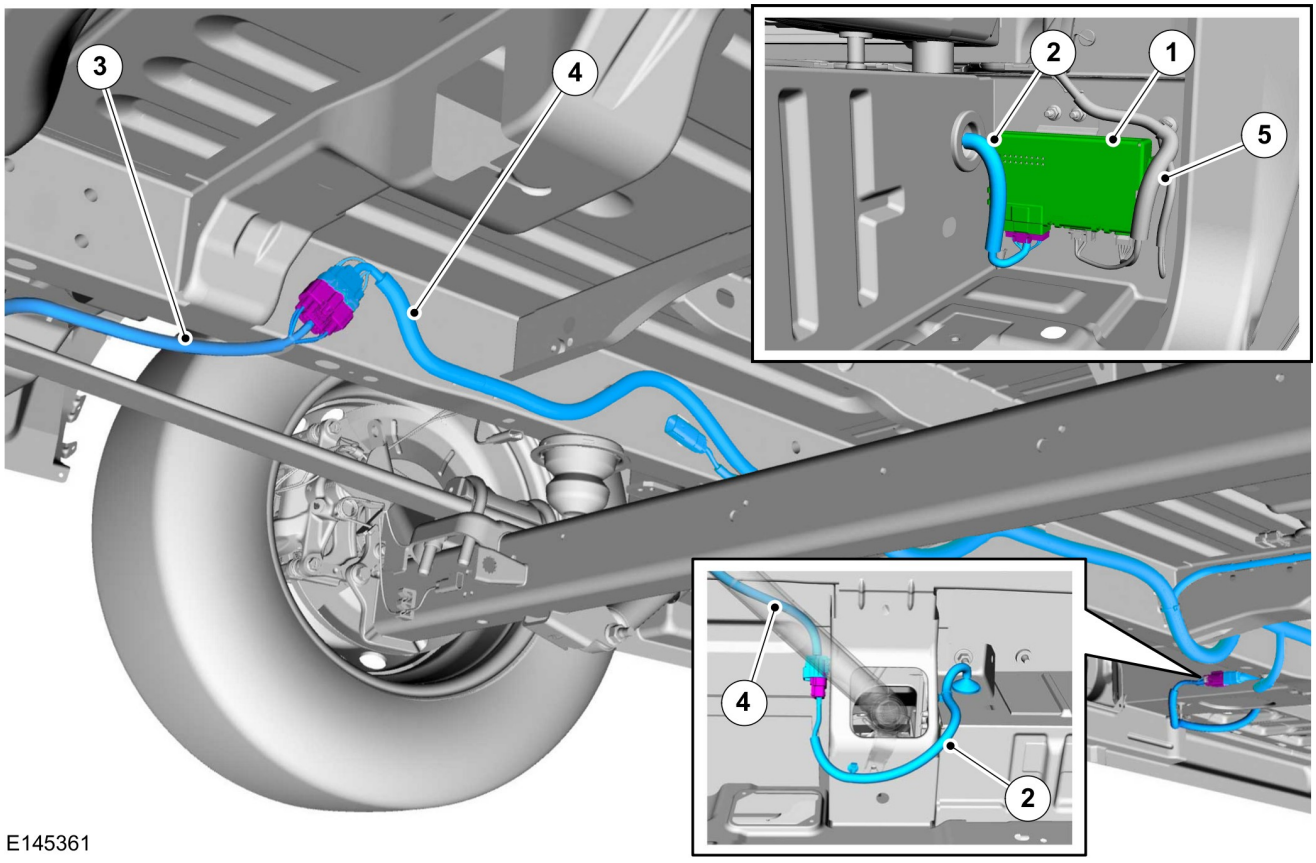
Precautionary Drill Zones L4/H3 - Right Hand Side



E167560

4.1.13 Electrics for Tow Bar

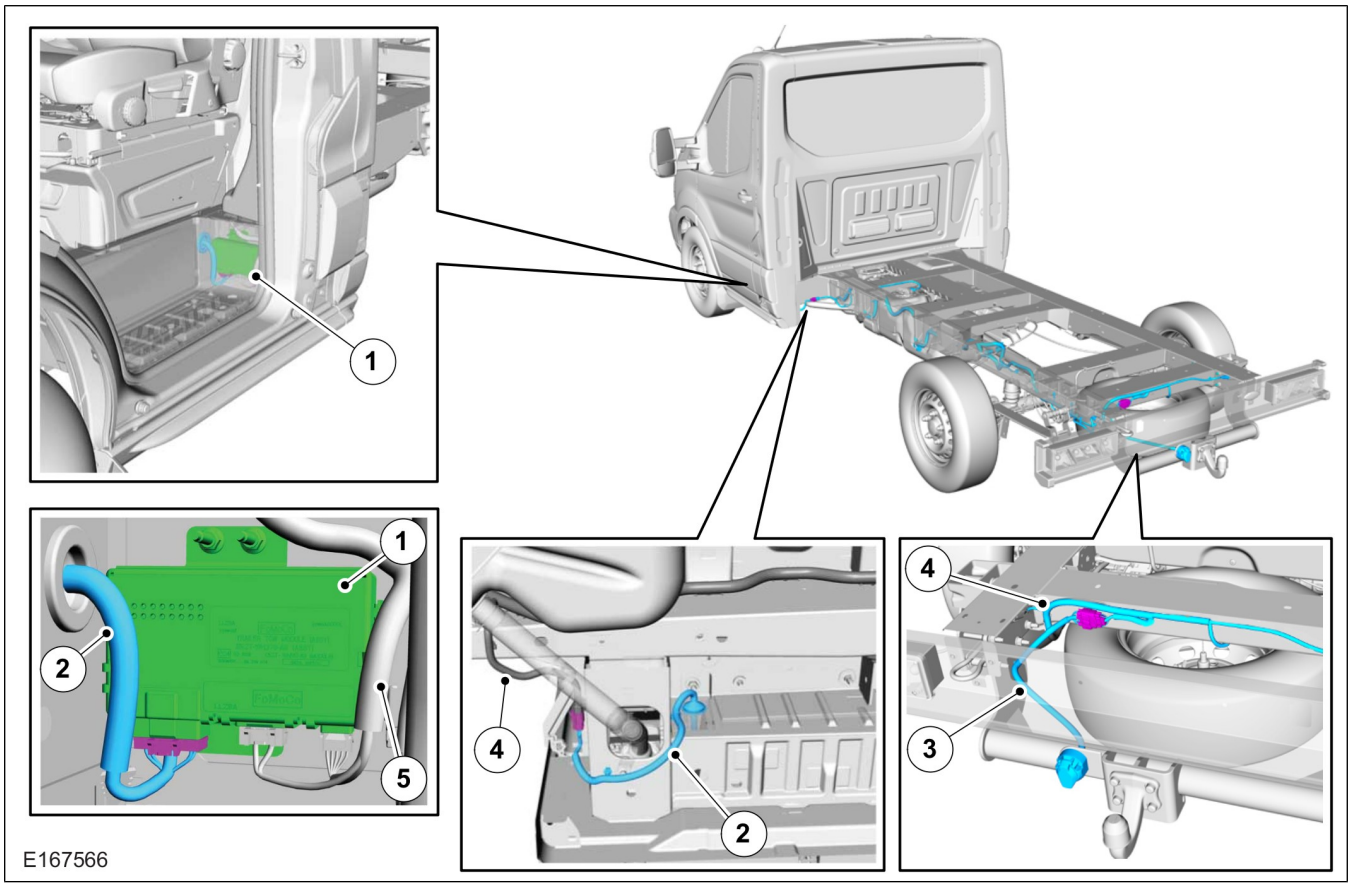
Trailer Tow Module and Harnesses - Van, Bus and Kombi Vehicles



E145361

Item	Description	Part Number
1	Trailer Tow Module	GK2T-19H378-A*
2	Trailer Tow Jumper (with Trailer Tow Module connector 'A' see figure E185972)	GK2T-13B576-A*
3	Trailer Tow Socket Jumper FWD	BK3T-13B576-E*
	Trailer Tow Socket Jumper RWD	BK3T-13B576-F*
4	Fuel Tank Harness	GK3T-14406-E*
5	Main Harness (with Trailer Tow Module connectors 'B' and 'C' see figure E185972)	GK3T-14401-**

Trailer Tow Module and Harnesses - Chassis Cab Vehicles



E167566

Item	Description	Part Number
1	Trailer Tow Module	GK2T-19H378-A*
2	Trailer Tow Jumper (with Trailer Tow Module connector 'A' see figure E185972)	GK2T-13B576-A*
3	Trailer Tow Socket Jumper	BK3T-13B576-G*
4	Fuel Tank Harness	GK3T-14406-E*
5	Main Harness (with Trailer Tow Module connectors 'B' and 'C' see figure E185972)	GK3T-14401-**

Tow bar electrical system may be ordered as a 13-pin DIN connector, as part of the original vehicle build.

Where it is required to add trailer towing to an existing vehicle, and to ensure compliance with lighting regulations, the appropriate wiring accessory kit can be obtained from your Ford Dealer.

Fitment of non-Ford trailer tow wiring is not advisable due to Body Control Module control of lighting, and meeting legal lighting regulations. Contact your local Ford dealer for details of a harness that connects to the base vehicle harness.

NOTE: The Ford trailer tow system is integrated with the Ford park aid system. When a trailer is connected, the system communicates on CAN only, to deactivate reverse park aid feature, there is no hardwired interface. It is not possible to turn off reverse park aid with an aftermarket trailer tow system.

NOTE: For Van tow bars it is necessary to connect into the rear lamp unit.

NOTE: If tow bar connectors are not used, appropriate fixing and cover must be applied for protection from water and contaminant ingress.

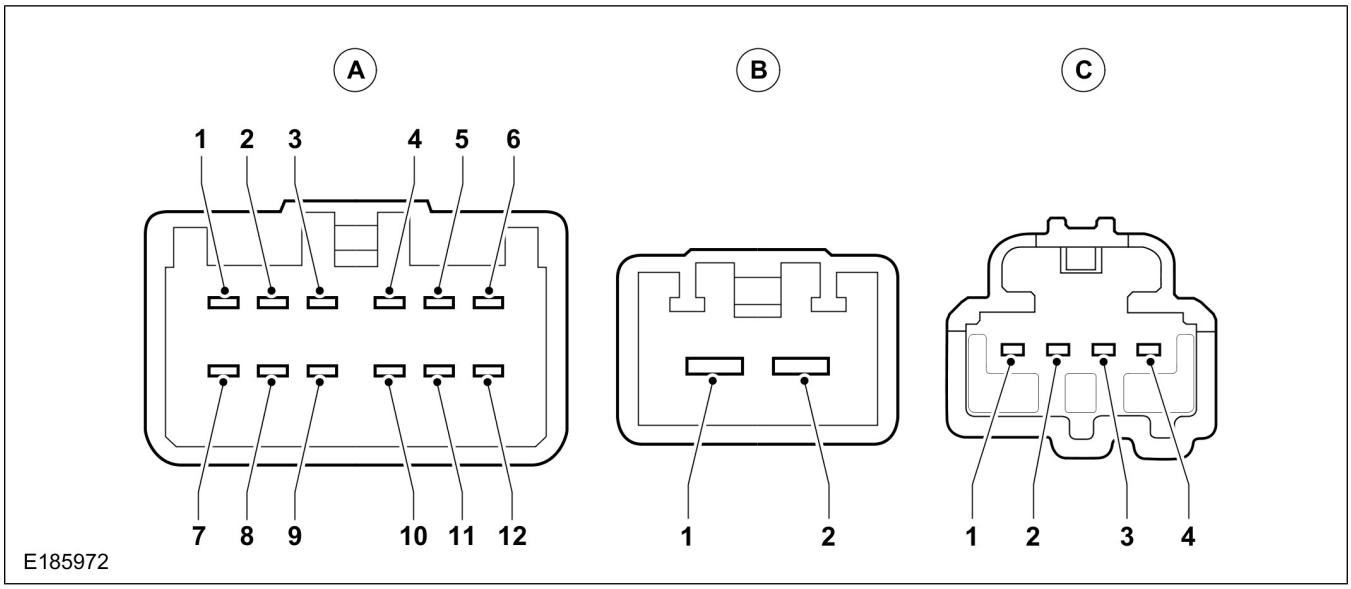
NOTE: The trailer detect circuit is part of the Ford Trailer Tow module, it can only be implemented on vehicles with power locking and perimeter or CAT 1 alarms.

A higher current is interpreted as short circuit. If a short circuit is detected the related output will be switched off. The following table shows the recommended output maximums per circuit.

Trailer Tow Module Connectors (Figure E185972 and E145361)

Component Terminal Number	Feature	Current (A)		Voltage (V)	
		Min	Max	Min	Max
Connector A					
1	Left Turn Lamp	2.1	3.4	8	19.0
2	Right Turn Lamp	2.1	3.4	8	19.0
3	Position Lamp	5.3	8.6	8	19.0
4	Not used	-	-	-	-
5	Reverse Lamp	3.1	5.0	8	19.0
6	Battery Charge	13.0	15.0	8	16.0
7	Stop Lamp	3.1	11.0	8	19.0
8	Rear Fog Lamp	1.7	2.2	9.5	16.0
9	Not used	-	-	-	-
10	Not used	-	-	-	-
11	Not used	-	-	-	-
12	Not used	-	-	-	-
Connector B					
1	KL30	19.9	27.6	8	19
2	Battery Charge Feed KL30	12	12	8	16
Connector C					
1	Ground	0.5	0.5	8	19
2	MS CAN L	0.1	0.1	5	5
3	MS CAN H	0.1	0.1	5	5
4	Trailer Parameter Alarm	0.01	0.013	8	19

Trailer Tow Module Connectors



The TTM offers a battery charge output. This output is used for loading a trailer battery with a maximum parameter current of 10A. If the current exceeds 10A the output is switched off until the current drain goes below 10A. The voltage used to charge this battery is designed to maintain current charge up to 10A but not fully charge the battery or let it discharge. This voltage is approximately 13.5V. Full charge strategy should be performed separately.

The maximum total current is 30A of all circuits. If this is exceeded the battery charge output is switched off.

Summary:

- Max permanent current: 10A
- Switch on condition:
  - Power Mode > = Accessory_1
  - Total power consumption (all lights + battery charge) < 30A
  - Permanent battery charge output current < = 10A
  - 9V < TTM power supply voltage < 16V
- Short circuit detection: 30A

If trailer tow system is to be added, the correct wiring and module needs to be ordered. The vehicle needs to have Central Car Configuration (CCC) programmed to the correct parameters:

CCC Parameter 20

- 0x1 without trailer tow
- 0x5 with trailer tow

NOTE: It is mandatory that a trailer is detected. Therefore at least one of the following lights have to be connected in the **on mode** or in the **stand by mode** (anti theft mode): Stop right, Stop left, Position lights or Direction indicator left.

If a trailer is detected the trailer detection hardware output (JP3-pin 5) is set low (open drain).

If a short circuit is detected or an overheating of the drivers occurs, the related output remains off until an ignition cycle is performed and the engine is restarted.

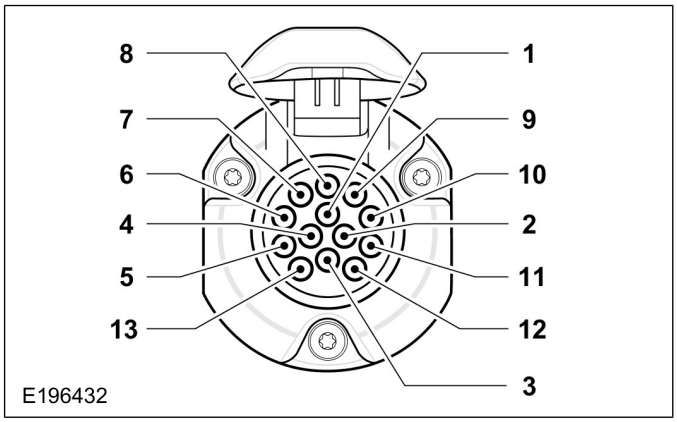
The trailer detection uses a strategy of having a 1K ohm resistor if the lights are not actually switched on to detect that the trailer has been connected. If a trailer light is already switched on the related current will be checked.

4.1.14 Trailer Tow Connectivity

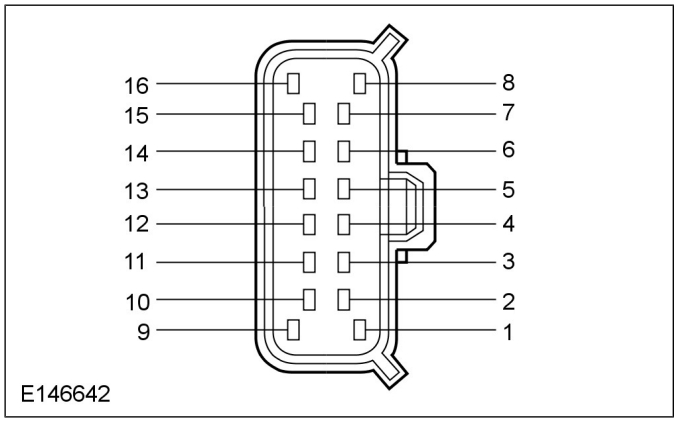
Trailer Tow Connectivity 13 Pin Socket

14406 Trailer Tow Connector		13 Pin Trailer Tow Connector	
Pin	**Color**	**Pin**	**Description**
3	Yellow	1	Left Turn Lamp
5	Grey/Orange	2	Fog
1	Black/Violet	3	Lamp Ground
6	Green	4	Right Turn Lamp
14	Brown	5	Right Position Lamp
12	Red	6	Stop Lamps
13	Brown	7	Left Position Lamp Licence Lamp
11	Grey/Brown	8	Reverse Lamp
9	Blue/Red	9	KL30 Power
10	Grey/Yellow	10	KL15 Ignition
8	Black/Violet	11	Ignition Ground KL15
Not Used	Not Used	12	Trailer Detect
16	Black/Violet	13	Power Ground

Trailer Tow 13 Pin Socket

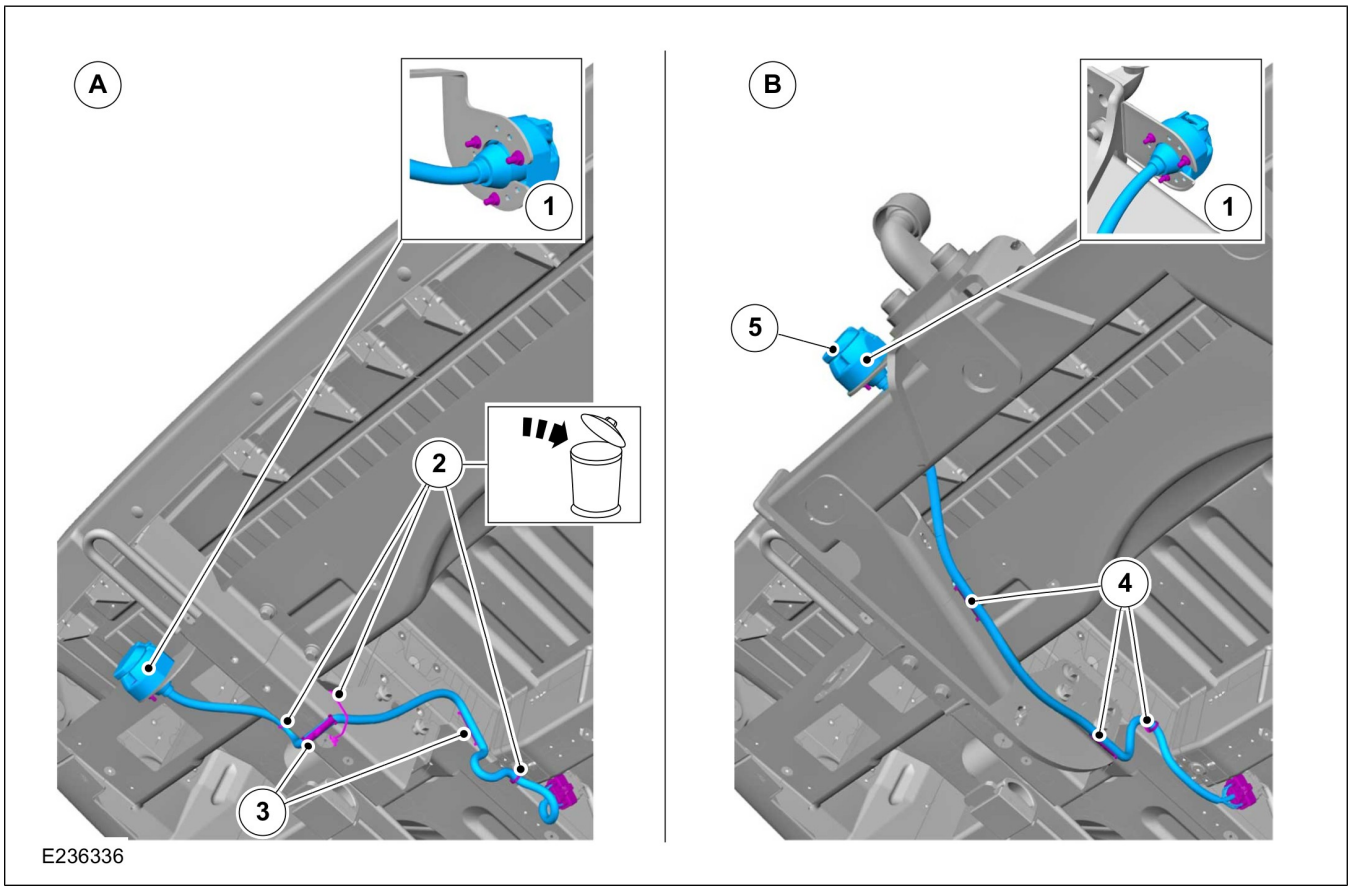


Trailer Tow 14406 Interface Connector



The Body Control Module **does not** support the incremental load of powering side marker lamps on a trailer, if these are required they should also be driven using separate relays.

4.1.15 Trailer Tow Electric (A055)



Item	Description
A	Trailer Tow Electric Wiring Kit without a Tow Bar
B	Rerouted Trailer Tow Electric Wiring Kit with a Tow Bar Retrofitted
1	3x Screw for 12V Socket
2	Cable Ties 3x
3	Wiring clips 2x
4	Recommended Wiring Clip Position 3x
5	Recommended 12V Socket Postion

NOTE: Fix overlength of the wiring on a secure area of the vehicle.

NOTE: The 12V socket bracket can stay in its original position when the socket is mounted in a different location.

Figure E236336 shows the routing for the Trailer Tow Electric Wiring Kit (A055) without a tow bar and the recommended wiring routing and wiring clip positions if a tow bar will be retrofitted.

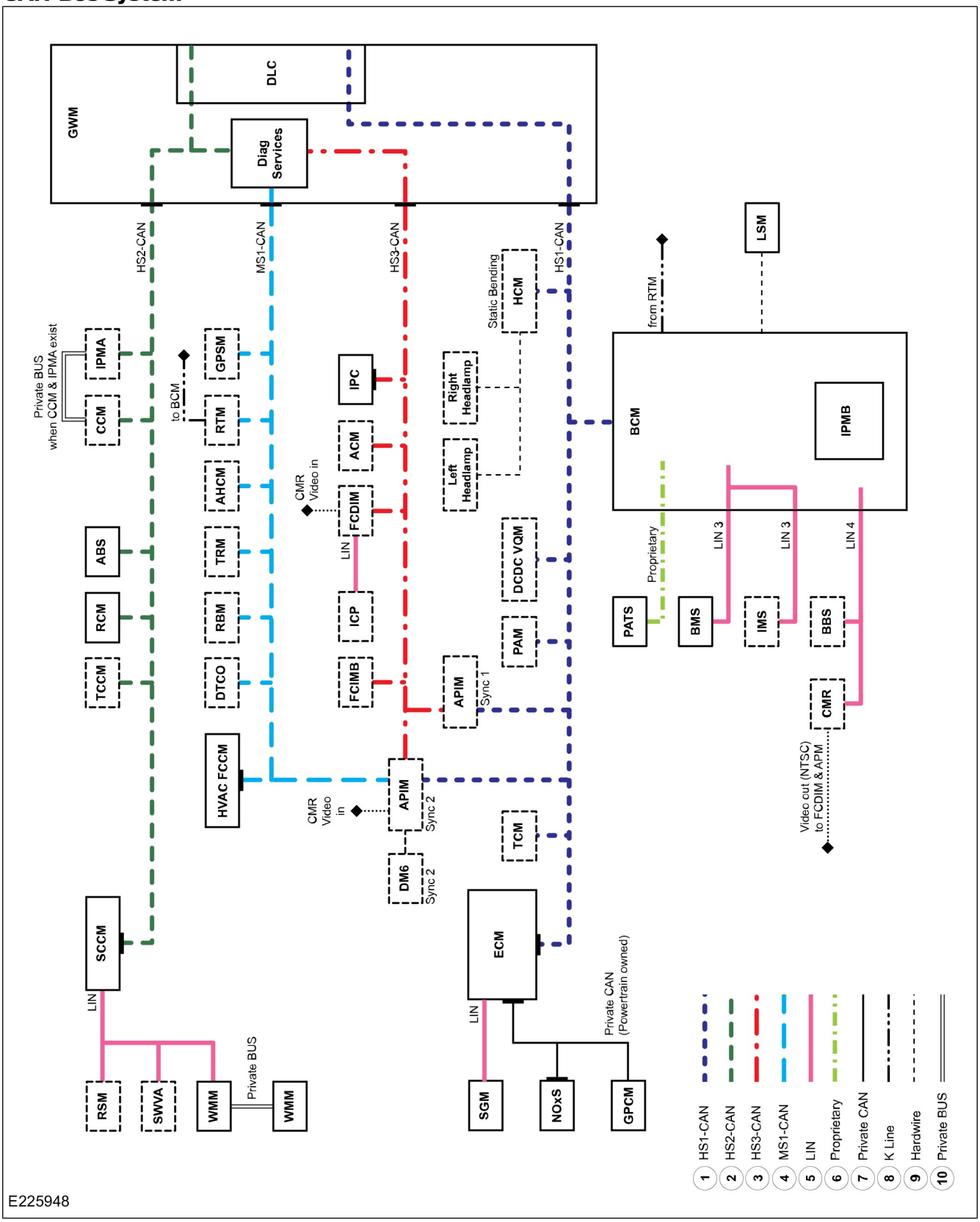
4.2 Communications Network

4.2.1 CAN-Bus System Description and Interface

WARNING: Do not tamper with, cut into or connect to any of the CAN-Bus interface wiring or connectors. The addition of unapproved CAN-Based modules could impact the safe operation of the vehicle.

CAN, Controller Area Network, uses propriety message sets to communicate between the devices shown, via Medium Speed (MS), High Speed (HS), Private and Public Buses. In addition there is localized application of Local Interconnect Network (LIN) and ISO 9141 K-line serial links.

CAN-Bus System



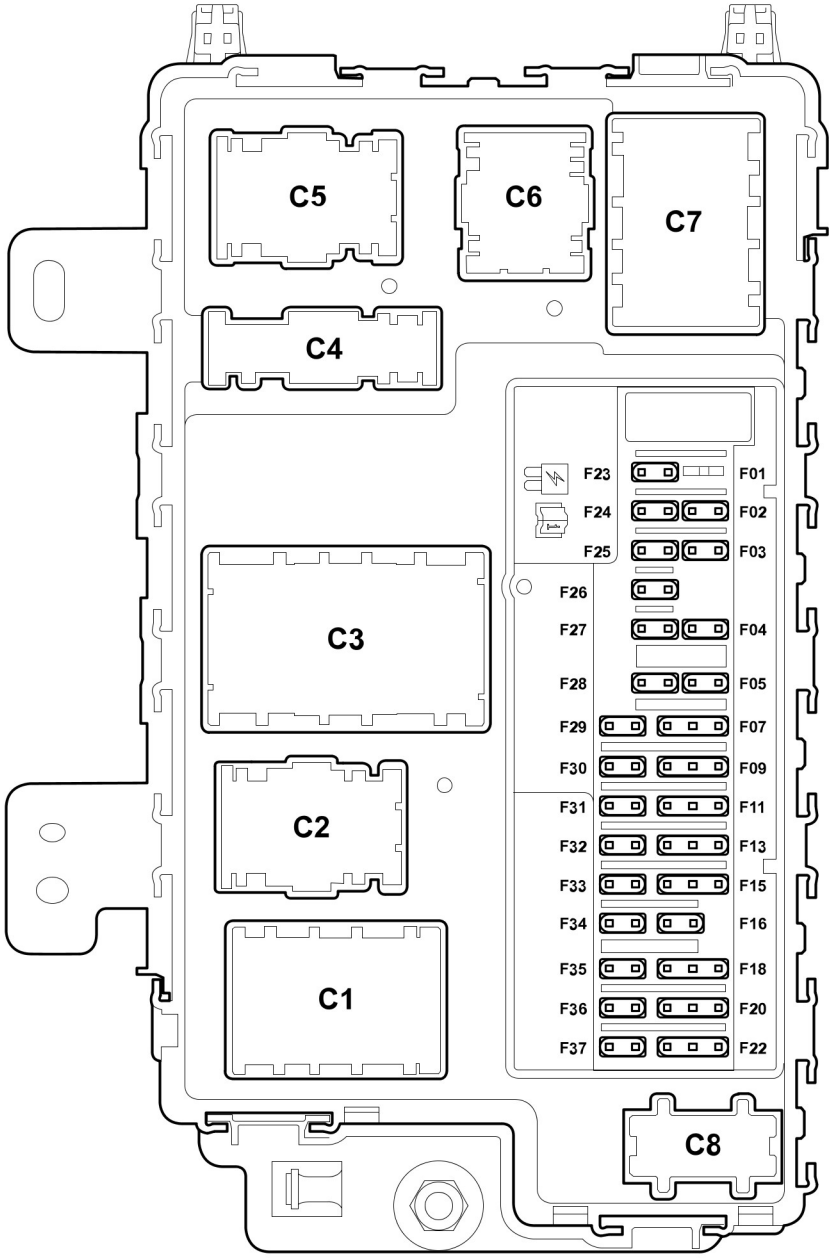
Communication Network System (Figure E225948 references)

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	HS1-CAN - High Speed 1 - CAN (500kb/s)	GPSM	Global Positioning System Monitor
2	HS2-CAN - High Speed 2 - CAN (500kb/s)	GWM	Gateway Module A (Smart Diag Link Connector)
3	HS3-CAN - High Speed 3 - CAN (500kb/s)	GPCM	Glow Plug Control Module
4	MS1-CAN -Medium Speed 1 - CAN (125kb/s)	HCM	Headlamp Control Module
5	Local Interconnect Connector (LIN)	HVAC-FCCM	HVAC Controls (was FCIM)
6	Proprietary	ICP	Integrated Control Panel
7	Private CAN	IMS	Interior Motion Sensor
8	K-Line	IPC	Instrument Panel Cluster
9	Hardwire	IPMA	Image processing Module A (Lane Departure System Camera)
10	Private BUS	IPMB	Image processing Module B (Part of BCM)
ABS	Anti-Lock Brake System Control Module	LSM	Light Switch Module
ACM	Audio Control Module - Radio Silver Box	NOxs	NOx Sensor
AHCM	Auxiliary Heater Control Module	PAM	Parking Aid Module
APIM G1	Sync Gen 1	PATS	Passive Anti-Theft System
APIM G2	Sync Gen 2 (inc DM6 - MFD)	RBM	Running Board Control Module (Power Step)
BBS	Battery Backed-up Sounder	RCM	Restraints Control Module
BCM	Body Control Module	RSM	Rain Sensing Module
BMS	Battery Monitoring Sensor	RTM	Radio Transceiver Module (RKE & TPMS Receiver)
CCM	Cruise Control Module (Adaptive)	SCCM	Steering Column Control Module (inc SAS)
CMR	Camera Module Rear	SGM	Alternator Regulator
DCDC-VQM	Volatage Quality Module	SWVA	Steering wheel Vibration Alert (IPMA Haptic Device)
DLC	Diagnostic Link Connector (was OBD)	TCM	Transmission Control Module
DTCO	Tachograph	TCCM	Transmission Case Control Module (All Wheel Drive)
ECM	Engine Control Module	TRM	Trailer Module (Trailer Tow)
FCIMB	Electronic Finisher Panel (Was EFP)	WMM	Wiper Motor Module (Master)
FCDIM	Front Control/Display Interface Module (MFD)	WMM	Wiper Motor Module (Slave)

kb/s - kilo bits per second

4.2.2 Body Control Module (BCM)

BCM - as viewed in-car position



E226021

WARNINGS:

Unapproved and/or incorrect connection to any of the mating wiring can cause either the associated systems to shut down (overload protection), or permanent damage to the BCM itself.

Vehicle BCM configuration must NOT be modified once the vehicle has left a Ford production plant, except for any changes that may be carried out using dealership integrated diagnostic systems equipment.

The BCM is the prime control module in the vehicle's electrical architecture. It is responsible for management of most of the vehicle's lighting, locking and security systems.

BCM Output Information

Function	Component	Load Type	Max. Load	Overload Condition
Dipped Beam Left	High Side Pulse Width Modulation	Bulb	55W	Output Shutdown
Dipped Beam Right	High Side Pulse Width Modulation	Bulb	55W	Output Shutdown
Main Beam Left	High Side Pulse Width Modulation	Bulb	55W	Output Shutdown
Main Beam Right	High Side Pulse Width Modulation	Bulb	55W	Output Shutdown
Daytime Running Light Left	High Side Pulse Width Modulation	Bulb	30W	Output Shutdown
Daytime Running Light Right	High Side Pulse Width Modulation	Bulb	30W	Output Shutdown
Position Lights Left Front	High Side Pulse Width Modulation	Bulb	10W	Output Shutdown
Position Lights Left Rear	High Side Pulse Width Modulation	Bulb	20W	Output Shutdown
Position Lights Right Front	High Side Pulse Width Modulation	Bulb	10W	Output Shutdown
Position Lights Right Rear	High Side Pulse Width Modulation	Bulb	20W	Output Shutdown
Front Fog Lights	Relay Driver	Micro Relay	250mA	Output Shutdown
Turn Indicators Left Front	High Side Pulse Width Modulation	Bulb	27W	Output Shutdown
Turn Indicators Left Rear	High Side Pulse Width Modulation	Bulb	27W	Output Shutdown
Turn Indicators Right Front	High Side Pulse Width Modulation	Bulb	27W	Output Shutdown
Turn Indicators Right Rear	High Side Pulse Width Modulation	Bulb	27W	Output Shutdown
Mirror Turn Lamp Left	High Side Pulse Width Modulation	Bulb	42W	Output Shutdown
Mirror Turn Lamp Right	High Side Pulse Width Modulation	Bulb	42W	Output Shutdown
Licence Plate (& Marker Lights)	High Side Pulse Width Modulation	Bulb/LED	27W	Output Shutdown
Reverse Lights	High Side DC	Bulb + Micro Relay	42W + 250mA	Output Shutdown
Rear Fog Lights	High Side Pulse Width Modulation	Bulb	42W	Output Shutdown
Stop Light Left & Right	High Side Pulse Width Modulation	Bulb	42W	Output Shutdown
Center High Mounted Stop Light	High Side Pulse Width Modulation	Bulb	16W or LED string	Output Shutdown
Switch Illumination	High Side Pulse Width Modulation	LED	2A at 16V	Output Shutdown
Battery Saver Supply	High Side Driver	Bulb	105W	Output Shutdown
Front Cabin Lights Courtesy	High Side Pulse Width Modulation	Bulb	65W	Output Shutdown
Rear Cabin Lights Courtesy	High Side Pulse Width Modulation	Bulb + LED	65W	Output Shutdown
Vehicle Horn	High Side Relay Driver	Micro Relay	250mA	Output Shutdown
Alarm Siren	Hign Side Driver	Electro Mechanical Sounder	4A nominal, 8A for 10ms in-rush	Output Shutdown
Engine Run Status	High Side Relay Driver	Micro Realy	250mA	Output Shutdown
Lock/Double Lock Relays	Relay	Latch Motor	-	Fuse Blow*
Unlock Relays	Relay	Latch Motor	-	Fuse Blow*

Repeated overloading of circuits can result in output lock-out requiring dealer reset. Repeated dealer resets can result in permanent loss of a function.

* Increasseing fuse rating above fitted may result in internal relay or PCB damage and render the BCM unusable.

BCM Fuse Overview

Fuse	Rating	Fuse Type	Function
F1	-	-	Not Used (Not Present)
F2	7.5A	Micro 2	Power Mirrors & Driver Window Switch
F3	20A	Micro 2	Locking - Unlock Driver & Passenger
F4	5A	Micro 2	Not Used (Spare)
F5	20A	Micro 2	Not Used (Spare)
F6	10A	Micro 3	Not Used (Spare)
F7	10A	Micro 3	Not Used (Spare)
F8	10A	Micro 3	Security Horn
F9	10A	Micro 3	Not Used (Spare)
F10	5A	Micro 3	Not Used (Spare)
F11	5A	Micro 3	Interior Motion Sensor & Rear AC
F12	7.5A	Micro 3	Climate Control & Hazard Switch
F13	7.5A	Micro 3	Steering Column, CLuster, OBDII Logic
F14	10A	Micro 3	Not Used (Spare)
F15	10A	Micro 2	OBDII Gateway Module
F16	15A	Micro 3	Locking - Unlock LH & RH Side Load Door
F17	5A	Micro 3	Battery Backed Sounder
F18	5A	Micro 3	Ignition Switch Supply
F19	7.5A	Micro 3	Passenger AIrbag disable Indicator & Switch
F20	7.5A	Micro 3	Tachograph
F21	5A	Micro 3	PTC Heater
F22	5A	Micro 3	Not Used (Spare)
F23	10A	Micro 2	Delayed Accessory (Radio) & Power Inverter
F24	20A	Micro 2	Locking - Central Lock & Double Lock
F25	30A	Micro 2	Not Used (Spare)
F26	30A	Micro 2	Not Used (Spare)
F27	30A	Micro 2	Not Used (Spare)
F28	20A	Micro 2	Not Used (Spare)
F29	30A	Micro 2	Not Used (Spare)
F30	30A	Micro 2	Not Used (Spare)
F31	15A	Micro 2	Not Used (Spare)
F32	10A	Micro 2	GPS, Voice Control, Sync, Display, Adaptive Cruise Control, Remote Receiver
F33	20A	Micro 2	Radio Sync
F34	30A	Micro 2	Ignition Run/Start Relay Pre Fuse. (Parkaid, Heater Control, Lane Departure Warning Camera, Restraints, Central Control Panel, Passenger Airbag Off Indicator, Tachograph, PTC Heater, Steering Wheel Module)
F35	5A	Micro 2	Restraints
F36	15A	Micro 2	Park Aid, Lane Departure Warning Camera, Steering Wheel Module
F37	20A	Micro 2	Not Used (Spare)
F38	-	30A Circuit Breaker	Power Window Supply

4.3.1 General Information and Specific Warnings

The Transit electrical system is a 12-Volt supply with a negative ground return. The factory fit alternator and battery equipment are designed for normal operations. The vehicle may have Standard Flooded, Enhanced Flooded or Absorbent Glass Mat (AGM) Batteries as factory fit. Higher capacity batteries are available as standard production options and special vehicle options offer AGM technology for heavy PTO and deep cycling applications. Before installing additional electrical equipment check that the battery capacity, technology type, harness load capability, and alternator output are suitable for the extra load.

Refer to: 4.4 Battery and Cables (page 102).
Power and Connectivity Usage Recommendations table.

The battery capacity, technology and charge available from the alternator must be adequate to ensure engine cranking in unfavorable climatic conditions, even after fitment of additional electrical equipment.

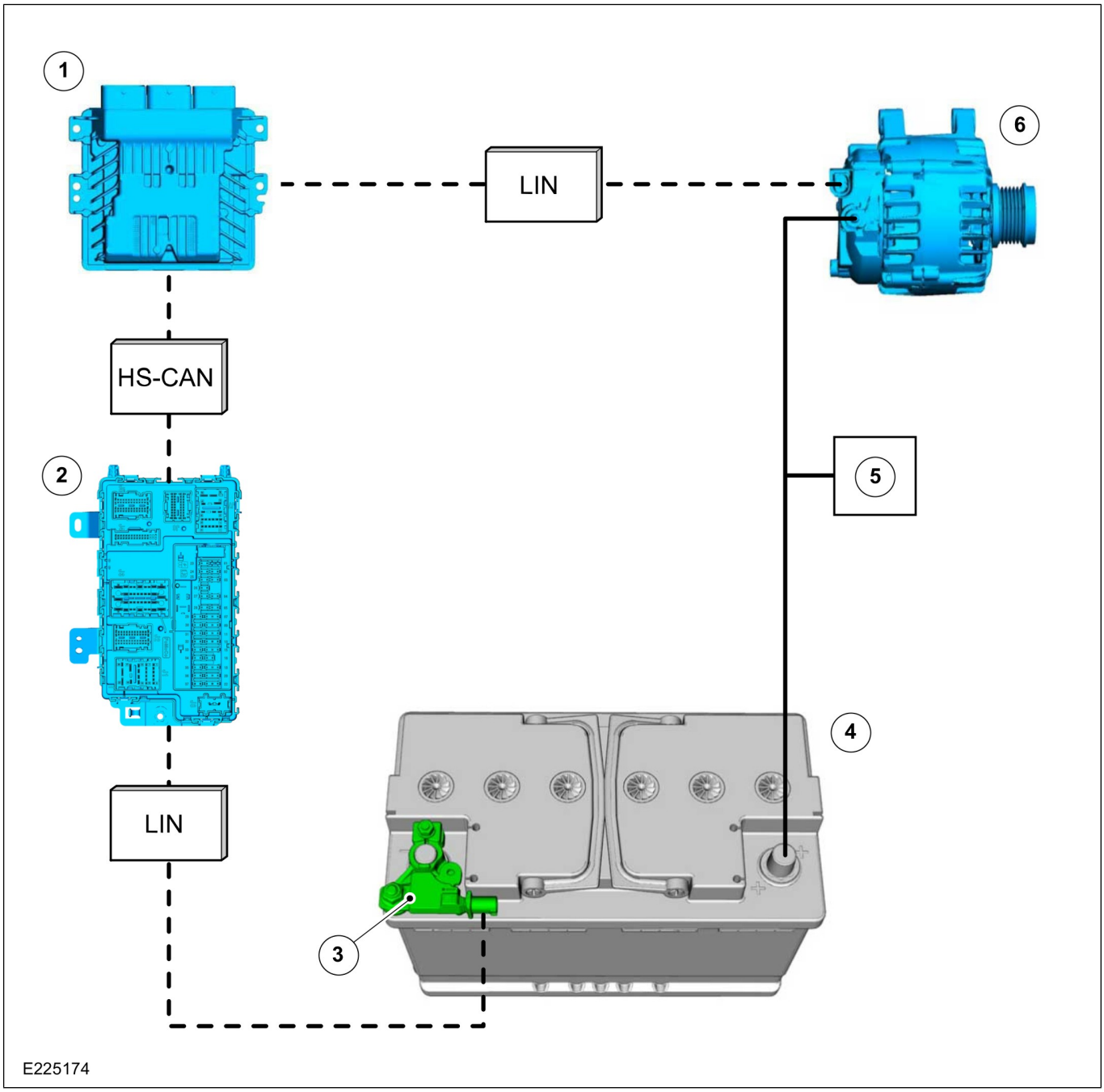
The Transit utilises multiplexed vehicle electronics, it is recommended that the appropriate Ford proprietary accessory systems are used. Inappropriate or incorrect connection of additional equipment could cause mis operation, or damage to the vehicle, and so invalidate any warranty.

Additional connection points are provided specifically for customer use, and are located on the outside of the driver's seat pedestal. A 60Amp fused connection is provided as standard on Single Battery Vehicles. 3x 60Amp fused connections are provided for Twin Battery vehicles. A further connection is possible for higher current applications, see 'Battery and Cables' section for information.

Do not jump-start the vehicle directly from the battery. Use designated jump-start points. Refer to the Owner's Manual. The wiper motor bracket **must not be used as a ground** as it is isolated from the body.

4.3.2 System Operation and Component Description

System Diagram



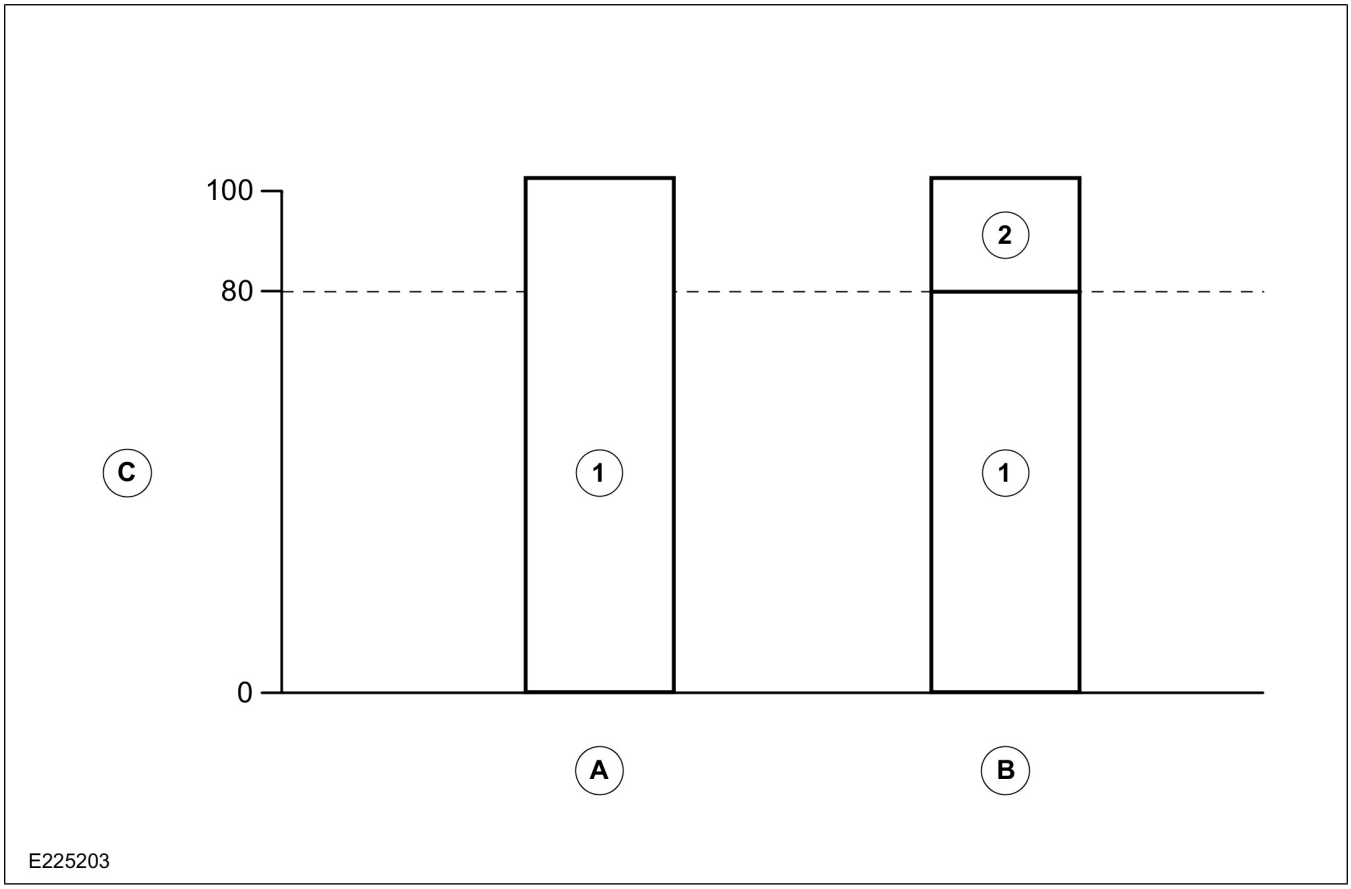
Item	Description
1	Power Control Module (PCM) or Engine Control Module (ECM)
2	Body Control Module (BCM)
3	Battery Monitoring Sensor (BMS) — Where fitted
4	Battery — Twin batteries are available as an upgrade or driven by specific features
5	Electrical consumers
6	Alternator

System Operation - Smart Regenerative Charging (SRC) Except Camper

Smart Regenerative Charging varies alternator output using information from the Battery Monitoring Sensor to reduce fuel consumption. Alternator output can be increased during deceleration to charge the battery without the use of additional fuel. Alternator output can also be decreased to reduce the load on the engine and therefor fuel used. During this condition the battery supports the electrical loads. This function can be turned off by the Start-Stop Switch or using the hardwire input as detailed later in this section of the manual.

By Comparison, Conventional Charging aims to charge the battery at a constant level which varies with battery temperature.

Smart Regenerative charging and Conventional Charging



Item	Description
A	Conventional Charging
B	Smart Regenerative Charging (SRC)
C	Battery Charge Level (%)
1	Minimum 13.5V
2	Minimum 12.2V

4.3.3 Start-Stop Override and Configurable Charging

There are two control methods to switch the power supply system to Conventional Charging. This maybe required for converters requiring battery voltage that is being charged by the alternator in the range of 13.5 to 14.9 volts. Such applications include boost or supplemental battery charging, compensation for volt drop or high Ampere electrical loads whilst the engine is running. Both these methods also inhibit Start-Stop.

1. Start-Stop Switch - Manual Operation

The Start-Stop deactivation button also deactivates SRC when pressed (LED telltale is illuminated). When deactivated, and the vehicle is stationary, the engine will not shutdown and the battery will be charged by the alternator with Conventional Charging.

Summary of the Available Charging Modes

Charge Mode		Approximate Charging Voltages (Measured at Jump Start post)
SRC	Smart Regenerative Charging - normal charge mode.	Minimum 12.2 - Maximum 14.9
CC	Conventional Charging - applies a strong charging voltage until the battery is full and maintains alternator voltage above 13.5V unless battery temperature >40degC. The actual voltage at the battery will vary depending on the alternator load.	Minimum 13.5 - Maximum 14.9
SS	Start-Stop - there is a 5 second delay from when the CC/SS inhibitor is activated to when SS is inhibited.	Not Applicable

The voltages in the above table are approximate as the charging system is dynamic and can vary the voltage at any time.

For further information on Start-Stop

Refer to: 4.8 Electronic Engine Controls (page 135).

2. Hardwire Input

The Hardwire Input can be accessed in three ways:

- Pre-installed as part of a Camper Donor vehicle.
- Pre-installed as part of the High Specification Vehicle Interface Connector (A608) and a link from the Hardwire Input to the chosen switch and ground point, but must not be a permanent ground. The grounding should only occur for a duration of the third party system needing a certain functionality and performance which can only be met by turning off the fuel save features of Smart Charging and Start-Stop. Grounding permanently might invalidate the emission and homologation of the vehicle and the vehicle could need to be re-homologated as part of the approval process by the converter. A mating 43 way connector with three meters of wiring (with all wires) is available as a kit (KTBK2V-14A411-D_) from your local Ford dealer. For information on High Specification Vehicle Interface Connector

  Refer to: 4.19 Electrical Connectors and Connections (page 178).
- As a kit to install to the standard 8 way Vehicle Interface Connector in the drivers seat pedestal, see 'Electrical Connectors and Connection' section.

Test Functionality: Start-Stop Inhibit - for vehicles with Start-Stop

1. Check Start-Stop functions as intended, refer to Owner's Manual for details.
2. While driving the vehicle, close the Hardware Input Switch, if safe to do so, and check that the Start-Stop no longer operates.
3. Open the Hardware Input switch and check Start-Stop functionality is restored.

Test Functionality: SRC Inhibit, Charging Mode Control

1. Ensure batteries have good charge. When charging, use the jump start point and engine bay ground point. Refer to the charging instructions in the Owner's Manual.
2. Measure voltage between jump start point and engine bay ground point with engine running and SRC inhibit switch open. Refer to the Roadside Emergencies section of the Owner's Manual.
3. With the engine running, close Hardwire Input Switch and measure voltage. The voltage should be in the ranges shown in the table 'Summary of the Available Charging Modes'.

4. Open the switch again and check voltage level returns to the original level measured in Step 2. SRC is active.

Note: There will be a delay between closing Hardwire Input Switch and change of voltage output. The voltage may depend on many factors including total electrical load, which loads are active, battery condition and others. The rate of charge between modes varies depending on which loads are active.

4.3.4 Power Management Settings

WARNING: The only method to return the vehicle to Transport mode is by using a Ford diagnostic service tool with the correct level of security clearance. The Ford dealer has the correct tools and level of security to do this if required.

If the cluster displays 'Transport Mode' the vehicle may have reduced functionality. This mode is mainly to conserve battery life/warranty during pre-delivery.

To change mode, the brake pedal must be depressed five times, and the hazard warning switch operated twice (in any combination) within a 10 second period.

4.3.5 Electrical Conversions

WARNING: The fitting of voltage boosters or other devices to enhance alternator output are not allowed. The fitting of such devices will not only invalidate vehicle warranties, but could damage either or both, the alternator and Engine Management System/Power Control Module, and possibly affect vehicle legal compliance. Check local legislation.

Operator requirements for additional and specialized electrical equipment varies. The vehicle converter/modifier must, therefore, consider the following points when designing the installation:

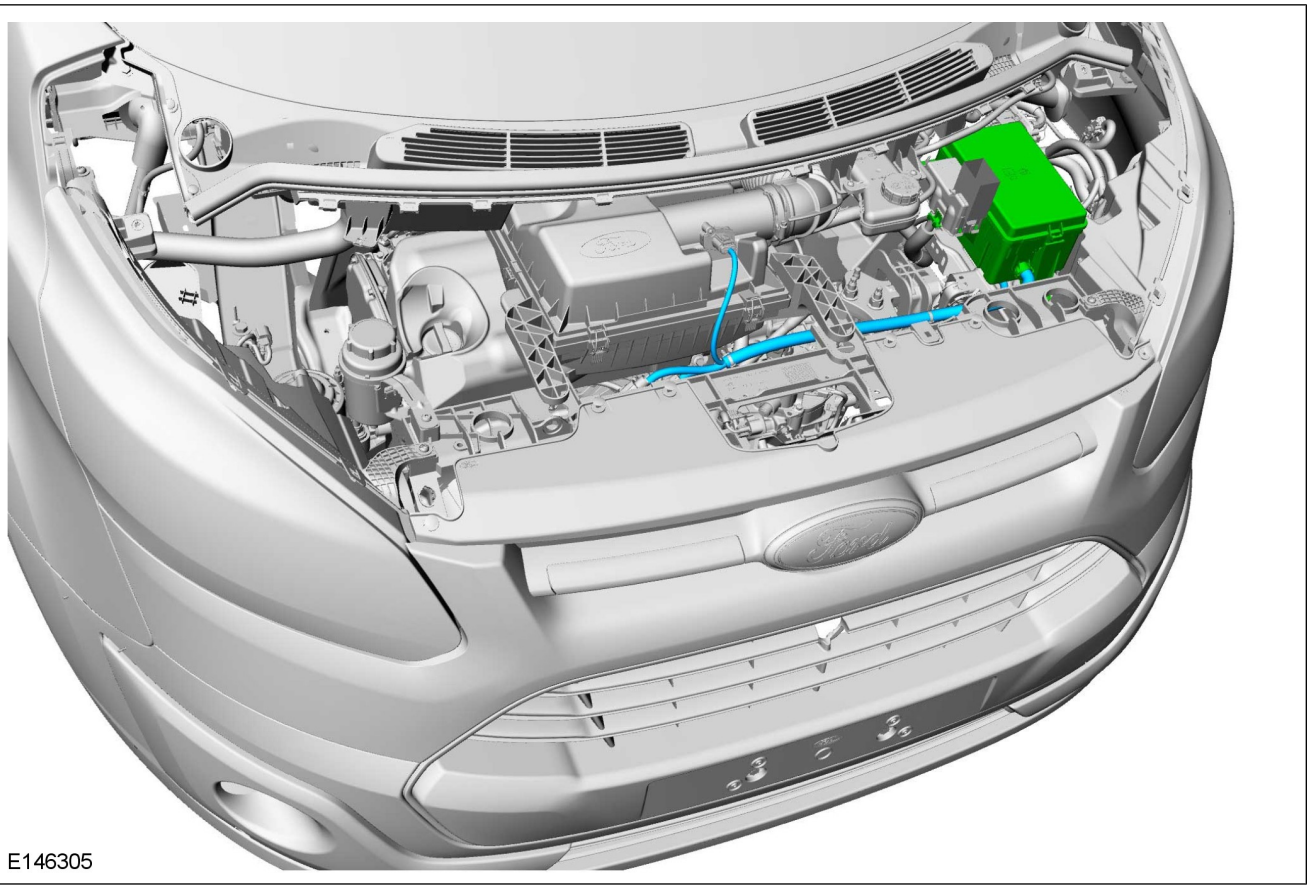
- Legality and regulatory conformity of the base vehicle.
- Drive-ability and serviceability of the base vehicle.
- The effect of regulations governing the proposed conversion including National Legislation in the country of sale.
- The method of integrating the circuit into the base vehicle.
- No additional circuits are to be run alongside the electrical circuits (shown in blue in figure E146305) associated with the Engine Management System (shown in green in figure E145305), due to the possible inductive or electrostatic coupling of electrical interference.
- The base vehicle is equipped with either a single or twin battery system. It is important to also read relative information on Start-Stop and SRC.

  Refer to: 4.4 Battery and Cables (page 102).
- There is a Ford option that is recommended for third party take off. This will allow power at engine off and protect energy for cranking/starting and help maintain third party battery charge, see also Battery and Cables section.
- When auxiliary electrical systems are added to the vehicle, it is recommended that the additional circuits are designed to be used with the Special Vehicle Option Auxiliary Fuse Panel to maintain the integrity of the electrical system.

  Refer to: 4.17 Fuses and Relays (page 172).
- The materials and installation must meet the quality standards described in this section.
- Any additional equipment or components must be designed such that they have no adverse Electro Magnetic Compatibility - EMC effect on the vehicle.
- The alternator and Engine Management System (EMS) — Also referred to as Powertrain Control Module (PCM) are interdependent.
- The alternator is LIN controlled. It does not have a conventional D+ (engine start) signal line.

  Refer to: 4.8 Electronic Engine Controls (page 135).
- Take special care with the routing of existing electrical harnesses within the vehicle to avoid damage when fitting additional equipment. Also see section concerning installation of equipment containing an electric motor.

Electrical Circuits Associated with Management System



For additional third part gound and +12V power cable connections to the Ford system

Refer to: 4.4 Battery and Cables (page 102).

Camper vehicles: When fitting an additional battery, the auxiliary battery circuit. If high loads are to be supplied, exceeding the customer connection point supplies or high in general, especially at ignition off loads, an isolation switch disconnect relay should be fitted. This is to protect the vehicle start battery from a failed start. Suitable capacity in the wiring, fuses and alternator will be required. If unsure of which battery to interface with or what system requirements are needed, please contact your local dealer who can advise.

Refer to: 4.4 Battery and Cables (page 102).

NOTE: Before disconnecting the battery, check availability of radio key code.

NOTE: When auxiliary electrical systems are to be added to the vehicle it is mandatory that the additional circuit design includes the necessary fuses.

The Auxiliary Fuse Panel is recommended.

Refer to: 4.19 Electrical Connectors and Connections (page 178).

Safety

Increased use of comfort and safety electronics in modern motor vehicles also requires the greatest attention to be paid during body work.
Over-voltages produced during welding and in alignment work during body shell rectification may cause electronic systems to be damaged. In particular, the safety instructions for performing welding / cutting work on vehicles with airbag systems must be adhered to. For additional information on welding

Refer to: 5.1 Body (page 214).

NOTE: After disconnecting the power supply and before performing further work, a wait time of up to 15 minutes must be maintained. Work on airbag systems may only be performed by persons who have a relevant certificate of competence.

Pay attention to the following points:

- Disconnect all the batteries, including ground and insulate the negative battery terminal(s).
- Disconnect the electrical connector at the airbag control module.
- Disconnect the alternator multi-plug prior to using welding or cutting equipment.
- If welding or cutting is to be performed directly near a control module, it must be removed before hand.
- 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.

4.3.6 Fitting Equipment Containing Electric Motors

WARNING: When electric motors are to be fitted, account must be taken of the potentially high in rush currents that a motor can draw.

CAUTION: The following must be observed:

- All motors must be driven via relays with contacts rated at least 3 times the maximum rated current of the motor.
- All motor supply circuits must be individually fused with the proper fuse rating for the motor.
- All power wiring must be rated for at least 3 times the rating of the motor and installed as far away as possible from any existing vehicle wiring.
- All motors fitted should be fully suppressed to European or applicable local Legislation relating to Electromagnetic Compatibility to ensure electrical interference does not affect the vehicle systems.
- Add EMC emissions statement to CE approval.

4.3.7 Vehicle Electrical Capacity — Alternator

WARNING: Do not cut into the alternator wires. The alternator is LIN controlled. It does not have a conventional D+ (engine start) signal line.

4.3.8 Charge Balance Guidelines

The base vehicle is fitted with a 150A alternator. It is recommended to conduct a charge balance calculation in case the conversion comprises a high number of electrical consumers or high electrical consumption is expected.

4.3.9 Circuit Diagrams

For circuit diagrams for Auxiliary Fuse Panel connections and standard Ford relays.

Refer to: 4.19 Electrical Connectors and Connections (page 178).
Refer to: 4.17 Fuses and Relays (page 172).

Full vehicle wiring and circuit diagrams are in the Ford Workshop Manual.

NOTE: For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

4.4 Battery and Cables

4.4.1 High Current Supply and Ground Connections

WARNINGS:

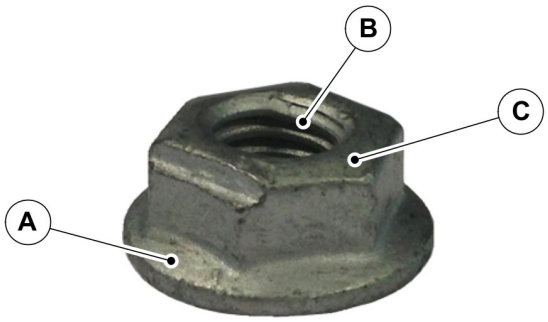
A self locking crimp hexagonal nut MUST be used for high current terminal stud connections, for battery positive and negative or chassis ground. Do not use locking, split washers or nylon lock type nuts.

It is recommended to only use one eyelet per stud for high current applications. If more than one eyelet per stud is unavoidable, the highest current eyelet feed should be connected closest to the supply terminal. Do not exceed two eyelets or crimp terminals per stud connection.

For additional information

Refer to: 4.19 Electrical Connectors and Connections (page 178).
Customer Connection Points.

Self Locking Crimp Hexagonal Nut



E171315

Item	Description
A	Large flange for maximum surface area current flow and large clamp force area.
B	Crimp / locking feature is obtained by deformed female thread only
C	Finish must be a low resistance material which complies with the Restricted Substance Management Standards (RSMS).

4.4.2 Battery Information

WARNINGS:

For electrical power take-off that requires deep discharge and cycling from third party systems, High Performance Deep Cycle AGM batteries (A738) must be ordered on the base vehicle. If option A738 is not on the base vehicle they can be fitted by your local Ford Dealer. See table in Single and Twin Batteries Section.

Take necessary safety precautions when handling batteries, for example: protective clothing, eye and hand protection.

Ensure batteries are charged in a designated charging area that is correctly ventilated.

Vehicles with Start-Stop require an AGM battery. You must replace the battery with one of exactly the same specification and technology.

Make sure that the battery box is correctly sealed including any additional cables routing in and out of the box. The box is not required for High Performance Deep Cycle AGM batteries option (A738) but includes drain tubes. After conversion, always check that the drain tubes have not been dislodged.

NOTE: If a converter intends to add systems or accessories that will add significant electrical load (particularly at key off), then vehicles with twin batteries should be specified. Twin options include the standard dual battery system for additional loads up to 5mA key off load or less than 30A at engine run. For loads greater than this High Performance Deep Cycle AGM batteries are recommended (option A738). It is also recommended to upgrade to the 240A alternator option if the extra loads are continuously active at engine run and exceed 30A above standard Ford systems. These loads may inhibit Start-stop functionality. In addition it is also necessary to consider the Engine RPM speed control system (A003), for engine run loads requiring extra high electrical capacity at idle.

In order to protect the battery system from direct ground shorts or continuous high current loads, a 470A main fuse is fitted in the Pre Fuse Box under the driver's seat. Converter fit peripherals must not use this fuse as its sole purpose is protection of the starting and charging system.

This fuse is not repairable — Use only a Ford replacement part.

Following battery disconnection, there is no need to reprogram the vehicle. It retains its 'normal' power management settings and configurations. However, the central locking latches may cycle if one of these was opened manually in the intervening period. With regard to the radio, all of the settings are retained.

There is no longer a need to re-program the electronic security code, as it is tied into the VIN of the factory fit Transit system. The clock initializes to 1200 and will need to be reset to correct time in accordance with the customer handbook procedure. After reconnecting, the Battery Monitoring Sensor (BMS) requires at least three hours quiescent period to re-calibrate to the correct battery state of charge, see also BMS information later in this section.

During a warm recrank the vehicle batteries will experience a voltage drop. All third party fit modules must be robust to the warm recranking waveform.

WARNING: Where a battery guard is fitted, the supply from a non-deep cycle standard flooded battery should not be set below 12.00 Volts. If a battery guard is monitoring a supply from a deep cycle battery, it is recommend not being below 11.50 Volts. If the battery guard is required because equipment can be active at engine off, then it is recommended to fit deep cycle batteries as standard. See also Power and Connectivity Usage Recommendations table later in this section. A battery guard high voltage set point should also not be below 15.30 Volts a this is the normal operation voltage of an SRC system, when in refresh mode. For full peripheral robustness, it is recommended that equipment can handle up to 24V to allow for accidental jump start by extra 12V supply in series and not parallel.

After market battery management systems are not required unless for converter fit equipment or third battery low voltage protection.

Any peripherals added to the power supply must be connected via the Customer Connection Points, from dedicated fuses such as the Auxiliary Fuse Panel (A526), the High Specification Interface Connector (A608)or the Ford Programmable Battery Guard (A540). For loads greater than 180A see 'Third Party +12V Power Take Off for Loads Exceeding 180 Amps' in the section of the BEMM.

Where twin batteries are required on vehicles with a single battery installation, associated wiring and hardware, should be fitted and aligned to Ford architecture. The extra battery must be of the same technology and performance rating as the existing battery. Alternatively both batteries can be upgraded to the High Performance Deep Cycle AGM batteries (A738).

If the battery type on a vehicle is changed to other compatible derivatives (see battery configuration table).

For special conversions requiring a third battery, a further disconnect switch is recommended. This should be controlled via the engine run signal to a normally open relay. A schematic of this architecture can be found later in this section.

Refer to: 4.8 Electronic Engine Controls (page 135).
and
Refer to: 4.3 Charging System (page 95).

Battery Voltage Requirements and Testing

To maximize battery life, at the time of arrival at the vehicle converter, all batteries must have a minimum Open Circuit Voltage (OCV) of not less than 12.5 volts. When the Closed Circuit Voltage (CCV) is applied, the voltage must not be less than 12.4 volts. This applies to any of the Ford battery technologies used and applies to both batteries if a twin system.

All voltages are to be measured with an accuracy of: + /– 5% of values published using calibrated meters.

Surface Charge Dissipation

Prior to carrying out manual voltage checks, it is necessary to establish that the battery voltage is stable and free from surface charge which occurs after engine run.

To ensure surface charge is not present measure the battery voltage after the vehicle has been standing, with the engine off and no loads switched on, for a prolonged period of about three hours (or over night). If this is not possible an estimate can be made using the following method:

1. Turn the ignition key to position II and switch on the headlamps (main beam) rear window demister and the heater blower motor (on position II). Leave the vehicle in this condition for at least 10 seconds to dissipate what ever surface charge is present in the battery.
2. Turn the ignition key to position 0 and switch off the loads; headlamps, rear window demister and heater blower motor. Leave the vehicle in this condition for at least 5 minutes, before taking a battery voltage reading.

Delayed Vehicles

Vehicles held at the vehicle convertor premises and not in use for longer than 7 days, should have the battery's negative cable disconnected. Before shipping to the customer, the battery negative cable must be re-connected and the voltage re-checked. The voltage should be not less than 12.5 volts.

For additional information

Refer to: 1.12 Vehicle Transportation Aids and Vehicle Storage (page 28).

Battery Charging Procedure

WARNING: Do not connect to any Ground or +12 volt potential points other than that specified in the Owner's Manual. There is a dedicated charge point under the hood. Failure to comply may lead to high current paths that may damage peripherals and ECU's especially in a jump start condition.

1. Cold batteries will not readily accept a charge. Therefore, batteries should be allowed to warm up to at least 5ºC (41ºF) before charging. This may require four to eight hours at room temperature depending on the initial temperature and battery size.
2. 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 or boost charge on chargers that have this facility.
3. To determine whether a battery is accepting a charge, follow the manufacturers instructions for the charger, for use of the dead battery/boost charge mode.

Battery Cable Fixing Torque

The battery cables should be fixed to the terminal positive and negative posts with a torque of 6.0 Nm ± 10% for vehicles without Battery Monitoring Sensor (BMS). Vehicles with BMS use a 8 Nm ± 1.2 Nm on the M6 negative post and 8 Nm ± 1.2 Nm on the positive post. For additional information see BMS later in this section.

Batteries Options

Any additional or different batteries must be checked for correct functionality on a Start-Stop or Smart Regenerative Charging (SRC) vehicle.

Refer to: 4.8 Electronic Engine Controls (page 135).
Start-Stop and SRC
Refer to: 4.3 Charging System (page 95).

NOTE: If wrong batteries or incorrect configuration, Start-Stop or SRC may not function correctly.

Battery Part Number	Type	Quantity	Size
Single Battery FWD (without Start-Stop)^			
GK2T-10655-D*	750 CCA (80Ah @20 hour rate) Standard Flooded Battery	1	H7
Single Battery FWD (without Start-Stop)^^			
GK2T-10655-E*	710 CCA (75Ah @20 hour rate) Enhanced Flooded Battery	1	H7
Single Battery FWD (with Start-Stop)			
DV6T-10655-B*	800 CCA (80Ah @ 20 hour rate) Absorbent Glass Mat Battery	1	H7
Single Battery RWD (with/without Start-Stop)			
DV6T-10655-B*	800 CCA (80Ah @ 20 hour rate) Absorbent Glass Mat Battery	1	H7
Twin Battery (without Start-Stop)^			
GK2T-10655-D*	750 CCA (80Ah @20 hour rate) Standard Flooded Battery	2	H7
Twin Battery (without Start-Stop)^^			
GK2T-10655-E*	710 CCA (75Ah @20 hour rate) Enhanced Flooded Battery	2	H7
Twin Battery (with Start-Stop)			
DV6T-10655-B*	800 CCA (80Ah @ 20 hour rate) Absorbent Glass Mat Battery	2	H7
High Performance Deep Cycle AGM Batteries (A738)			
8C1V-10655-A*	850 CCA (95Ah @ 20 hour rate) Absorbent Glass Mat Battery	2	H8

^ 2 year warranty territories, ^^3 year warranty territories

4.4.3 Battery Rules

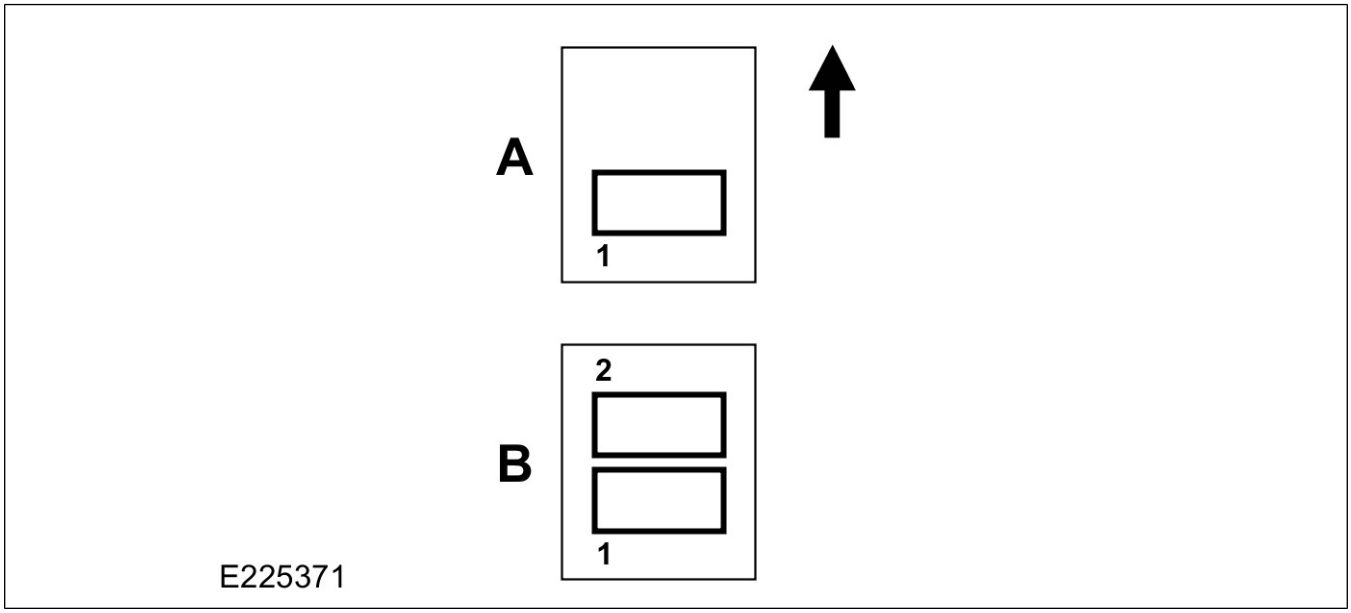
- Batteries in parallel must be of the same type and capacity and listed in the Ford battery table.
- Third party batteries and loads are to be isolated from the standard Ford system at key off.
- For External charging of batteries ensure that the maximum voltage of 15.2V is not exceeded. Normal proprietary charging equipment should operate below this voltage.

NOTE: Charge balance calculations are required when adding additional systems taking into account alternator size and battery capacity. On battery choice a number of factors are important:

- Battery specification capability in ampere hours for continuously loading until empty. For instance an 80Ah fully charged battery can supply 4 Ampere over a 20 hour period at 20 degrees centigrade until it is fully discharged.
- The Cold Crank Ampere (CCA) rating is the maximum rating for cold start requirements.
- For deep cycling and micro cycling requirements (engine off loads) the deep cycle battery system (A738) is recommended.

Extra batteries added to the power supply should be connected as shown at the end of this section.

4.4.4 Battery Configurations (always in the drivers seat pedestal)



Item	Description
1	Main Battery
2	Auxiliary Battery
A	Single battery system
B	Twin battery system
Arrow	Front of vehicle direction

4.4.5 Battery Configuration, Additional Loads, Start-Stop and Smart Regenerative Charging (SRC)

Start-Stop and SRC will operate within specification only if a correct battery configuration is installed in the vehicle.

NOTE: The following battery configurations are NOT compatible with Start-Stop and SRC:

- Mixed battery types - for example: 1 x AGM and 1 x Flooded.
- Mixed sizes.
- Battery types other than those listed in the Battery Part Number and Usage table.
- Extra batteries than factory fit - for example: 3 or more, if not isolated from existing power supply at Key off.
- If twin Ford battery configured only fitting single Ford battery.
- If single Ford battery configured, fitting twin Ford battery.

Start-Stop and SRC system functionality cannot be guaranteed with these configurations. If such a battery configuration is required, it is recommended not to equip the vehicle with Start-Stop in the factory so the vehicle should be originally ordered without. It will not be possible to decommission the Start-Stop and SRC features due to Homologation, Vehicle Tax and Excise Requirements.

If the battery type on a vehicle with Start-Stop or SRC is changed to other compatible derivatives (see battery configuration table) it is required to reconfigure the vehicle to the new battery types from the dealer.

The feature content of the vehicle must still remain an Start-Stop or SRC vehicle to be in line with the Homologation, Vehicle Tax and Excise Requirements.

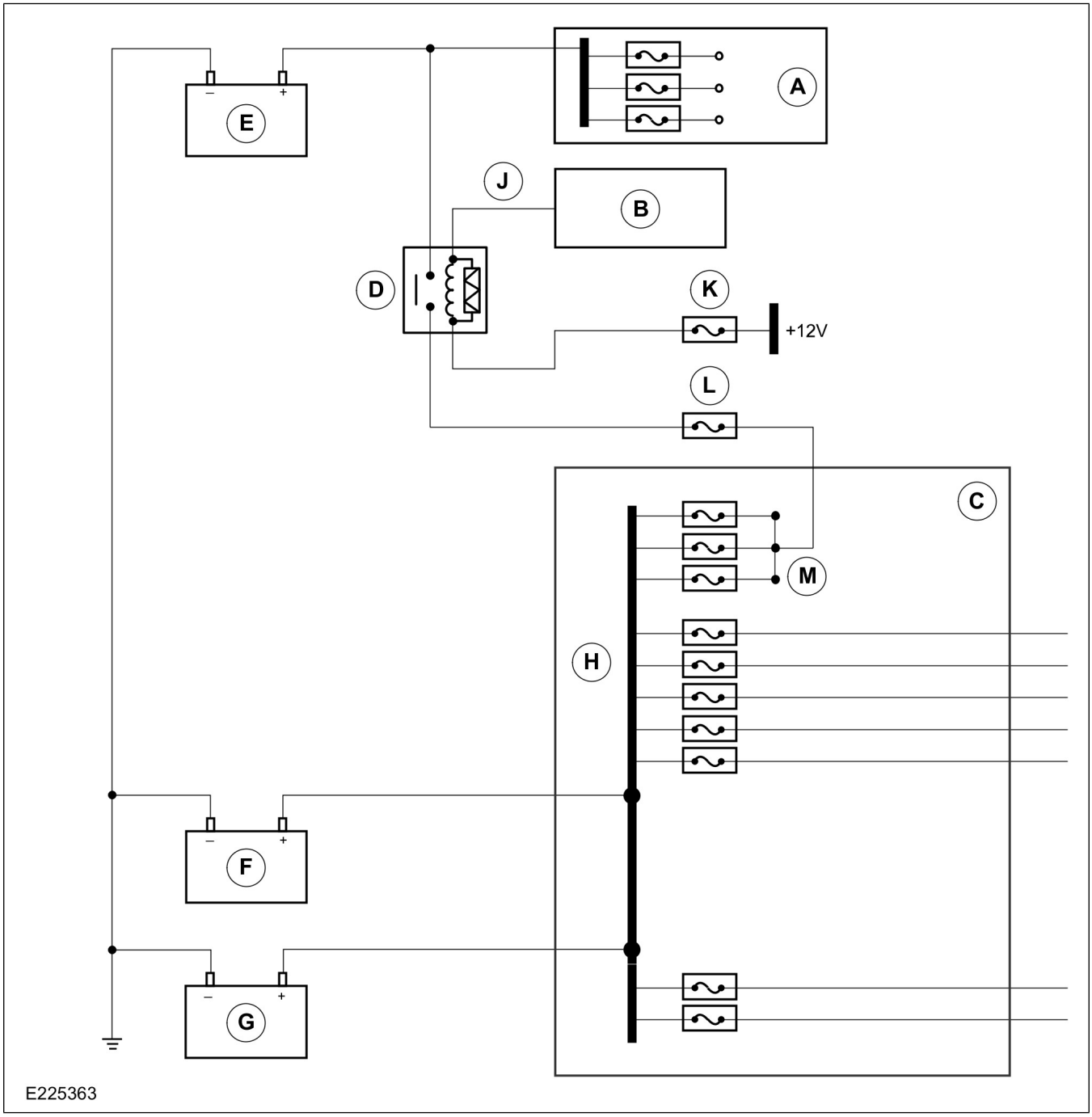
Convert Fit Additional Third Batteries

If additional batteries are added, a disconnect relay or main manual switch system is advised to isolate the converter fit battery from the Ford fit batteries. It is recommended to only connect the third battery to Ford fit batteries and alternator at engine Run. The third battery should be connected to the auxiliary battery side of the system via the customer connection points or the Ford Programmable Battery Guard (A540) for the +12V supply. If the third party battery and added system requirements exceed 180A of current, connection to the battery positive 6mm stud is permissible, as detailed in the 'Third Party +12V Power Take Off for Loads Exceeding 180A' section of this manual. This ensures the vehicle start battery is untouched. If supplemental chargers are added for the third converter fit battery, direct connection of such chargers to this battery is required. Connection to the auxiliary battery also reduces the number of crank micro cycling that a third battery will be exposed to on a Start-Stop variant. This is because the starter motor in an auto start condition, only uses energy from the vehicle start battery, the rest of the power supply is isolated until the engine is running. Gel batteries in particular are vulnerable to multiple starter cycles, see next figure E225363 for an example of converter fit third battery installation to existing Ford power supply architecture.

The Charge can also be applied to the Ford fit batteries, all relays/switches connected, but only for an emergency charge.

When changing from an incompatible battery configuration to a compatible system, Start-Stop and SRC functionality will take some time (ignition off overnight and multiple ignition run cycles) to re-establish full functionality.

Refer to: 4.3 Charging System (page 95).
System Operation



ITEM	DESCRIPTION
A	Converter Fit — Loads
B	Body Control Module — Provides Engine State
C	Pre Fuse Box — Drivers Seat Pedestal
D	Converter Fit — Normally open Third Battery Control Relay
E	Converter Fit — Third Battery
F	Ford Fit — Auxiliary Battery
G	Ford Fit — Vehicle Start Battery
H	Ford Fit — Loads (from Auxiliary Battery)
J	Switched Ground Engine Run Signal (250mA)
K	Converter Fit — +12V Fused KL30 Supply
L	Converter Fit Power Supply Fuse
M	Customer Connection Points - 60A standard, 180A with any SVO Fuse Box option (including A526)

Converter fit power supply fuse may not be required if custom connection points are the correct value.

Third Party +12V Power Take Off for Loads Exceeding 180 Amps

Third party +12V power take off connectivity should be made to the Customer Connection Points (CCP) where possible. In the event of greater than 180A current power requirements but less than 250A peak loading (maximum fuse value third party installed), connecting to the rear battery +12V clamp, 6mm stud, is permitted.

The following fusing principles must apply:

- If for a long duration (greater than one hour continuous), the fuse must be no higher rating than the alternator fitted to the vehicle. For example: vehicles fitted with a 150A alternator, a maximum 150A fuse can be fitted, vehicles fitted with a 210A alternator, a maximum 210A fuse can be fitted. Conversion example: 2 kW Inverter installation.
- For short term loads such as one minute peak loads, a 250A fused cable can be installed. Conversion examples: Crane, Tipper, Tail-Lift.

This is only allowed if testing by the converter confirms that there are no issues (documentation must be held to confirm the tests) and the following criteria is met:

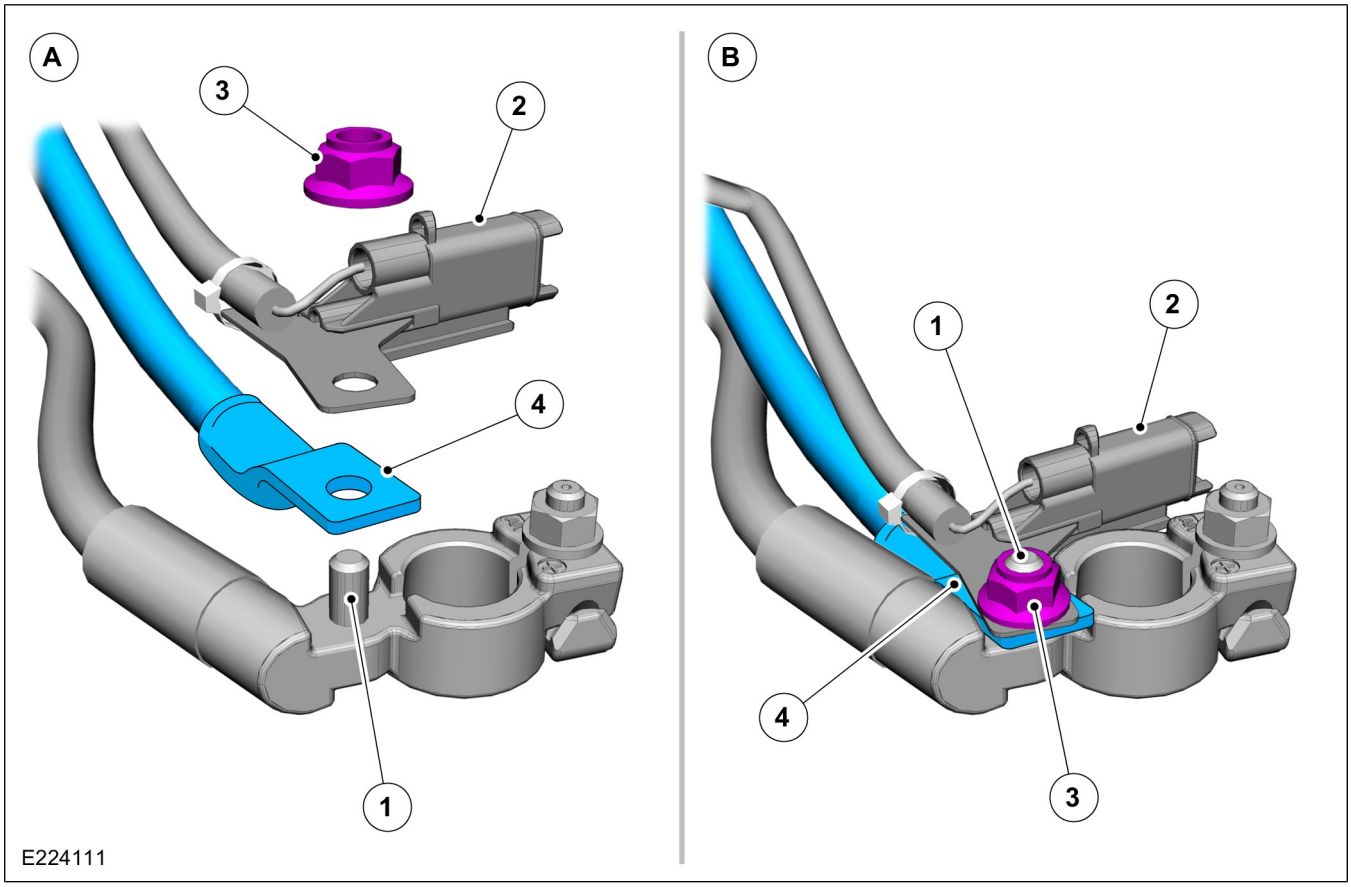
- No movement before full tightening of the nut (no risk of rotation). The third party eyelet must be a tight fit within the battery clamp slot and have a maximum Cross Sectional Area (CSA) for current flow.
- The cable CSA must be oversized,

  Refer to: 4.1 Wiring Installation and Routing Guides (page 76).
  Wiring Specifications table. For example: 245A has 70mm CSA cable.
- The third party positve conductor is mounted directly to the battery clamp with the supply for Battery Monitoring Sensor (BMS) last, see figure E224111.
- No deformation to the Ford BMS can occur. The conductor terminal/eyelet may need to be inverted, see item 4 in figure E224111.
- Only one termination (third party conductor) can be added to the 6mm stud in addition to the BMS.
- The Ford 6mm self-locking nut is to be re-used and torque to 9Nm ±10%. Separate locking washers are prohibited.
- A Mega inline fuse must be fitted as close to the 6mm stud as possible. Not to exceed 250A for short duration applications such as on Tippers, Cranes or Tail Lifts.
- For long duration continuous power applications such as High Power Inverter, the Mega fuse must not exceed the rating of the alternator fitted to the vehicle. The alternator saturation voltage must be above 13.0V when testing full load. AGM battery twin system (A738) must be fitted to the derivative. See 'Single and Twin Battery System' and 'Power and Connectivity Usage Recommendation' table in this section of the BEMM.
- A higher ampere alternator must be fitted if long duration (greater than one hour) high loads are required. See 'Single and Twin Battery System' and 'Power and Connectivity Usage Recommendation' table in this section of the BEMM.
- The SRC override feature must be used for Engine Run applications.

  Refer to: 4.3 Charging System (page 95).
  Start-Stop Override and Configurable Charging.
- Efficient isolation of third party equipment, when not required, to minimize battery discharge/deep cycling.
- Testing for end customer usage, including duty cycle, at a range of temperatures and drive cycles, worst case.
- Testing of vehicle converters system must confirm no heating of Ford or third party cables or any junctions utilized.
- Testing of vehicle converters +12V conductor must demonstrate no loosening possible to Ford battery cable clamp.
- No detriment to Ford systems from Volt drop/Inrush current by third party system (functionality or Warnings).
- If Engine Off can still operate the third party system then testing also required in this vehicle state.
- A Charge Balance must also be performed to confirm system has correct battery and alternator ratings.
- If Idle loading can saturate the alternator (fully load and go below 13.0V) then Engine RPM speed control system must be utilized to increase alternator output at idle.
- The return ground cable is recommended, routed in parallel to +12V supply for EMC compliance.
- When in Engine Run, unrequited systems should be turned off to help the alternator supply the main load of the third party system. This information should be passed onto the end user by the vehicle converter.
- The BEMM is adhered too in all relevant areas. This document allows connectivity to Ford battery clamp if the above criteria is met.

For further information please contact VCAS@ford.com

Third Party +12V Power Take Off Assembly



Item	Description
A	Assembly sequence
B	As installed
1	+12V Battery Clamp 6mm Stud
2	BMS Fuse
3	Self Locking Crimp Hexagonal Nut - Re-use and torque to 9Nm ±10%
4	Third Party Eyelet and Cable - Must be a tight fit to the battery clamp

4.4.6 Additional Loads and Charging Systems

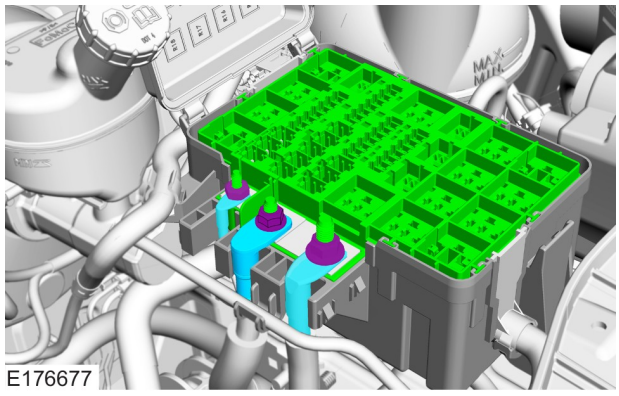
NOTE: Auxiliary customer electrical loads must only be made via the Customer Connection Points provided, the Auxiliary Fuse Panel or the High Specification Vehicle Interface Connector. For loads greater than 180A see 'Third Party +12V Power Take Off for Loads Exceeding 180A' section in this BEMM. For further information or advice contact your local Ford Dealer or National Sales Company representative.

NOTE: Do not make any additional connections to the Engine Junction Box (EJB) terminals, as over-torquing could cause damage to the EJB. Any electrical loads should be taken from the customer connection point.

For additional information on number of available Customer Connection Points

Refer to: 4.19 Electrical Connectors and Connections (page 178).

EJB Terminal Studs



All loads that exceed 100mA continuous key off load must be fitted with an isolation switch or disconnected relay. In general all loads should have some form of isolation. A supplemental battery may be required to power systems, for example: GPS vehicle tracking systems, that pull high key off loads continuously.. This is to protect from discharging batteries at ignition off and interfering with the BMS correlation of battery state of charge. This supply should also have a dedicated protection fuse of the correct value. High loads should also be grounded directly to the vehicle body and not the negative battery terminal. Connecting to the negative battery terminal will bypass the BMS and affect the correct assessment of the battery state of charge. Refer to BMS section in this manual.

If separate charging systems are added, the ground side of the charger must also be connected to the body. An auxiliary ground stud eyelet, see figure E176720, can be ordered, part numbers DU5T-14436-G_ for single battery or GK2V-14301-F_ for twin battery systems. This will be standard when pre ordered with Special Vehicle Options, A526, A606, A607,A608, A738 and A652. For additional information on order codes

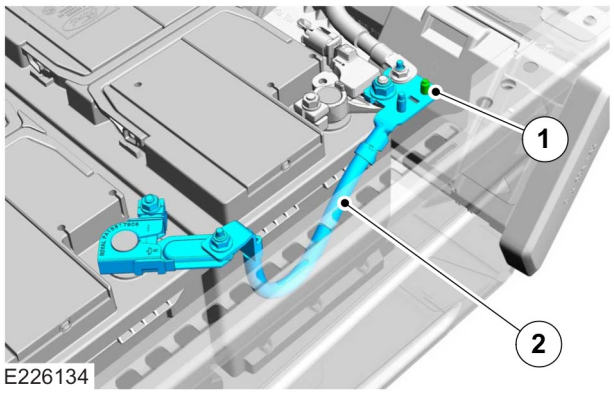
Refer to: 1.4 Conversion Type (page 15).

NOTE: If there is an isolation relay, check settings to ensure batteries are connected to the charging circuit.

For additional information

Refer to: 4.19 Electrical Connectors and Connections (page 178).
Customer Connection Points.

Auxiliary Ground Stud Eyelet



Item	Description
1	6mm Auxiliary Ground Stud for Converter Equipment - Torque 8Nm +/- 0.8Nm
2	Battery Ground Jumper Cable part number GK2V-14301-F*

4.4.7 The Ford Programmable Battery Guard (A540)

WARNINGS:

The Ford Programmable Battery Guard (FPBG) is not designed for long duration engine run power for loads greater than 70A. The system is mainly designed for engine off short duration heavy loads, or long duration low loads with the protection by isolation to allow enough energy to still crank the engine. The guard can still provide engine run power to provide high current short duration, charge systems such as third party batteries and systems such as inverters but only for amperage versus time durations as described further in this section.

If the vehicle does not come with the 240A alternator, or longer duration is required at the amperage above values further in this section, then a dedicated alternator and power cabling must be applied to avoid saturation to the Ford alternator and any thermal issues on vehicle wiring and related systems. The table described in Power and Connectivity Usage Recommendations also applies when to upgrade alternators and batteries.

NOTE: FPBG is not available until May 2016, for availability please contact your National Sales Representative or your Local Ford Dealer.

FPBG is not available with relocated handbrake.

System Overview

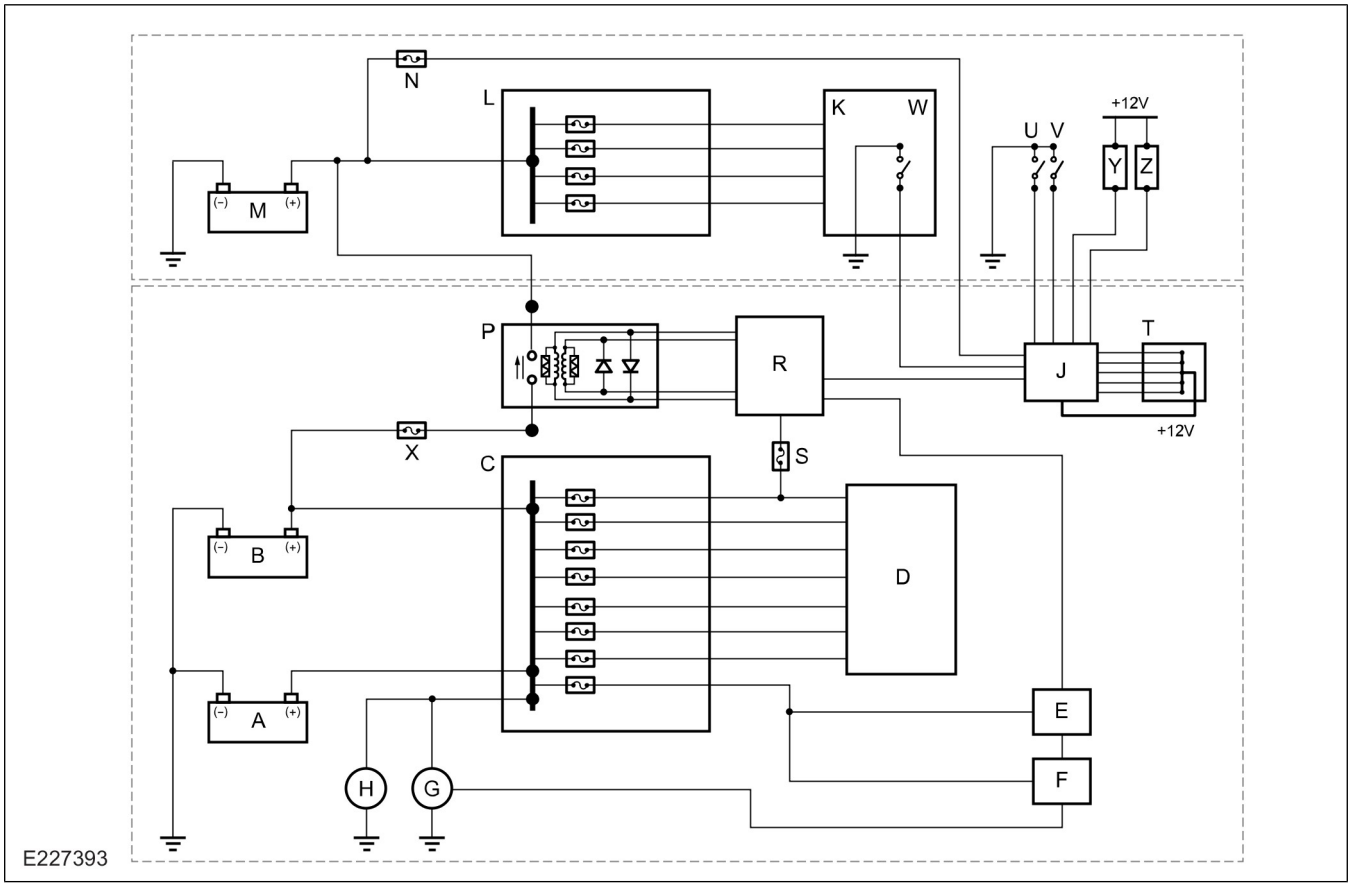
The Ford Programmable Battery Guard (FPBG) is a production or service fit system which provides 175A fused 12V power for customer use at any engine or ignition state. The system can be down-rated depending on the Mega fuse range available, changed by the Converter.

Main System Benefits Include:

- Intelligent control of power that isolates the 175A power to third party systems protect vehicle`s crank capability. Fuse values can be lowered if required.
- Third party batteries can be connected and monitored including charging where required.
- Easy setup operation modes(1 to 10) depending on the battery configuration on the vehicle and time duration power requirements at engine off.
- Protects Ford battery State of Charge (SOC) by isolating the power relay when a low voltage is detected or a specific time point is reached.
- Efficiently controls the Ford SRC and Start-Stop Inhibit to receive maximum charging to the third party batteries whilst protecting Ford battery SOC.
- Provides warning signals prior to timed or required power shut down.

- Immediate relay close function to receive emergency power, after auto disconnect, for a limited period of time.
- Immediate relay open function to isolate third party system when isolation is needed.
- Controls voltage range to smaller band width between 14.0V and 14.9V, in high load mode at engine run – less variation than seen with SRC which can range from 12.2V to 15.2V.
- Will provide a charge to all batteries when detecting a mains charger applied to one of the batteries, at engine off
- Will protect third party batteries, particularly leisure type GEL batteries from crank cycles and only use energy if required.
- Provides a warning that a mains charger is still connected to the vehicle if the system sees an ignition state change to start the engine.
- Reduce fuel usage and emissions from less charging time due to mains charging and efficient isolation of third party system.
- Improves third party battery warranty as system will now monitor the state of charge of the third party battery and protects from the majority of engine crank cycles.
- Helps maintain the standard Ford SRC system.
- Will provide continuous power at engine off if mains charger applied by manual switch demand.

Overview of System



Item	Description	Item	Description
A	Ford Battery - Standard	N	Third Battery Voltage Sense Line Fuse
B	Ford Battery - Standard/Optional	P	Power Relay*
C	Ford Power Distribution	R	Module*
D	Ford Vehicle Load	S	Ford Battery Voltage Sense Line Fuse*
E	Body control module (BCM)	T	Mode Wires*
F	Power Control Module (PCM)	U	Immediate Relay close
G	Alternator	V	Immediate Relay Open
H	Starter Motor	W	Third Party SRC Inhibit
J	FPBG Interface Connector*	X	Mega Fuse*
K	Third Party Loads	Y	Status Indicator
L	Third Party Power Distribution	Z	Power Isolation Warning
M	Third Party Battery	-	-

* Ford Programmable Battery Guard (FPBG). See figures E227390, E227391, E227392 and E227394

Modes and Set Up

NOTE: Where a third battery is fitted, and directly coupled to a third party device, it is recommended that a deep cycle type battery be installed such as AGM (Absorbent glass matt) or GEL technology. Due to the resilience of AGM technology, these batteries will work in any mode. The timer duration will be met providing the system voltage stays above the cut off threshold. However, if the voltage value is below the set point within the timer value, isolation will occur at 60 seconds after the minimum voltage is reached.

NOTE: The modes in the following table are a guide. It is not recommended to go below 12.0V with a single standard flooded battery. If an incorrect battery mode is selected for a set timer duration, the timer duration may never be achieved and also not the most efficient for fuel.

Battery Quantity, Type and Timer Modes

Mode	Ford Battery	Minimum Voltage (V)	Key Off Time (Minutes)
1	Single Standard Flooded, No Third Party Battery	12.2	30
2	Single Standard Flooded, With Third Party Battery	12.2	60
3	Twin Standard Flooded, No Third Party Battery	12.0	45
4	Twin Standard Flooded, With Third Party Battery	12.0	90
5	Single AGM, No Third Party Battery	12.0	60
6	Single AGM, With Third Party Battery	12.0	120
7	Twin AGM, No Third Party Battery	11.8	90
8	Twin AGM, With Third Party Battery	11.8	180
9	Nordic Market Twin AGM Batteries, No Third Party Battery	11.8	60
10	Nordic Market Twin AGM Batteries, Wth Third Party Battery	11.8	90

Set Up

1. Locate FPBG Interface Connector, under the parking brake console.
2. Find the System Mode Pins 15,14,8,7,6, see Retro Fitting The Ford Programmable Battery Guard System, figure E227392 item 12.
3. Configure as per Battery Configuration Table. Cut and isolate pins where shown as OFF in the Mode Configuration Pin table. For example: If Mode 8 is required, cut wire and isolate to pin 15,14,8 and 6.

Mode Configuration Pins

Mode	Pin 15	Pin 14	Pin 8	Pin 7	Pin 6
	Black Wire	Red Wire	Blue Wire	Green Wire	Grey Wire
1	ON	OFF	OFF	OFF	OFF
2	OFF	ON	OFF	OFF	OFF
3	ON	ON	OFF	OFF	OFF
4	OFF	OFF	ON	OFF	OFF
5	ON	OFF	ON	OFF	OFF
6	OFF	ON	ON	OFF	OFF
7	ON	ON	ON	OFF	OFF
8	OFF	OFF	OFF	ON	OFF
9	ON	OFF	OFF	ON	OFF
10	OFF	ON	OFF	ON	OFF

Function

Low Voltage Cut off – Engine off: The system will disconnect power when voltage is sensed below the mode threshold value (11.8V or 12.2V). The system will only disconnect if the low voltage is below threshold for 60 seconds continuously. The system will keep the relay contacts open until a key cycle occurs or a voltage increase is detected (for example: an external charger applied) above the low set point threshold.

External Charger – Engine off: The system will close the relay contacts if a voltage over 13.1V is detected in the system (an external charger is added to the Ford or third party battery) for 8 hours to provide a charge to all batteries in the system. Manual override can be done by keeping Immediate Relay Close Pin grounded during the period when continuous power is required. A third party fit latched switch type would achieve this functionality. When a low voltage condition is detected on Ford battery system in modes 2,4,6,8,10, relay will not be opened if third party battery system has voltage higher than defined threshold.

Low Voltage Cut off – Engine on: The system will close the relay contacts when an engine run is detected and the voltages prior to crank event was higher than the threshold value. An SRC Inhibit request is sent, 5 seconds before closing the relay contacts if the converter battery voltage is detected lower than the threshold value. This allows time for the alternator to ramp up to full charge voltage. Isolation of the relay, will occur immediately when the ignition signal is detected, if a mains charger is connected to the system prior to the crank event. A warning will also be given via the Status Indicator circuits. It is up to the converter as to decide whether third party visual or audible warning devices are fitted to the signal.

Smart Regenerative Charging and Start Stop Inhibit: The system has an SRC Inhibit input and can be utilized by third party systems in conjunction when third party heavy loads are active, such as a Power Inverter, Crane or Tipper. This feature is to maintain a stable voltage at a conventional charge state of between 14.0 to 14.9V. The system will also inhibit SRC and start stop if it measures the third party battery at a low state of charge and requires to be charged. The SRC Inhibit will happen with the following circumstances;

a) When the relay is open and a converter load input is received, The system will give SRC Inhibit output immediately, 5 seconds later close relay contacts.

b) If converter battery low voltage is detected after an engine off event (below set point voltage reached >60 seconds), the system will send SRC Inhibit signal immediately at engine run for a defined period of engine run duration. The system will re-assess the battery voltages on the next engine run if the first engine run duration is less than the defined period.

The assessment will be made in correlation with voltage and SOC relation. The following table refers to estimated charge times. When system is sharing alternator charge on all batteries, the target value is 80% SOC but some may be higher.

SRC Inhibit Timer Chart

Mode	Ford Battery Configuration	SRC Inhibit Timer (Hours)	Min. Voltage (V)	SOC at Min. Voltage (%) per Battery	Target SOC for SRC Inhibit Turn Off (%)
Mode 2	80Ah	**2.0**	12.2	35	80
Mode 4	2 x 80Ah	**3.7**	12.0	20	80
Mode 6	80Ah AGM	**2.8**	12.0	35	80
Mode 8	2 x 80AH AGM	**4.4**	11.8	20	80
Mode 10	2 x 95Ah AGM	**4.4**	11.8	35	80

If the third party battery voltage is above 12.6V, The system will not perform an SRC Inhibit assessment with no inhibit output.

Power Isolation Warning: The system provides a Power Isolation Warning at the dedicated output. This is a switched ground output and requires a third party audio or visual device to be fitted, such as an LED lamp or buzzer installed and is activated prior to main supply disconnect.

The value of this output is a low side driver rated at 1000mA. This is to provide early warning that the supply is imminent for disconnect and gives a chance to restart the engine, add a mains charger or finish their power usage task.

Power Isolation Warning output will be given when voltage is sensed to be under the voltage threshold value for 30 seconds.

This assessment is required to ensure there is no instant voltage drop in the system because of an initial start of high power equipment or cranking.

The Power Isolation Warning output will be continuous until the 60 seconds completed under threshold and relay is already open circuit. This allows the operator to understand why they have lost power. In extreme power take off events, but with a good state of charge of battery, there may be events when the warning is triggered but disconnection does not occur, if the load is removed within the trigger period due to the battery recovering voltage above the cut off threshold. This is normal operation and further loads could be applied before an engine start and charge is required.

Status Indicator: The system provides a Status Indicator output which is the indication of the system status on certain functions. The value of this output is a low side driver rated at 1000mA. This is a switched ground output to be used by third party audible or visual device, such as an LED lamp or buzzer.

Status Indicator output will be given when an Immediate Relay Contact Close switch(third party switch) is detected to be on. The output will be continuous as long as the Immediate Relay Close is active.

Status Indicator output will also be given when Ignition is detected if the voltage is higher than external charger voltage threshold 13.1V. This is to give the warning that external charger is still on before the crank and user should check the cable connections. The warning will be given as a pulse signal 500ms ON 500ms OFF. Output will be stopped after 30seconds regardless of the engine state.

Status Indicator also gives output with a dot-space matrix pre-defined set of functions when related conditions occur. The set of conditions are shown in Diagnostic section.

Immediate Relay Contact Close Feature: If CLOSE relay signal is activated it will immediately close relay contacts. This overrides all other functions of operation at engine off for 2 minute duration except the immediate relay contact OPEN function.

After 2 minutes, the system will go back to normal operation monitoring. When the 2 minute duration is reached, the function will not be available unless a switch cycle is detected.

Immediate Relay Contact Open: If OPEN relay signal is activated, it will immediately open relay contacts and override all other functions until next key ignition cycle and the switch is deactivated. When a new key cycle is detected (Ignition Position 0 then 2), the module will go back to normal operation. If the signal is still activated regardless of ignition state, the relay contacts remain open. This system should not be used as an emergency stop. A separate emergency stop for safety critical systems must be included in the third party system.

Engine Run Alternator Protection When voltage is detected below low voltage threshold for 5 seconds continuous during an Engine Run, FPBG will activate SRC Inhibit output until next engine off state is achieved. This is to protect the alternator under engine run if there is not enough capacity under the SRC voltage to support immediate high power loads. After activation of the SRC Inhibit output the system will assess the voltages for 15 seconds. When the voltage is detected higher than 12.8V the system will keep the relay contacts close. When voltage is detected below 12.8V the system will open the relay contacts for 4 minutes. When 4 minutes open-contact timer ends the system will check the voltages for 10 seconds and close contact if voltage is detected higher than 12.8V.

Over-Voltage Protection When a voltage above 15.5V is detected the system will send open contact signal if the voltage is below 15.8V. The module then stops sending outputs until voltage recovers below this voltage upper limit.

When voltage is detected above 15.8V the system will still understand voltages up to 17.4V but will not send any outputs. Diagnostic LED will light continuously RED-RED-ORANGE sequence in Over-Voltage when it is higher than 15.8V.

Sleep Mode: The system will be active when it sees ignition position 2 signal from position zero or key out. When ignition position 2 is deactivated, the key-off operation timer starts where it will monitor voltages and continue normal operation for a timed period set, depending on which MODES from 1-10 are set. The module will go to Sleep mode after 10 minutes from the timer duration period or low voltage cut off point. To wake up the module, the following conditions need to occur, either: Ignition state change back to position 2, Battery Voltage increase or Immediate Relay Contact Close.

Cold Crank Aid and third party battery starter motor protect: The system will keep the relay contacts open after ignition position 2 is detected until it receives the engine run signal unless crank does not initiate within a 30 second period. When engine run signal is received within the first 30 seconds, the system will close the relay contacts immediately if converter battery is above the low voltage threshold set point. If the third party battery is below the threshold voltage set point, the system will activate SRC inhibit after engine run and close the contacts 5 seconds later. If the system detects a second ignition position 2 cycle without engine run within the first 30 seconds, it will immediately close the contacts for 30 seconds. This is to provide supplemental crank energy from the third party battery whilst not always exposing the third party battery to the starter motor inrush current. Also the feature is designed to avoid third party systems competing for energy with the starter motor and so maximize energy for crank on the first attempt. For continuous key cycles, the relay will remain open for each 60 seconds period. Function will reset after 60 seconds and can be used again.

Diagnostics

The system will provide diagnostic messages via an LED indicator on the modules enclosure. Certain conditions will be transmitted to the Status Indicator pins to show the normal operation state or fault during operation. This will help identify a failure mode coded by a mark space ratio output, see the System Diagnostic - Operation table.

The system will expect 12V on the 5 MODE pins with various combinations. When a change happens in the MODE bridge pins, the system will detect the change and give necessary response via an LED. The system will check the mode pins every ignition cycle or when a hardwire voltage reset is detected. Checking which mode can therefore be done at every ignition cycle. The system transmits an LED color message when a bridging change is detected on the MODE pins, see System diagnostic – Mode Setup.

If the system detects more than one failure mode, the failures are transmitted to an LED one after the other. When one of the fault condition is cleared (corrected), the next detected failure mode would be transmitted until all faults are cleared. The system will give an LED light colors and flash rates as shown in the System Diagnostic

FPBG Diagnostic - Operation

Function/Signal	Status	LED Color Sequence*	Status Indicator Output (Signal Pattern)
12V Ford Battery (Battery Sense & Power)	OK	G	
	Low Voltage	OO	
12V Converter (Battery Sense)	OK	G	
	Low Voltage	OOO	
	Open Circuit	RRR	**O O O**
Engine Run Alternator Protection	OK	G	
	Low Voltage Cut-Off	RRRR	**O O O O**
Power Isolation Warning	Not Triggered	G	
	Triggered	OOOOO	
External Charger - Engine Off	Not Detected	G	
	> 13.5V Detected	O-O	
	IGN2 Detected	R-R	**O**
Over Voltage Protection (>15.8V)	OK	G	
	Over Voltage	RRO	**O-OO**
SRC Inhibit Output	Not Triggered	G	
	Triggered	OO-O	
Converter Load SRC Inhibit Input	Not Triggered	G	
	Triggered	O-OOO	
Immediate Relay Contact Open	Not Triggered	G	
	Triggered	OO-OO	**O O - O O**
Immediate Relay Contact Close	Not Triggered	G	
	Triggered (Close Switch)	OOO-O	**O** Continuous
Ignition Position 2 (Engine Run)	OK	G	
	Open Circuit	RRR-RR	**O O O - O O**
FPBG Internal Failure	No Failure	G	
	Soft Voltage Reset (Ignition Cycle)	RRR-R	**O O O - O**

* G = Green, O = Orange, R = Red, -= Space

FPBG Mode Setup LED Sequence

Condition	Status	LED Color Sequence*	Number or Repeat Sequence
MODE Pin Check - Ever Ignition Cycle & Hardware Voltage Reset	Change Detected	G O R	2
MODE Setup Change Issue	Not OK Combination	O R	3
MODE Setup Successful	OK Combination	G O	3
MODE 1 Selected	OK	G	1
MODE 2 Selected	OK	G G	1
MODE 3 Selected	OK	G G G	1
MODE 4 Selected	OK	G G G G	1
MODE 5 Selected	OK	G G G G G	1
MODE 6 Selected	OK	G G G G G G	1
MODE 7 Selected	OK	G G G G G G G	1
MODE 8 Selected	OK	G G G G G G G G	1
MODE 9 Selected	OK	G G G G G G G G G	1
MODE 10 Selected	OK	G G G G G G G G G G	1

* G = Green, O = Orange, R = Red

Further Information:

- Normal functionality at ignition ON or OFF may lead to a clicking sound of the relay opening and closing as part of its strategy. The end operator may need to be advised of this condition.
- The main +12V feed supply is taken from the main Ford battery cable. It is not permitted to touch this interface. Further power take off must come from the Ford Customer Connection points as shown in the section Electrical Connectors and Connections.
- If the fuse needs to be down-rated, a Mega fuse size can only be used. The fuse value must not exceed 175 Ampere.
- Emergency isolation for safety applications must not be used by the isolation feature. If control is lost, to the main relay, it remains in the same state as is a latched type relay.
- It is recommended that a latched switch on the relay close circuit always be installed. There are certain scenarios related to mains chargers and engine off quiescent voltage that may be above 13.1Volts, that the relay contacts would need to be closed manually, to deliver power to the third party systems when required.
- If the timer value is never or rarely achieved, the following factors maybe the reason:
  - Wrong battery and alternator specification (too small ratings) for the third party load.
  - System degradation has occurred, such as failing batteries (always check battery condition, if this keeps occurring contact your local Ford dealer for a battery health check), other systems are fitted draining the batteries (such as trackers or other third party loads, connected to the CCPs).
  - Incorrect installation such as battery sense lines not installed.
  - Wrong mode configuration set to required timer value.
  - Main mega fuse is open circuit
  - Cold temperatures will lower battery voltage and ability to hold or receive charge.
  - Drive cycle versus engine off application is not providing enough time to charge up the batteries.
  - Alternator performance issues, saturated or failed.
  - Peripherals left always plugged into 12V Power Cigar sockets (which are no longer on 30 minute battery saver but deactivate at 60% Battery SOC).
- When cutting the linked wires to set the mode, it is recommended to insulate each cut wire.
- The system at full load must not let the alternator drop below 13.0V. This is an indication that the alternator and system is saturated and cannot meet the demand for power.

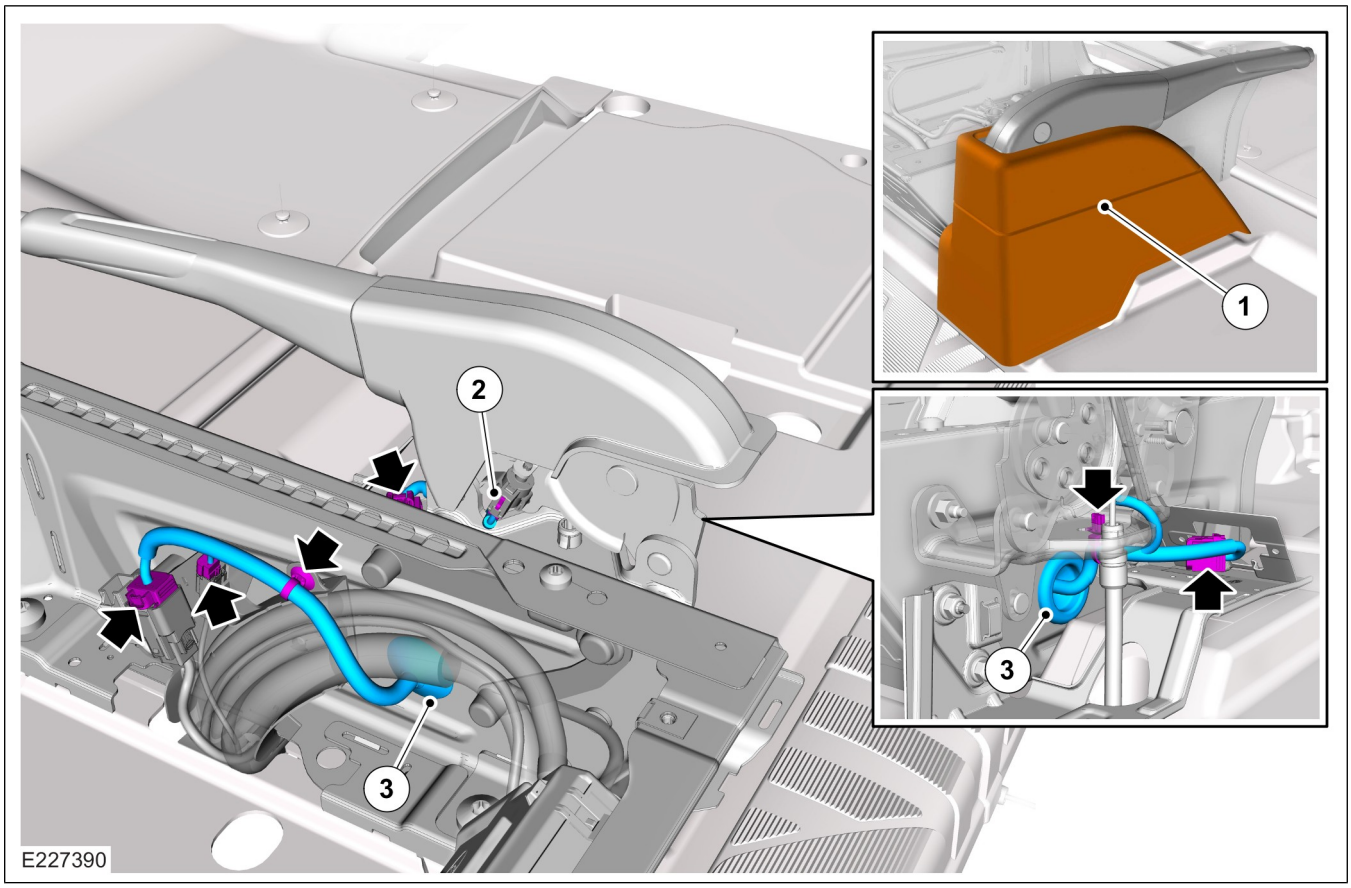
- For static conditions, in workhorse mode for the third party main load, the operator may need to be instructed to manually load shed Convenience Ford systems to maximize available energy from the alternator. Further systems may also help performance such as the Engine RPM option A003. This system elevates engine idle which will increase current output of the alternator.
- The Ford Programmable Battery Guard System can also be bought as part of the Converter High Power Pack grouping dealer option A550. This pack includes the Engine RPM control, the AGM batteries and a 240A up rated alternator.
- Mains chargers must be of the multi stage type (include trickle charge) and be checked for performance before installation as the system will connect all batteries to the charger. For instance, the charger has adequate current limiting to avoid overload.
- The output warning features may occur during a normal drive cycle. Therefore audible or visual peripherals, connected to the outputs should be located where not deemed a distraction to the driver. I.e. a buzzer only on the cherry picker external platform and a small LED warning lamp in the CAB area.
- The system cannot be ordered as factory fit option or retrofitted with the Ford 150 Watt inverter as it utilizes the same package space. However, this system can power a 2,000 watt third party fit inverter as long as the 175A rating is not exceeded.
- The relay may cycle between 8 hour periods, closing the relay when connected to a mains charger at key off load, depending on battery voltage during long engine off periods. This is normal functionality and designed to ensure adequate charge is given to all batteries.
- For the 175A ground point, the converter is to supply their own ground location or utilize the auxiliary ground as shown in battery and cables or ground points section.
- Before performing a Mode change or initial setup, the converter is to un-power the system to avoid risk of contact between Mode Pins (+12V) and the vehicle body. The Mode pins have to be cut according the Mode Table to setup correct Mode for vehicle battery configuration. This could be achieved either by disconnecting the system feed connector, or removing all battery B- terminals completely. Note that removing the system cable from the battery is not enough to disconnect the power from the module. On the Mode Pins setup, none of the cut mode wires should be grounded as damage to the module could occur.
- For high current applications above 70A and at engine Run, vehicle load shedding must be applied and battery cables and alternator temperatures must be monitored. For these applications the 240A high power alternator must also be fitted.
- If continuous heavy load usage is required the following values and duration must comply to the following:
  - 70A to 90A, a maximum of 10 minutes is allowed
  - 91A to 120A a maximum of 4 minutes is allowed
  - 121A to 175A a maximum of 1 minute is allowed
- If the vehicle does not come with the 240A alternator, or longer duration is required at these amperage values above, then a dedicated alternator and power cabling must be applied to avoid saturation to the Ford alternator and any thermal issues on vehicle wiring and related systems.
- Under heavy load applications, total system impedance should be calculated to design for volt-drop conditions. Power supply cable should be added as short as possible and to the correct cross sectional area as described in Wiring Specification Table.
- For heavy current applications at engine run, Third Party SRC Inhibit (FPBG Interface Connector Pin 9) must be utilized.
- General system re-setting function is performed via Ignition cycle. If functionality does not restore, check Status Indicator output message or Diagnostic LED on the module. If further help is required, contact your local NSC.

4.4.8 The Ford Programmable Battery Guard System - Aftermarket Fitting

NOTE: If the vehicle is fitted with 150W Inverter this will need to be removed to enable retrofit of the Ford Programmable Battery Guard System. A new Hand Brake Console will be required for less 150W Inverter. For further information contact your local Ford dealer.

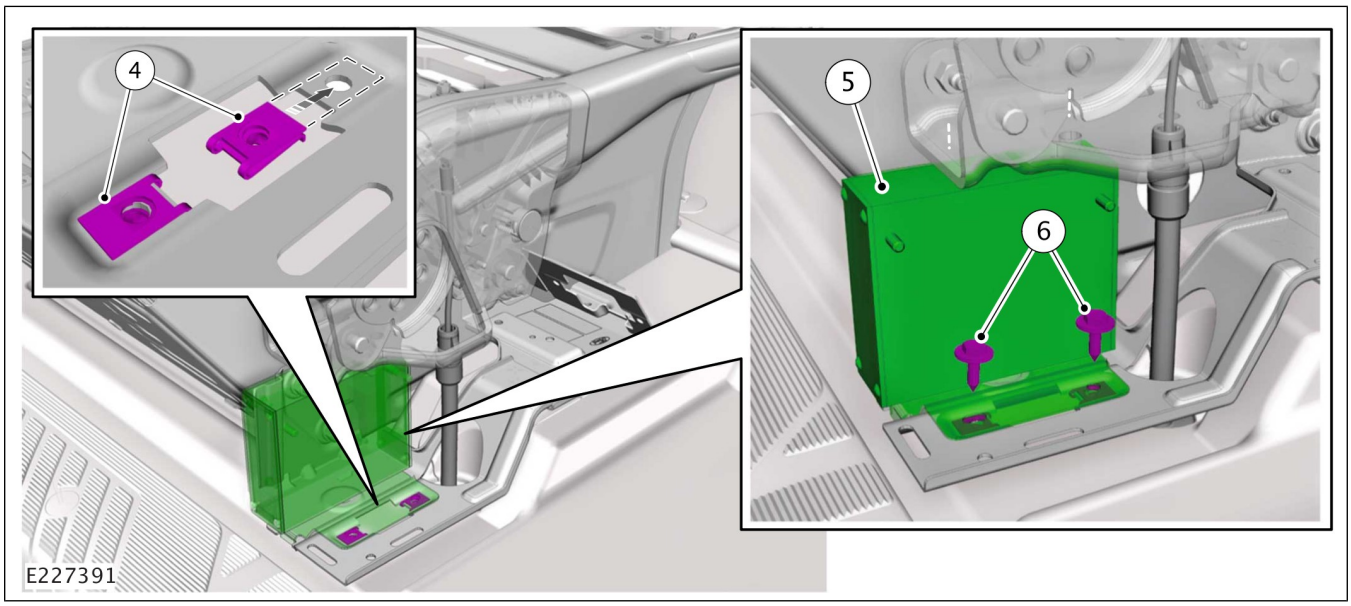
NOTE: It is necessary to remove the upper seat, disconnect the battery/batteries power and take out the battery/batteries (and box if one) prior to fitting the Ford Programmable Battery Guard System.

Removal of Handbrake Harness



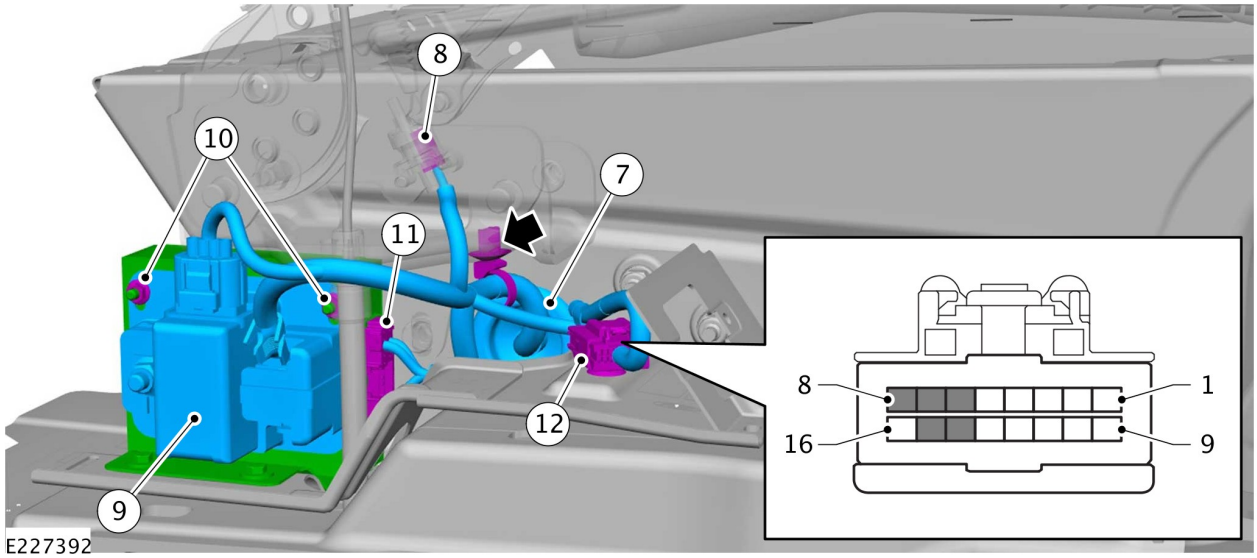
1. Remove Handbrake Console
2. Disconnect the Handbrake Lever Connector
3. Remove Grommet, disconnect Connectors, Firtree Clips, Tiewraps. Dispose of Harness.

Ford Programmable Battery Guard Module



4. Fit 2x U Nuts
5. Fit Module GK2V-10B727-A*LHD/B* RHD.
6. Secure Module with 2x screws - torque 3.2Nm ±0.5Nm

New Harness Routing - Outside Pedestal

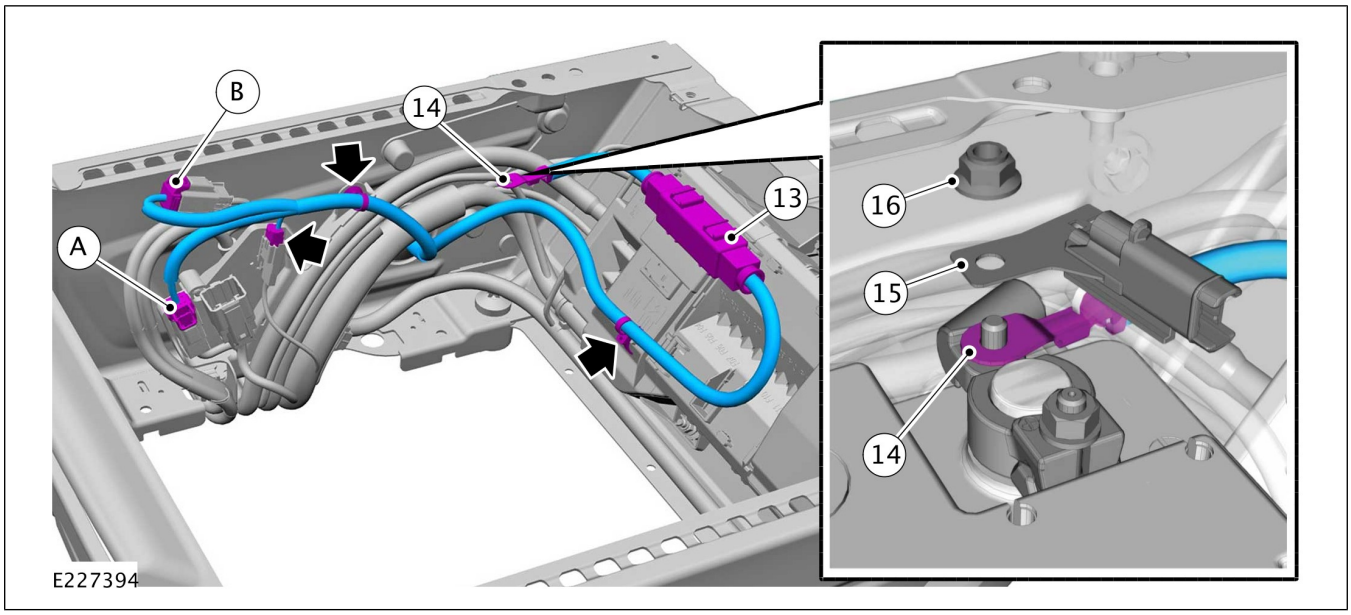


7. Route Harness GK2V-15K857-E*LHD/F*RHD through the drivers seat pedestal, making sure the grommet is seated/sealed properly making sure the harness does not obstruct or interfere with the handbrake cable.
8. Fit Handbrake Connector
9. Fit Relay Holder
10. Secure Relay Holder with 2x M5 Nuts - Torque 3.2Nm ±0.5Nm
11. Fit Module Connector
12. FPBG Interface Connector - Mating Connector face view showing Mode Configuration Pins 15,14,8,7 and 6

FPBG Interface Connector

Pin	Description	Wire Color
1	Close Relay Request Input - SW GND	Yellow/Grey
2	Open Relay Request Input - SW GND	Blue/Red
3	Empty	-
4	B+ Converter Battery Sense Line	Black/Grey
5	Empty	-
6	Mode Configuration Pin 6	Grey
7	Mode Configuration Pin 7	Green
8	Mode Configuration Pin 8	Blue
9	SRC Inhibit Converter Request Input - SW GND	Blue/Grey
10	Empty	-
11	Power Isolation Warning	Black/Yellow
12	Status Indicator / Diagnostics	Grey/Orange
13	Empty	-
14	Mode Configuration Pin 14	Red
15	Mode Configuration Pin 15	Black
16	Ignition KL15 +12V	Grey/Yellow

New Harness Routing - Inside Drivers Seat Pedestal



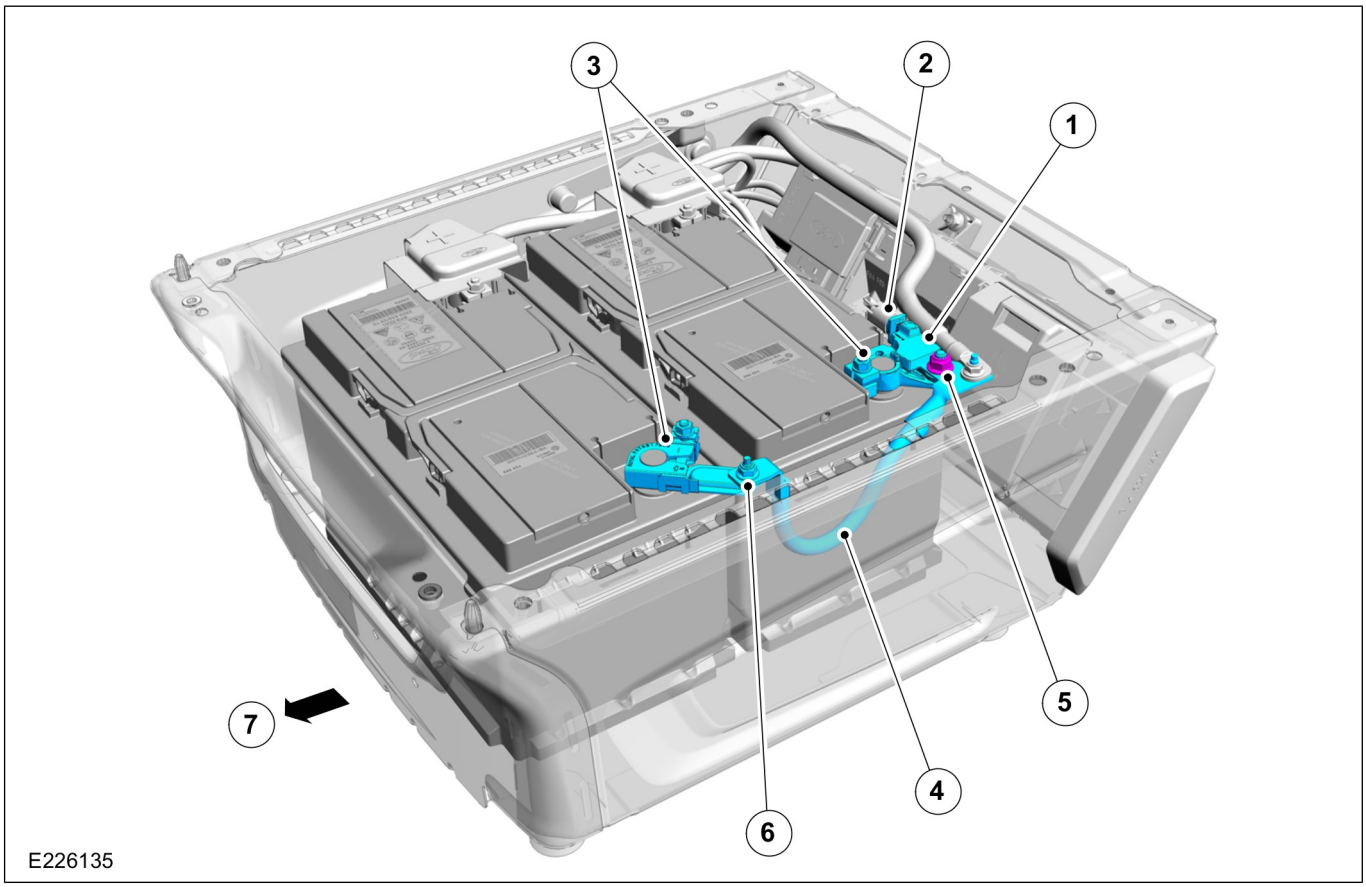
13. 175A Mega Fuse - Route and connect harness as shown in E227394
14. Battery Positive Eyelet*
15. Battery Monitoring Sensor
16. M6 Nut - Torque 8Nm ±10%

NOTE: Vehicles without Auxiliary Fuse Panel need to use connector 'A' location, Vehicles with Auxiliary Fuse Panel need to use connector 'B' location.

* After routing the FPBG System, refit the battery/batteries into the pedestal and reconnect as shown in E227394.

Use correct torque when re installing the upper seat.

4.4.9 Battery Monitoring Sensor (BMS)



Item	Description
1	Battery Monitoring Sensor (BMS) GK2T-10C652-A*
2	Plug-in connection — Local Interconnect Network (LIN) and Battery Positive +12 volts (B+) Feed
3	Connection to Negative Terminal of Main Battery Post — See 'Battery Cable Fixing Torque'
4	Jumper Cable (GK2T-14301-A*) only with twin batteries
5	1x M8 nuts. Do not loosen or remove
6	1x M6 nut. Do not loosen or remove
7	Front of vehicle direction

CAUTION: Do not permanently remove jumper cable (GK2T-14301-A*) from BMS.

The BMS continuously monitors the condition of the main battery (or twin batteries). To do this, it is bolted directly to the negative terminal of the battery. It is recommended that this is not removed. However, if removal is required, please refer to the ETIS workshop manual, local Ford dealer or customer services.

The BMS re-calibrates itself at regular intervals. This occurs during a rest period at key off, when the battery closed-circuit current is less than 100mA. The rest period must last for at least three hours. If the system cannot carry out a re-calibration then it is unable to establish the correct state of charge of the battery. In this case, the Start-Stop system may be deactivated.

It is recommended that the total Ampere consumption, in sleep mode, does not exceed 100mA. This is because BMS will not be able to accurately correlate the battery state of charge. Note there is approximately 20mA of key off load from existing Ford fit systems so the additional maximum is 80mA of converter fit system. Any third party installations should ideally be activated via Ignition or engine RUN. However, a sleep mode of 100mA is still high and will lead to deep discharge. Regardless of battery system, long periods of discharge may necessitate long periods of recharge. See 'Power and Connectivity Usage Recommendation' table at the end of this section.

After Converter system is installed, it is recommended to measure total key off load to battery with a clamp on ammeter calibrated and sensitive to milli ampere's (mA). Perform this test after 10 minutes of key off with all doors shut so that the vehicle remains in sleep mode.

NOTE: If the key off load only drops to the expected lower value after 30 minutes, its probably because a feature is still active, controlled by the battery saver timer. This could be because any door is ajar, interior lamp is switched on. Peripherals plugged into the power sockets will continue to drain power until the battery reaches a low level of charge.

4.4.10 Single and Twin Battery Systems

Wiring of Batteries in Parallel for High Current Applications

If higher current is required an additional battery can be added as shown in the proposed interface schematic. In this case the engine run signal is used to control relay "D", see figure E225363, third party topology diagram to allow the third battery to be charged when the engine is running. Also see figure E227393, Overview of System for Ford Programmable Battery Guard system.

Single to Twin Battery Conversion

Any additional or different batteries must be checked for correct functionality on a Start-Stop or SRC vehicle, please refer to Battery Configuration, Additional Loads, Start-Stop and Smart Regenerative Charging (SRC) and also:

Refer to: 4.3 Charging System (page 95).
Refer to: 4.8 Electronic Engine Controls (page 135).

If a requirement exists, it may be viable to order vehicles installed with a single battery, a battery disconnect relay, and a kit of harnesses to be fitted by the installer. See following table for battery cables and components.

NOTE: A vehicle ordered with a single battery cannot be converted into a Start-Stop derivative.

Battery Cables and Components

A vehicle ordered with a single battery can be converted to twin standard batteries or to High Performance Deep Cycle AGM batteries. When converting to the standard option it is necessary to order an additional single battery to the same specification as the original fit. Alternatively when converting to the High Performance Deep Cycle AGM batteries it is necessary to replace the original battery with two AGM batteries of the same type. The battery part numbers for each option is shown later in this section.

Generic items when converting from Single to Twin Batteries

Part Number	Description	Quantity
GK2T-14301-A*	BMS Jumper Cable - less auxiliary ground stud	1
GK2V-14301-F*	BMS Jumper Cable - with auxiliary ground stud	1
BK2T-14300-A*	Left Hand Drive positive cable	1^
BK2T-14300-D*	Right Hand Drive positive cable	1^

^only one battery pending on drive.

Replacing with Twin Basic System – Same as Single Fitted

Part Number	Description	Quantity
GK2T-10655-D*	Lead Acid 80Ah Standard Flooded Battery - 2 year warranty territories	1
GK2T-10655-E*	Lead Acid 80Ah Enhanced Flooded Battery - 3 year warranty territories	1

Replacing with High Performance AGM System

Part Number	Description	Quantity
8C1V-10655-A_	High Performance Deep Cycle 95Ah AGM Battery	2
BK3V-10A721-C_	Bracket Battery Clamp	1
BK3V-10A818-A_	Dual Drain Tube	1
BK2V-14277-A_	Battery Positive Isolation Covers	2
BK3V-10N669-A_	Battery Tray	1
BK21-63227-A*	Driver Seat Pedestal LHD	1
BK21-63226-A*	Driver Seat Pedestal RHD	1

4.4.11 Power and Connectivity Usage Recommendations

Engine State	Power Usage	Recommended Specification (order code in brackets)
Engine OFF Loads	LOW CONTINUOUS POWER TAKE OFF - Up to additional 5mA at Key OFF, for example: KL30 fed small current peripheral chargers.	Donor Vehicle Battery(s)
	MID CONTINUOUS POWER TAKE OFF - Between 5mA and 30mA at Key OFF, for example: Trackers(with sleep function, no GPS), Control Gear, KL30 fed medium current peripheral chargers.	Twin Batteries of same type (only standard on certain applications)
	HIGH CONTINUOUS POWER TAKE OFF - Between 30mA and 180mA at Key OFF, for example: Trackers with GPS, Control Gear, KL30 fed high current peripheral chargers DO NOT EXCEED 180mA.	2 High Performance Deep Cycle AGM batteries (A738)
	OCCASIONAL SHORT TERM HIGH POWER TAKE OFF - 40-240A at Key OFF, for example: Cranes, Tippers, Tail Lifts, 230V Inverters, Ambulances.	2 High Performance Deep Cycle AGM batteries (A738) + Ford Programmable Battery Guard -max 175A* (A540). Additional batteries maybe required, for further information see Battery Configuration, Additional Loads, Start-Stop and SRC, in this section.
Engine RUN Loads	LOW CONTINUOUS POWER TAKE OFF - Up to 30A, for example: Maintenance Van with water heater and additional lighting but no further systems.	Donor Vehicle Alternator
	HIGH CONTINUOUS POWER TAKE OFF - 30A - 240A, for example: Ambulance, High Load Maintenance Vehicle, Refrigeration. DO NOT ALLOW BATTERY DISCHARGE AND DO NOT ALLOW SYSTEM TO DROP BELOW 13V, for further information see Battery Configuration, Additional Loads, Start-Stop and SRC, in this section.	Up rated 240A Extra Heavy Duty Alternator AND/OR RPM Speed Control (A003) to improve Alternator Output at idle if required. For further information see Battery Configuration, Additional Loads, Start-Stop and SRC in this section and Charging Systems to configure charge mode.
	Power Take Off applications which require elevated idle engine speeds, for example: Mobile Tire Filter Van, Welders Vehicle, Mechanical PTO from engine.	RPM Speed Control (A003)
	For application where the Customer Loads requirement exceed HIGH CONTINUOUS POWER TAKE OFF, for example: total Ford and Converter loads exceed the highest available Ford alternator rating	High Power Pack Option (A550) and Supplemental Batteries and Supplemental Energy Source pending charge balance calculation, see Battery and Cables section

NOTE: The Ford Programmable Battery Guard (A540)) can be stand alone or bought within the HIGH Power Converter Pack (A550). The system is an Intelligent PATENTED battery guard for Power Take Off requirements that has features including preserving enough energy to crank even with engine off power requirements, charge the entire battery system from a mains charger, charge third party batteries from engine run, preserve leisure batteries from too many crank cycles and helps maximize fuel save, reducing emissions, charging requirements by efficiently disconnecting third party loads that are not required. There are further features to warn from disconnect and override controls. Full details of the system can be found in this Battery and Cables section.

Connectivity Usage	Recommended Specification (order code in brackets)
Additional fused relay outputs. For example: Service Engineers Van.	Auxiliary Fuse Panel (A526) option includes 3 Customer Connection Points (3 x 60A Fuses).
Roof Beacons/Additional switches. For example: Highway Maintenance Vehicles.	Beacon Preparation Pack (A606)/Utility Vehicle Switch Pack (A607)* Note: includes Auxiliary Fuse Panel (A526)
Conversions using various vehicle signals are required, such as indicators, stop lamp, door ajar, handbrake on. For example: Police Vehicles and Ambulances.	High Specification Vehicle Interface Connector (A608)* Note: includes Auxiliary Fuse Panel (A526).

*Utility Vehicle Switch Pack (A607) and High Specification Interface Connector (A608) can not be ordered together.

WARNING: If the lifetime vehicle usage regarding frequency cycles of discharge, total current drain or real time battery state of charge, cannot be defined, as mentioned below, then the Conversion must default to AGM battery technology.

Standard Flooded Lead Acid Batteries can be utilized, though prior to choosing Standard Flooded over High Performance AGM batteries, the following parameters should be considered.

Taking account of standard vehicle operation over a 3 year period, the following Ah capacity cycling is available:

- Standard Flooded Battery = 30 times the battery Ah capacity
- AGM = 600 times the battery Ah capacity

For example: For an 80Ah Standard Flooded Battery, 30 x 80Ah = 2400Ah of battery turnover is available for the converter to use during the battery life (3 years)

The following are examples (in an engine off condition, using this battery size) of equivalent loading:

- 8 Amp draw for 1 hour and 300 times during battery life
- 20 Amp draw for 10 minutes and 720 times during battery life
- 60 Amp draw for 1 minute and 2400 times during battery life
- 160A mp for 1 minute and 900 times during battery life

When calculating the available capacity it is also recommended the battery state of charge does not fall below 50% at any time.

WARNING: Vehicles with Single or Twin batteries should always fit battery guards if engine off power is required. Ford recommend (A540)

NOTE: Use AGM Batteries for deep cycle applications i.e. charge and discharge on a regular basis.

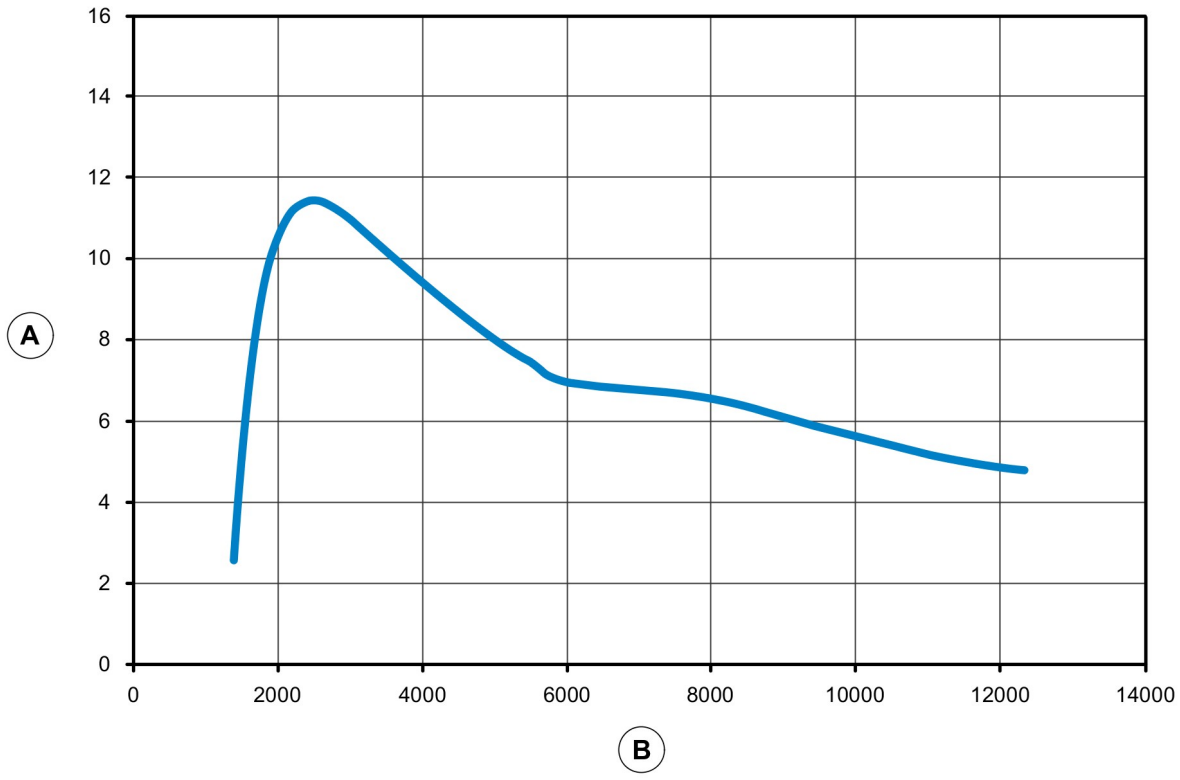
NOTE: · When considering battery discharge, the converter needs to consider the current drawn when the added system is in operation, plus any continuous key off loads even when not in use. For example, an inverter fitted will consume power even with no load connected.

NOTE: · Where possible, engine run operation of electrical equipment reduces battery discharge; both Vehicle Start and Auxiliary Batteries are utilized in conjunction with the charging system.

NOTE: · User training and appropriate battery maintenance on a regular basis will assist in ensuring correct battery operation.

4.4.12 Generator and Alternator

Torque Curve of Alternator - 165A



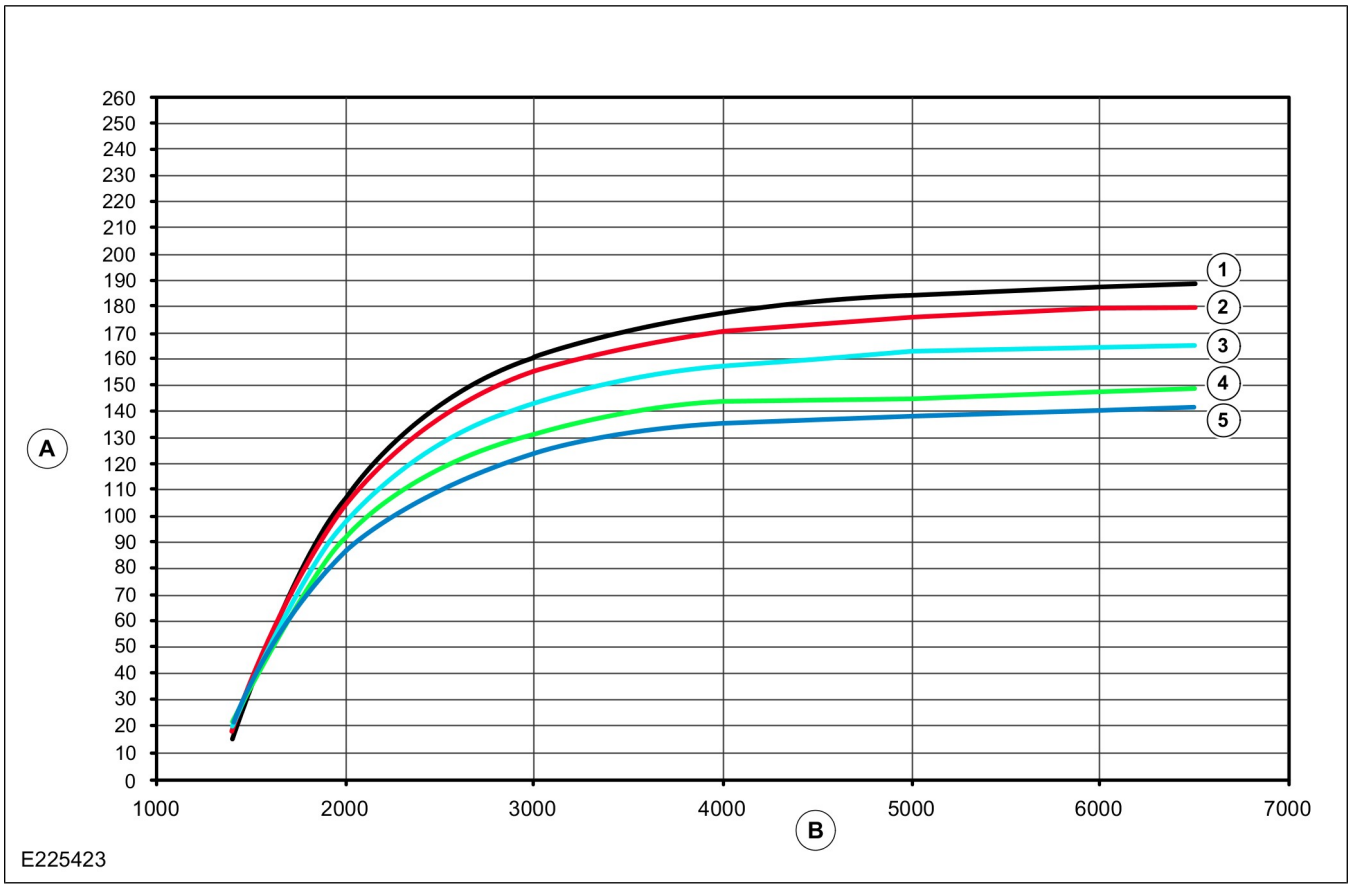
E225420

Diagram E225420 shows the torque in Nm which is required to drive the alternator. The vertical axis (A) shows the torque (Nm) and the horizontal axis (B) shows the alternators revolutions per minute (1/min).

NOTE: For equivalent engine revs per minute (RPM), the alternators revolutions, axis (B) should be divided by the following factor: 2.79 for 2.0L diesel.

NOTE: These alternator curves do not show spare output capacity as this would be dependant on original vehicle features and options.

Output Performance of Alternator - 165A



Item	Description
1	Temperature 0°C — Voltage 14.1V
2	Temperature 27°C — Voltage 13.8V
3	Temperature 60°C — Voltage 13.5V
4	Temperature 93°C — Voltage 13.1V
5	Temperature 115°C — Voltage 12.9V

Diagram E225423 shows the alternator output performance at five different temperatures In accordance to Ford specification at five different temperatures. The vertical axis (A) shows output current (Amps) and the horizontal axis (B) shows Alternator speed in revolutions per minute (1/min).

Torque Curve of Alternator - 220A

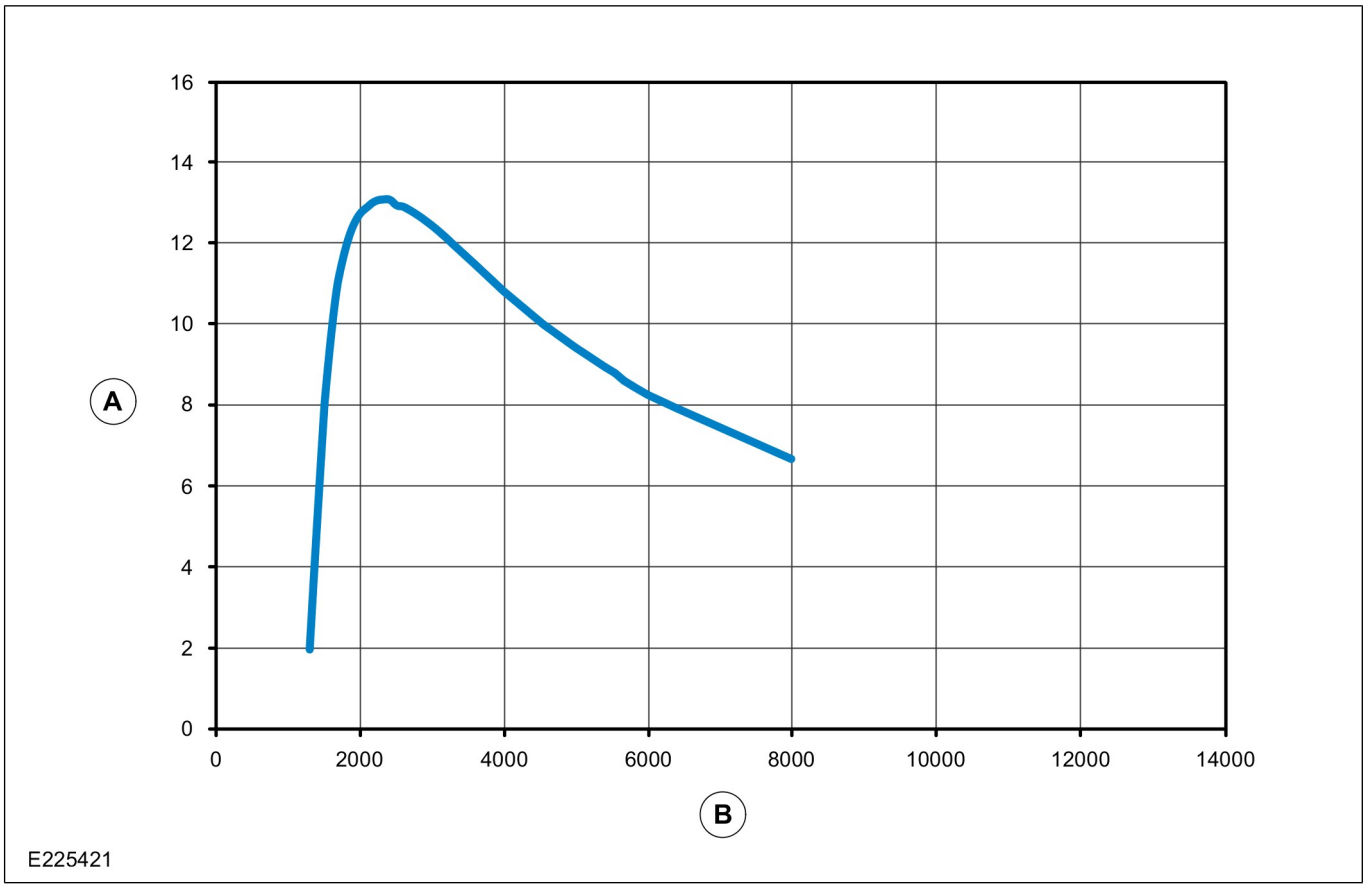
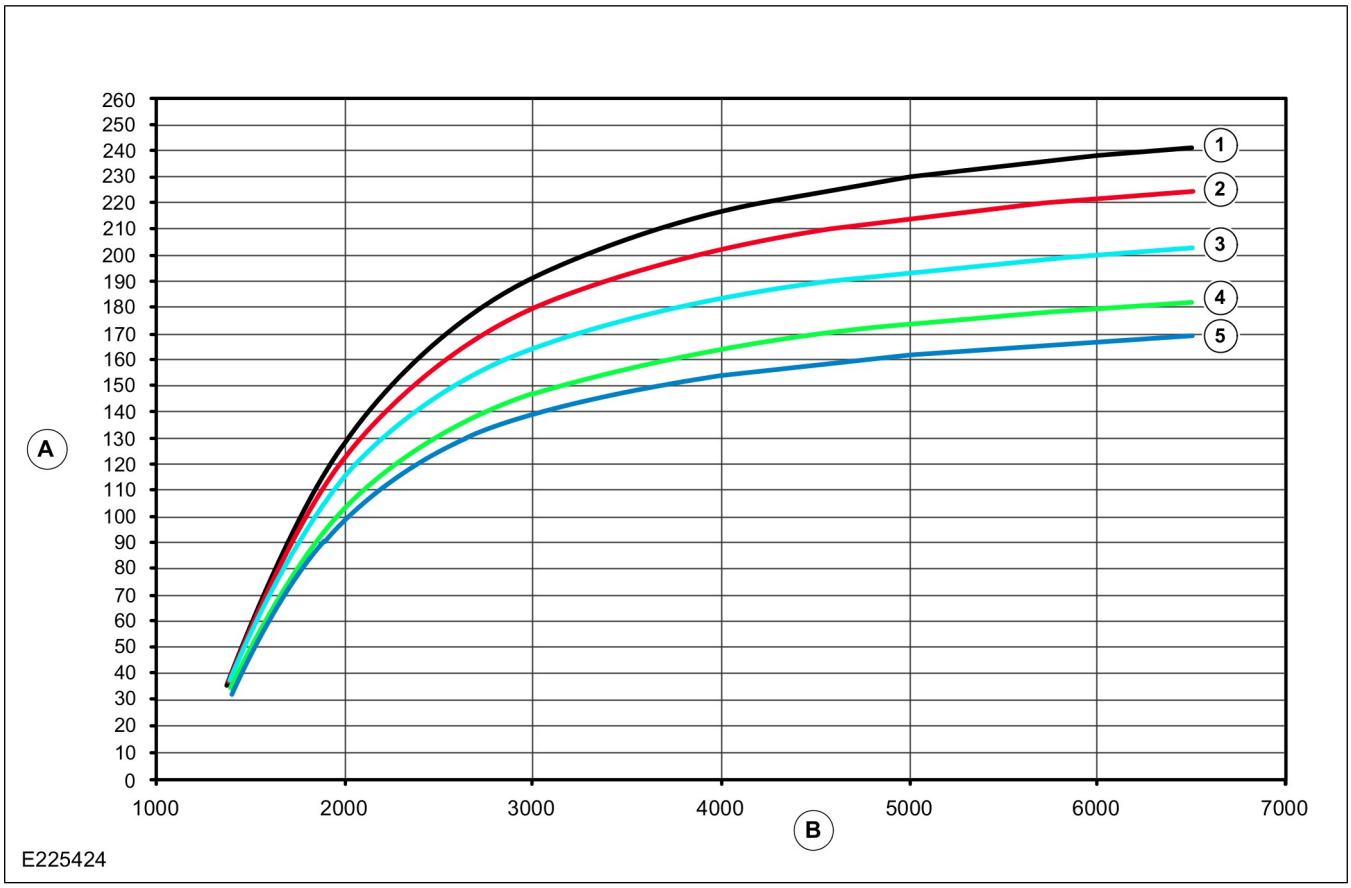


Diagram E225421 shows the torque in Nm which is required to drive the alternator. The vertical axis (A) shows the torque (Nm) and the horizontal axis (B) shows the alternators revolutions per minute (1/min).

Output Performance of Alternator - 220A



Item	Description
1	Temperature 0°C — Voltage 14.1V
2	Temperature 27°C — Voltage 13.8V
3	Temperature 60°C — Voltage 13.5V
4	Temperature 93°C — Voltage 13.1V
5	Temperature 115°C — Voltage 12.9V

Diagram E225424 shows the alternator output performance at five different temperatures In accordance to Ford specification at five different temperatures. The vertical axis (A) shows output current (Amps) and the horizontal axis (B) shows Alternator speed in revolutions per minute (1/min).

Torque Curve of Alternator - 240A

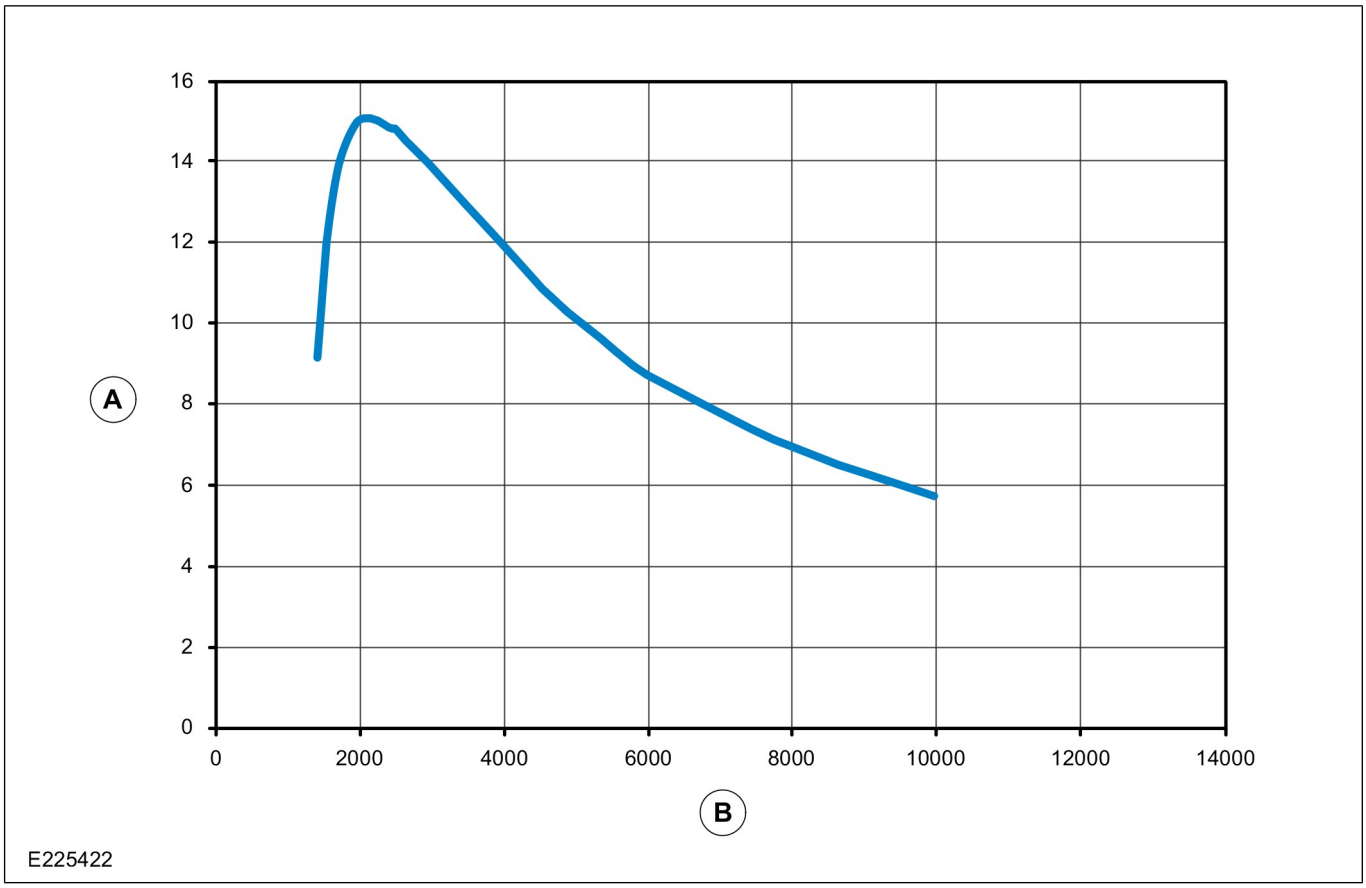
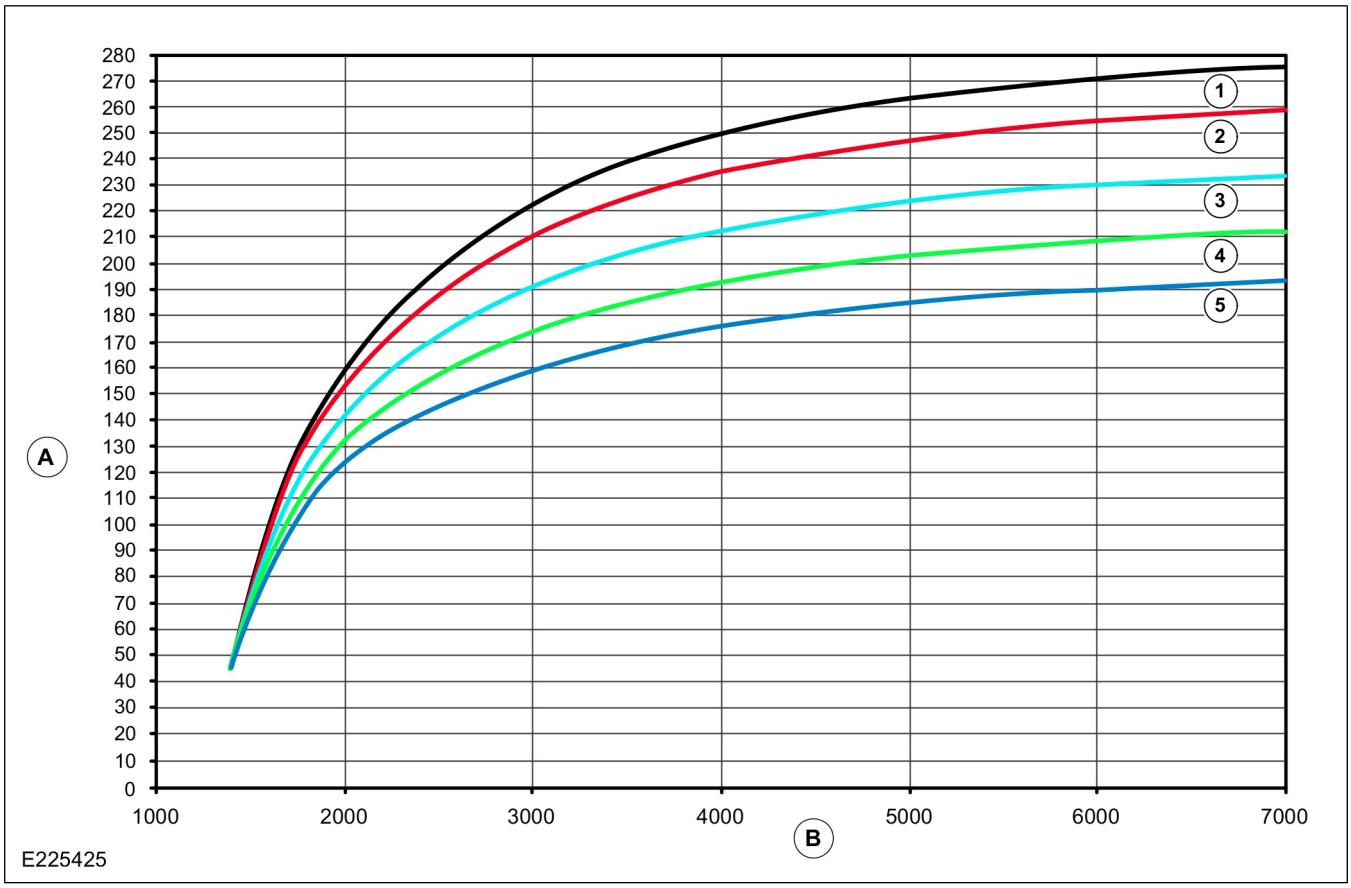


Diagram E225422 shows the torque in Nm which is required to drive the alternator. The vertical axis (A) shows the torque (Nm) and the horizontal axis (B) shows the alternators revolutions per minute (1/min).

Output Performance of Alternator - 240A



Item	Description
1	Temperature 0°C — Voltage 14.1V
2	Temperature 27°C — Voltage 13.8V
3	Temperature 60°C — Voltage 13.5V
4	Temperature 93°C — Voltage 13.1V
5	Temperature 115°C — Voltage 12.9V

Diagram E225425 shows the alternator output performance at five different temperatures In accordance to Ford specification at five different temperatures. The vertical axis (A) shows output current (Amps) and the horizontal axis (B) shows Alternator speed in revolutions per minute (1/min).

4.5 Climate Control System

WARNING: Do not use propylene glycol based coolant.

- Never secure hoses or tubes to the transmission fill or dip stick or to any fuel system or brake component.
- Do not route heater or refrigerant lines near or directly over any exhaust system component, including the exhaust manifolds.
- Avoid routing of hoses in the wheelhouse or stone kick-up arch. If routing is required in these areas, shield against stone pecking as appropriate.
- Do not route hoses near sharp edges. Utilize guards to protect against cutting or chafing.

Climate Control System Pin-Outs

Pin	Description
J1-1	Temp Door C
J1-2	Temp Door A
J1-3	Mode Door D
J1-4	Mode Door B
J1-5	KL31 - Ground
J1-6	ECO Switch Input
J1-7	DC Motor Recirc 1
J1-8	DC Motor Recirc 2
J1-9	EVAP Temp Sensor Input
J1-10	Not Used (connected to ground on Printed Circuit Board Assembly)
J1-11	Heated Front Screen - Button Input
J1-12	Heated Front Screen - Indicator LED Output
J1-13	Not Used (connected to ground on Printed Circuit Board Assembly)
J1-14	Mode and Temp Door Power Supply
J1-15	Heated Front Screen - Relay Output
J1-16	Heated Rear Window - Relay Output
J1-17	Mode Door A
J1-18	Mode Door C
J1-19	Temp Door D
J1-20	Temp Door B
J1-21	Supplier Diagnostic Line
J1-22	ECO Mode Indicator LED Output
J1-23	CAN Bus High
J1-24	CAN Bus Low
J1-25	Ground For Evap Temp - Sensor
J1-26	Not Used (connected to ground on PCBA)
J1 - 27	Heated Rear Window - Button Input
J1 - 28	Heated Rear Window - Indicator LED Output
J1 - 29	Smart Regenerative Charging Input
J1 - 30	Pulse width Modulation Signal for PTC Heater Control
J1 - 31	Blower Fan Relay Output
J1 - 32	Battery Power Supply (+12V)

4.6 Instrument Panel Cluster (IPC)

WARNING: Do not tamper with, cut into or connect to any of the CAN-Bus interface wiring or connectors.

Most of the functions are managed over the CAN-Bus interface.

Instrument Cluster

Connector Pin (C1)	Description	Wire Color	
1	Fuel Sender	Yellow/Violet	-
2	Low Washer Fluid	Violet	-
3	Positive Power supply	Grey/Red	-
4	High Speed CAN Low	White/Green	Twisted
5	High Sped CAN High	Green/Blue	
6	-	-	-
7	Fuel Sender Return	Green/Blue	-
8	-	-	-
9	Not in Park	Green	-
10	-	-	-
11	-	-	-
12	Negative Power Supply - Ground	Black/Violet	-

4.7 Horn

Any other aftermarket horn (for example an air horn) will need to be driven by a separate relay energised by the horn circuit.

4.8 Electronic Engine Controls

CAUTION: Do not make any additional connections to the electrical circuits associated with the engine management system.

NOTE: It is not necessary to disconnect or remove engine management modules.

4.8.1 Start-Stop

WARNINGS:

The engine may restart automatically if required by the system. It will only automatically restart when the clutch pedal is pressed. If no pedal is pressed, the Start-Stop indicator will flash and a message will be shown in the display.

Switch the ignition off before opening the hood or carrying out any maintenance.

Always switch the ignition off before leaving your vehicle, as the system may have shut down the engine but the ignition will still be live.

The system may not function if you leave additional loads connected with the ignition off.

It is very important not to make any modifications to the shielding around exposed moving parts on the engine, for example the drive belt.

General Information

Start-Stop is designed to improve fuel economy and reduce CO_2 emissions by automatically stopping the vehicle's combustion engine during idle phases when it is not required for motive power, and restarting it when required.

Start-Stop Logic

Automatic engine stops and restarts are controlled by the Start-Stop logic within the Electronic Control Module (ECM). This is connected to a number of vehicle and powertrain signals, sensors and switches and decides when to shut down and when to restart the engine, based on the particular Start-Stop strategy employed. Stop-in-Neutral is a Start-Stop strategy applicable to manual transmissions which stops the engine, subject to inhibitors, whenever the vehicle is stationary AND neutral is selected AND the clutch has been fully released. The engine is restarted on clutch pedal press in neutral.

Inhibitors

Sometimes the engine may not shut down or will request auto restart due to one or more system inhibitors being active. The engine will shutdown only when all inhibitors are cleared, which maybe some time after the transmission is shifted to neutral and the clutch pedal is released.

Typical examples of inhibitors are:

- If the ambient temperature is below the lower limit or above the higher limit for Start-Stop.
- Engine coolant temperature not warmed up (value dependent on ambient temp).
- Heated front screen is on.
- Insufficient battery charge to sustain a stop event or too high a current drain or battery is cold or battery failure.
- Driver's door has been opened and vehicle has not been driven over 5 kph since.
- Engine management reason, for example: during a DPF regeneration event.
- The ABS warning lamp is on or the vehicle is on a steep gradient
- High electrical load where total vehicle current A drain exceeds 50 Amps.
- Ford Engine RPM (Revs Per Minute) Speed Controller System is active.
- Un-recognized battery fitted or BMS damaged or removed.
- Start-Stop is pressed (LED illuminated).
- Accelerator pedal or clutch pedal is not released.
- Greater than 100mA continuous load at ignition off. The BMS will be unable to correctly assess battery state of charge.
- Vehicle in Factory or Transport mode.

Stall Recovery/Start Abortion Recovery

Stall recovery is an additional feature available with Start-Stop, and is active even if Start-Stop itself has been deselected or is inhibited. Under stall recovery, an automatic engine restart is invoked if the clutch pedal is fully depressed immediately following a vehicle stall, thus enabling the driver to quickly recover from a stall condition without needing to cycle the ignition key. Stall recovery is only available for 5 seconds following a stall.

Start-Stop De-selection (Start-Stop button with LED illuminated)

The Start-Stop function may be deselected by the driver by means of the Start-Stop button on the dash panel. An integral amber LED in the button illuminates to indicate that the function is disabled. After ignition OFF and ON, Start-Stop will be re-enabled. Pressing the button again (LED not illuminated) will make auto Start-Stop active.

Vehicle Modification Considerations

There are two main considerations: impacts to Start-Stop behavior as a result of vehicle modifications and impacts from the Start-Stop system.

Impacts to Start-Stop Behavior

Inhibitor occurrence may be increased by vehicle modifications. For example the 12V energy management system on the vehicle is designed to allow the engine to shutdown only if the current drain is less than 60A. High current loads may lead to this threshold being exceeded. In addition engine stops will be inhibited if the battery state of charge is below 68%, which may occur if added electrical loads are active during key-off periods. When installing extra peripherals, be aware of the continuous / quiescent current drain of such equipment, even when in Off or Standby mode. Any module should not draw more than 5 mA (milliamps) in electrical load when off. If current draw is high at key-off, a different battery system should be considered instead of the standard fit battery system. The AGM 2 x 80Ah twin system which has been engineered to work with Start-Stop, should be considered if electrical loads will be high at Engine Run and Off but total key off load including Ford systems must not exceed 90mA. Please contact your local Ford dealer to enquire about this option.

NOTE: Regardless of the battery configuration, key-off load in excess of 100mA for 7 days or more will cause Start-Stop to inhibit.

For additional information

Refer to: 4.4 Battery and Cables (page 102).
Battery Monitoring Sensor.

Start-Stop uses a small DC-DC converter (Voltage Quality Module) to isolate sensitive electrical modules from the effects of the voltage transient caused by the starter motor in-rush current when the engine restarts.

Start-Stop is only designed to operate with the specified Battery type for the system. Fitting additional batteries or the incorrect type will cause incorrect state of charge assessment leading to Start-Stop becoming permanently inhibited and therefore the fuel saving features lost. This is the same as for Smart Regenerative Charging (SRC).

Refer to: 4.3 Charging System (page 95).
SRC.

The driver's door switch is used to help identify if the driver has left the vehicle and prevent engine shutdowns. If any modifications are made to the door or switch then this functionality may be affected. If the driver's door is not used then ensure this switch is permanently closed (input grounded).

The system uses signals from switches/sensors on the clutch, brake and accelerator pedals along with and the transmission shift mechanism. To avoid compromising the safety of the system, no electrical connection should be made to any of these signals.

Impacts from Start-Stop System

Start-Stop is designed to shut down the engine when it would otherwise be idling. Some modifications may rely upon a running engine to operate. Ford's RPM speed controller will automatically inhibit Start-Stop from shutting down the engine when the vehicle is stationary. Aftermarket systems do not have this facility so the driver may need to use the Start-Stop button to disable Start-Stop when such devices are being used. The starter relay should never be bypassed or driven directly.

With the Ford-fit RPM controller, please be aware that the throttle pedal functionality is different. For instance, if RPM is active, pressing the throttle pedal will stall the engine. If an RPM controller is required – it is recommended to use the Ford engineered system as this is developed with the Start-Stop System. An aftermarket fit system may still have the engine switch off when not expected.

The Special Vehicle Option feature Engine Run signal, which is a switched ground signal, on a Start-Stop vehicle is only active when the vehicle's engine is actually running (for example: not active during an auto-stop). Any equipment connected to the Engine Run signal will therefore experience more cycles than on a conventional vehicle. Such equipment must ensure that it can handle a lifetime of 300,000 cycles. A quiet or silent type relay may also be required as these increased cycles may be audible to occupants during Start-Stop Events. Alternatively, consider packaging the control system away from the occupants.

All converter fit loads should be connected to either customer connection points. Converter fit loads must not be connected to the vehicle start battery, on a twin battery system.

4.8.2 Engine RPM (Revs Per Minute) Speed Controller (A003)

System Overview

This feature enables the engine in the vehicle to be run at elevated RPM speeds. The power from the engine can then be used to drive ancillary equipment. The ancillary equipment may be powered via a Front End Accessory Drive (FEAD) layout (in a similar fashion to the air conditioning compressor).

The maximum power that is available for front end accessory drive applications at any engine speed is 6kW (in lieu of the 26Nm air conditioning compressor). For additional information please contact the Vehicle Converters Advisory Service, VCAS@ford.com

The converter should consider any increased engine cooling requirements due to the conversion and running the vehicles engine under load for extended periods while the vehicle is stationary.

3 Modes of Operation

There are 3 principle modes in which this feature can operate, they are:

1. **3 Speed Mode** this provides the end user a choice of up to 3 preset RPM values of 1100, 1600 and 2030rpm to select from. The end user cannot easily override these values so there is minimal risk of damage to ancillary equipment due to it being run at speeds it was not designed for. Very limited vehicle speed is allowable while in this mode (up to 2.5mph approx)
2. **Variable Speed Mode** this provides the end user with RPM speed ramp up and down buttons. The end user is free to select RPM values between 1300-3000rpm in 25rpm steps. A single press results in a 25 rpm jump. If a ramp button is held depressed by the end user then the rate of change is 250rpm/sec. Very limited vehicle speed is allowable while in this mode (up to 2.5mph approx).
3. **Idle Up Speed** this mode allows the engines normal idle to be increased (in 25 rpm steps) in the range 900-1200rpm. There is not a vehicle speed restriction in this mode as the intended use is to raise the engine idle to reduce the likelihood of engine stall when ancillary equipment is being run from the engine during normal drive operations. For example: Refrigerator units used to keep the cargo bay cool.

System Availability

This feature is built into the latest Powertrain Control Module (PCM) software on all diesel engine variants.

By default the feature is not enabled unless the vehicle is specifically ordered with the feature from the factory.

Vehicles which have not been ordered with this feature may have the feature enabled at a dealer via the IDS diagnostics system. There is a dealer charge for this service.

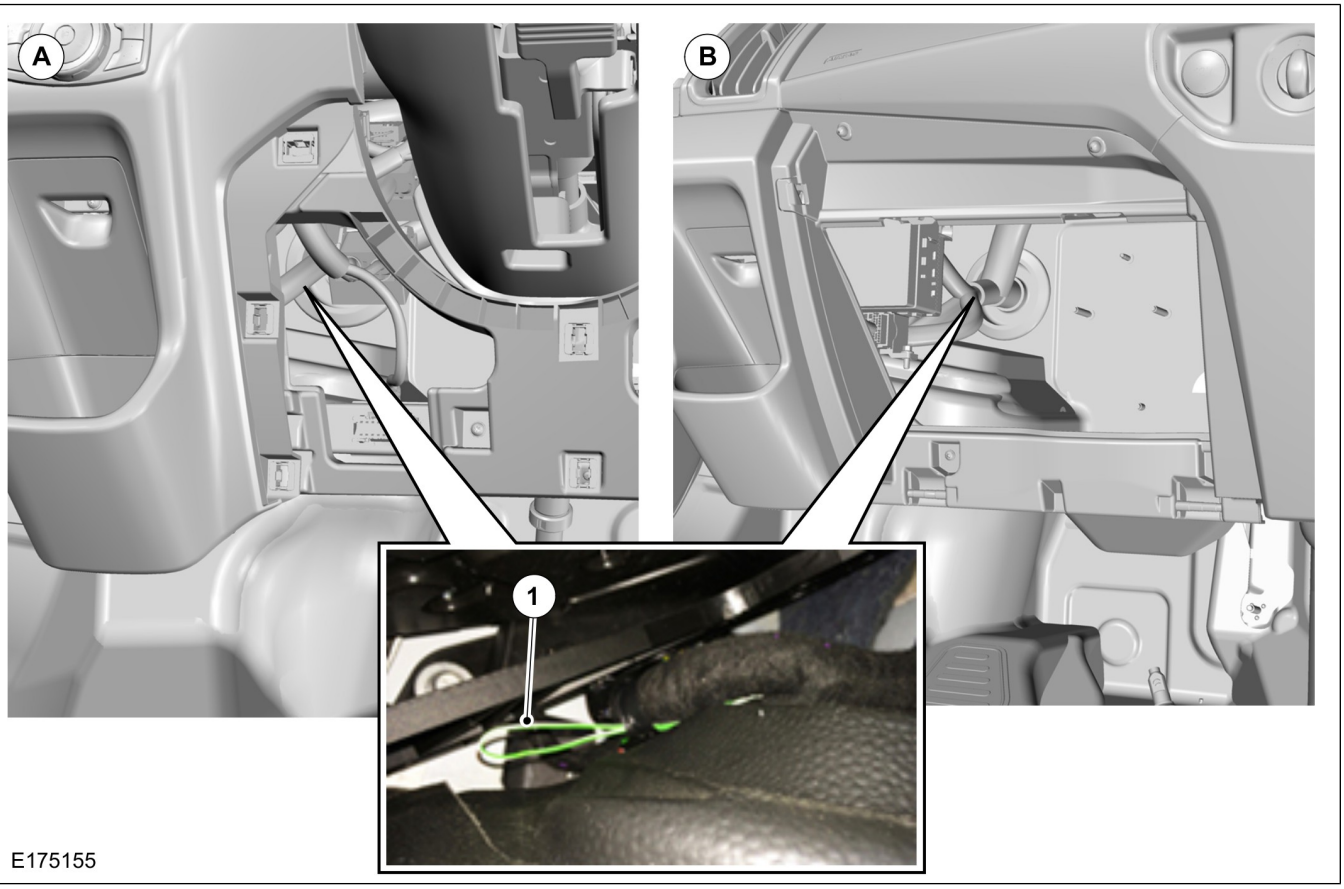
Vehicles fitted with Start-Stop technology may be converted to RPM speed control, however, the customer should turn Start-Stop off prior to starting RPM speed control. For more information refer to 'Impacts from Start-Stop System' in this section.

How to control this feature

A loop of wire (green/white) is provided in the main electrical harness to permit control of the RPM Speed Control software. Cutting this loop will provide two wires to connect a control box to the PCM.

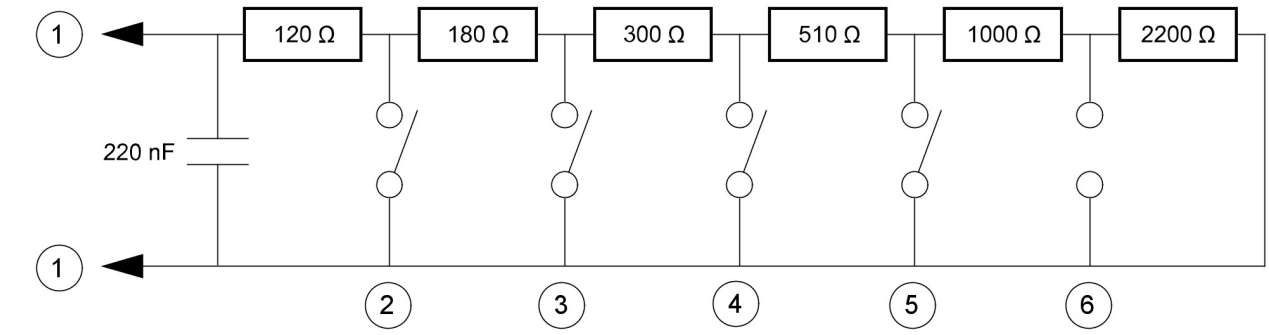
The control box needs to switch resistors into the circuit across the two green/white wires which formed the loop prior to being cut. This sort of circuit is known as a resistance ladder, see figure E88295. The PCM software monitors the green/white wire circuit and when certain resistance's are detected they are interpreted as various inputs which control the feature. The switch box can be located where it is ideally required for the vehicle conversion in question, rather than having to be mounted on the Instrument Panel (IP). If the converter chooses to locate the switch box in a location which is subject to an adverse environment then the converter should design the switch box to withstand with these conditions.

Green/White Loop — Right Hand Drive Shown



The harness is loosely taped in this location, so the green/white loop should be easy to extract. Figure E175155 shows right hand drive (A) and left hand drive (B) location of the green and white loop (1). Refer to Workshop Manual for removal of trim.

Resistance Ladder Circuit



Item	Description
1	To Green/White Wire
2	Stop Engine
3	RPM 1 on/off or Variable Control 'Idle'
4	RPM 2 on/off or Variable Control 'Negative (-)'
5	RPM 3 on/off or Variable Control 'Positive (+)'
6	RPM Control Armed or Increased Idle on/off

The resistance ladder circuit acts as a potential divider. The PCM has an internal reference voltage of 5 volts. Current passes through an internal 320 ohm resistor (not shown above) prior to passing through the resistance ladder. There is also a (second) 220 nF capacitor internally within the PCM between the 320 ohm resistor and ground (not shown above) and this is to reduce EMC effects.

With all the switches open there is a total resistance in the green/white loop of approx 4310 ohms and this corresponds to normal driving operation (the condition prior to the loop being cut).

To ensure robust operation, it is recommended for all switches that a switch de-bounce specification is chosen as close to zero ms (milli seconds) as possible.

Starting from the right of the diagram, when the key switch is closed only 2110 ohms is in the circuit and the PCM software recognizes this as the RPM mode being armed and ready for operation (Key switch closed = on, open = off). A key switch is recommended in this position for a couple of reasons:

- If the control box is located externally on the vehicle, the requirement for a key avoids any passers by being able to put the vehicle into RPM Speed Control mode by simply pressing a button.
- Using a key switch where the key can be removed in either the on or off condition could be used as an aid to anti theft. If the operator uses a key to put the vehicle into RPM Speed control mode and then removes the key, then the vehicle cannot quickly and easily be taken out of RPM speed control mode. If a foot pedal is pressed while in either the 3 speed or variable speed modes, the vehicles engine will stall and therefore the vehicle can not easily be driven away and stolen.

When in 3 speed mode pressing any of the middle 3 switches (with the feature armed) results in the engine RPM jumping to the corresponding RPM value held in memory (defaults of 1100, 1600 or 2030rpm) for the 3 switch positions. A second consecutive press of the same button returns to normal idle.

When in variable speed mode the same 3 buttons act as ramp up, ramp down and return to idle selections respectively.

The software in the PCM responds to the change of state, so it is recommended that these 3 middle switches be non-latching push button micro switches. When going from idle to an elevated RPM the execution of the command will occur as the button is released. When going to idle the execution of the command occurs as the button is pressed.

The final button (the one on the left in figure E88295) acts as an emergency vehicle engine stop. It is recommended that this be a red and oversize non-latching micro switch button. The execution of this command will occur as the button is pressed.

All wiring connecting the PCM to the resistance ladder control box should be shielded and twisted (33 twists/m) to reduce EMC effects.

All resistors should have a tolerance of +/- 5% or better.

Switch contact, connectors and loom (loom between the green/white wires and the control box) total resistance must be no greater than 5 ohm max.

The PCM to resister ladder control switch box loom should not come within 100mm of any other harness, especially any carrying heavy loads.

Designs which do not require all the button switches must still have the complete resistor network with the switches positioned correctly within the network.

A suitable two way quality connector should be used to connect the control box to the two green/white wires.

How to change the default settings

NOTE: It is not possible via either method below, to change the step value of 25 rpm per press or the 250 rpm per sec for a held down button, in the variable rpm speed.

By default, when the feature is first enabled (either via factory order or via dealer IDS tools), it will be set to the 3 speed mode of operation with preset RPM values of 1100, 1600 and 2030rpm for the 3 speeds.

There are two methods by which these defaults can be modified:

1. Via the IDS diagnostics system at a Ford dealer (there may be a charge for this).

Via the IDS system the mode of operation can freely be changed between any of the 3 principle modes of operation, the feature can even be turn off (disabled). The 3 default RPM speeds can also be modified within the allowable range for the mode of operation as detailed in this section.

Via IDS the RPM Speed Controller menu is under the tool box tab, then Powertrain, then Service Functions, then PCM. The IDS on screen menus will guide the dealer through the options and setup.

2. Via an inbuilt vehicle 'learn mode'.

Via the vehicle 'learn mode', it is possible to switch from the default 3 speed mode to variable speed mode, however it is not possible to switch back using this method.

How to enter vehicle 'Learn mode'

1. Make sure that the RPM Speed controller switch box is connected but turned off.
2. Start the engine (vehicle out of gear and no foot pedals being pressed, handbrake on).
3. Wait a couple of seconds for the instrument panel start up diagnostic lamps to extinguish.
4. Press and release the clutch pedal.
5. Press and release the brake pedal.
6. Repeat steps 4 and 5 a further four times (clutch & brake pressed a total of five times sequentially each).

NOTE: Steps 4 to 6 have to be started within 10 seconds of the engine start.

The vehicle should now be in 'learn mode'.

How to Select between modes

NOTE: If the engine stalls out at the initial brake pedal input then the vehicle was not in, or has dropped out of learn mode and you will have to restart the learn procedure.

1. Enter learn mode (see directions above).
2. Arm the RPM speed controller (turn the key switch to ON).

If the vehicle is already in 3 speed mode (the initial default):

3. Press and release the brake pedal five times.

The vehicle should now be in variable speed mode. The new settings can be saved and learn mode exited (see below).

or

4. Press and release the brake pedal once.

The vehicle should now be in 3 speed mode. The new settings can be saved and learn mode exited (see below).

Using this method it is easy to change between these two modes of operation for the RPM speed controller.

How to change the 3 pre-set default RPM values in the 3 speed mode

NOTE: If the engine RPM responds to the initial RPM button press, then the vehicle has not entered 'learn mode' correctly and you will have to restart the procedure. If the engine stalls out at the brake or accelerator pedal inputs then the vehicle was not in, or has dropped out of 'learn mode' and you will have to restart the procedure.

1. Enter 'learn mode' (see directions above).
2. Arm the RPM speed controller (turn the key switch to 'on').
3. Press and release the brake pedal once.
4. Press and release the RPM button that requires re-programming.

5. Use the accelerator pedal to rev the engine to the new desired RPM speed and hold at this speed (only speeds between 1200 to 3000 rpm can be selected in 3 speed mode).
6. Press and release the same RPM button to reset the stored RPM speed to the current engines RPM.
7. Release the accelerator pedal.
8. Repeat steps 4 to 7 for the remaining RPM buttons.

The 3 RPM speeds should now be re-programmed to the new RPM speeds. The new settings can be saved and 'learn mode' exited (see below).

How to save new settings and exit from 'Learn mode'

NOTE: The engine stalling indicates that the settings should have been saved and the vehicle has exited from 'learn mode'. Learn mode however is very specific that the exact steps are taken in the correct order and within certain time limits otherwise the learn procedure fails and it may take several attempts to get this order and timing correct and a successful modification from the default settings.

1. From within the 'learn mode' and with the RPM Speed Control switch box 'armed', fully press & release the clutch pedal at least five times in quick succession. The engine may stall out on the last depress which is normal, however if the engine does not stall out after at least 5 clutch pedal depresses, then you can key off after the sequence of rapid clutch depresses.
2. Restart the engine and test the new settings, repeat above procedures if necessary.

Reasons why RPM speed Control operation may stop or fail

The RPM Speed control software monitors vehicle information during operation in RPM speed control mode and will drop out of RPM speed control and/or stall the engine should any adverse signals be detected. For example:

- If the engine temperature becomes too hot then RPM speed control will stop in order to protect the engine.
- If the engine oil lamp illuminates then RPM speed control will stop in order to protect the engine.
- If the low fuel level lamp illuminates then RPM speed control will stop so that the vehicle can be driven to a refueling point.
- If the vehicle speed exceeds approx 2.5 mph while in 3 speed or variable speed modes, then RPM speed control may stop. RPM speed control should normally be operated with the hand brake on, but some uses may require a low level of vehicle 'creep' during RPM speed control operation.
- The software monitors for 'stuck on' buttons on the control switch box, this may result in RPM speed control being halted. A button that is held down for too long may be registered by the software as a 'stuck' button.
- The software monitors the foot pedals, if depressed these may stall the engine if in 3 speed mode or variable speed mode (does not apply to idle up speed).
- If the control switch box circuitry significantly exceeds 2110 ohms or there is a short circuit then RPM speed control will not be possible.
- If a PTO conversion has been attempted on a vehicle with a non anti braking system (ABS) then RPM speed control will fail due to vehicle speed being registered via a transmission speed sensor and / or the need to press the clutch in order to put the vehicle in gear while in RPM speed control mode.

4.8.3 DPF and RPM Speed Control

The Diesel Particulate Filter (DPF) captures soot in the exhaust fumes to improve vehicle exhaust emissions. The condition of the DPF is monitored by the vehicles electronic systems. Under normal driving conditions a regeneration feature is triggered to clean the filter. If the DPF becomes full, a red engine warning lamp illuminates on the instrument cluster and the vehicle will need to be taken into the local Ford dealer to have the DPF specially purged.

Vehicles fitted with DPF, running under RPM Speed Control with the engine running under load at elevated idle, may produce soot build up over time. With the vehicle stationary, the DPF is unable to start a regeneration event. It is therefore recommended that vehicle converters advise operators to break up any long periods under RPM Speed Control operation with some normal driving to permit the DPF to regenerate. Rapid cycling of the engine RPM, while in the RPM Speed Control mode, should be restricted where possible, as RPM transients increase soot generation rate. Where the anticipated use for RPM Speed Control is expected to be for longer durations, it is strongly recommended that the Operator Commanded Regen (OCR) option is also specified in conjunction with RPM Speed Control (check with your local Ford dealer for availability of option). OCR allows the driver/operator to manually perform a DPF regeneration while the vehicle is stationary, after confirming that it is safe to do so.

WARNING: Do not park or idle your vehicle over dry leaves, dry grass or other combustible material. The DPF regeneration process creates very high exhaust gas temperatures. The exhaust will radiate a considerable amount of heat during and after DPF regeneration and after you have switched the engine off. This is a potential fire hazard.

For additional information on DPF

Refer to: 3.6 Exhaust System (page 71).

4.8.4 Changing Vehicle Speed Maximum Setting

The Vehicle Speed Maximum Setting can be changed via the Integrated Diagnostic System (IDS) menu under the following tabs: Toolbox, Powertrain, Service, Functions, PCM. The IDS on screen menus will guide the dealer through the options and setup.

4.9 Tachograph

It is recommended that any vehicle that requires a tachograph is sent to an authorised Continental Tachograph Service Center (previously known as Siemens VDO) for system installation and calibration.

NOTE:

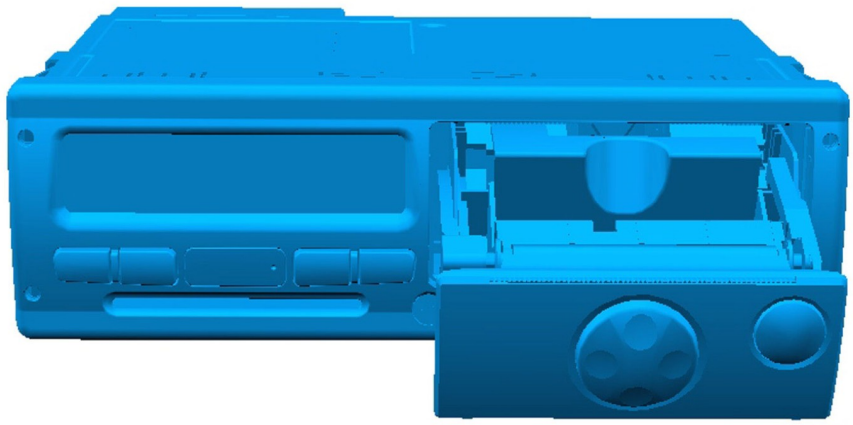
Details of all recommended service centers can be found on VDO web sites. These sites also contain details of current regulations and tachograph operation.

4.9.1 Legislation

WARNING: All tachographs require the same wiring connections as this is controlled by tachograph legislation.

NOTE: Digital Tachograph (DTCO) is the legal requirement for Europe.

Digital (DTCO) Tachograph



E75502

Pin Assignment

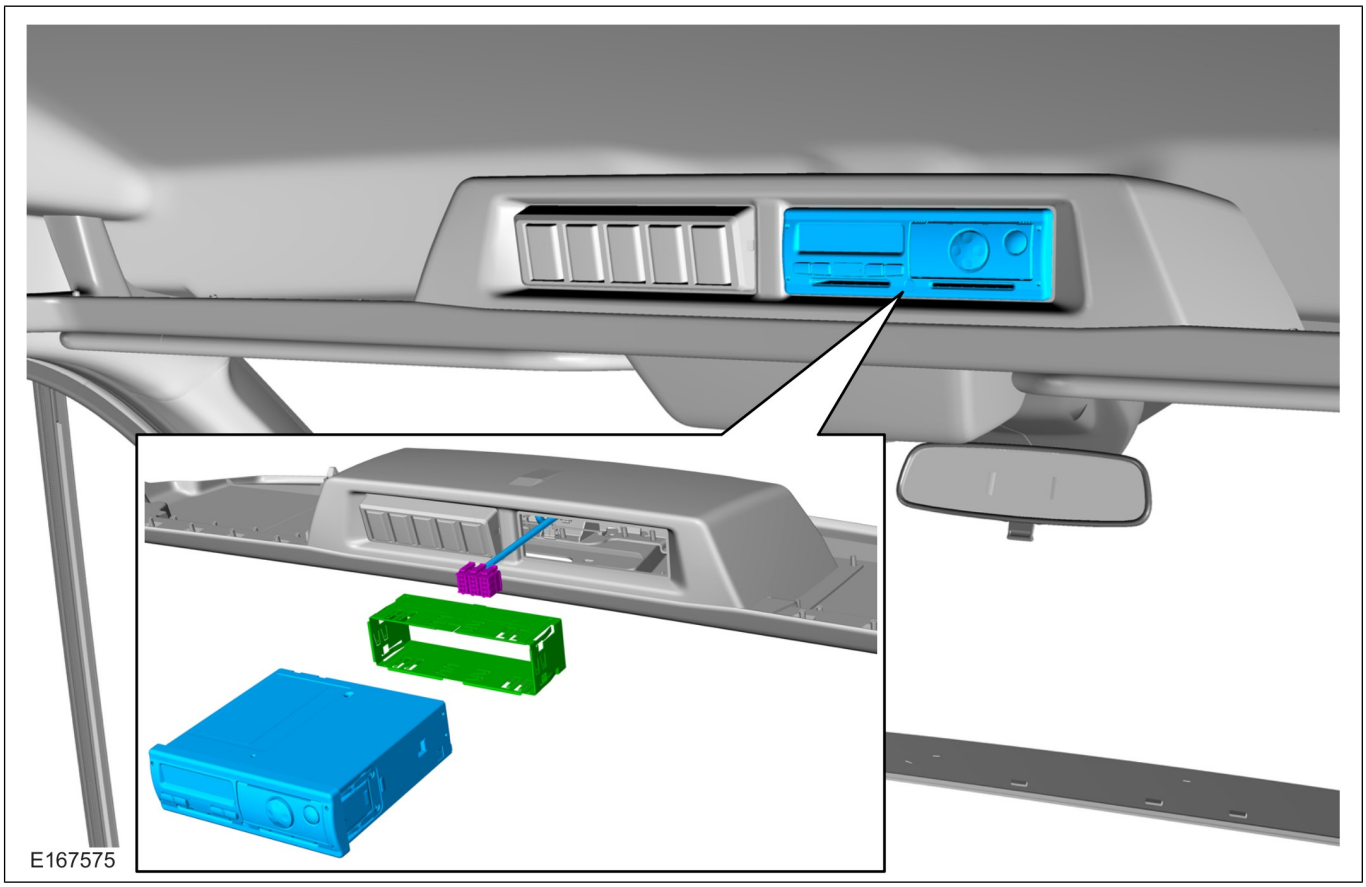
For detailed information about pin assignments please contact your local National Sales Company representative or Continental Automotive Group directly.

Wiring

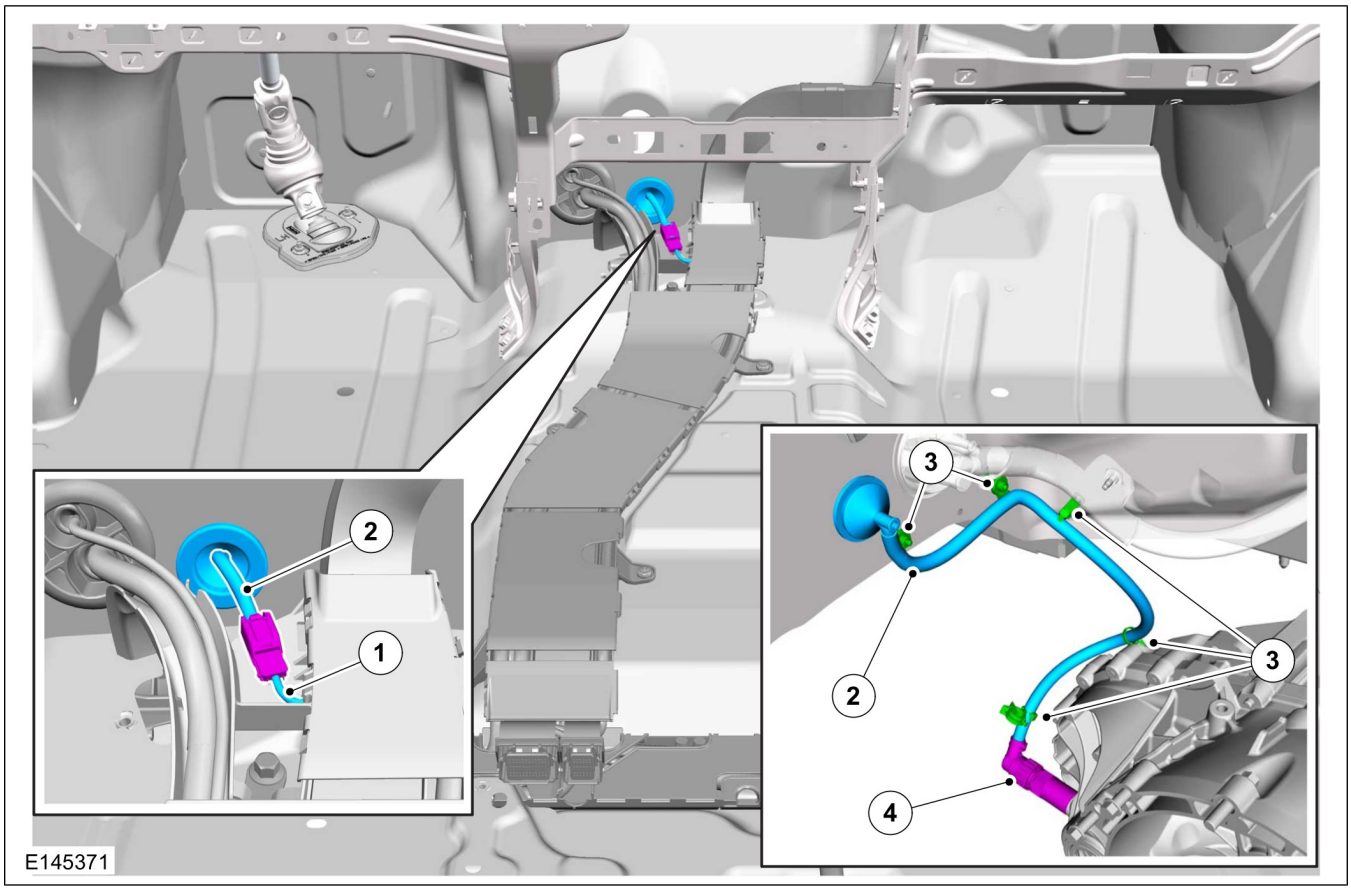
The tachograph wiring consists of two parts:

- Speed Sensor Harness, see figure E167576 for harness routing.
- Tachograph Harness, see figures E145371 and E167575 for mounting and harness routing.

4.9.2 Tachograph Harness Mounting

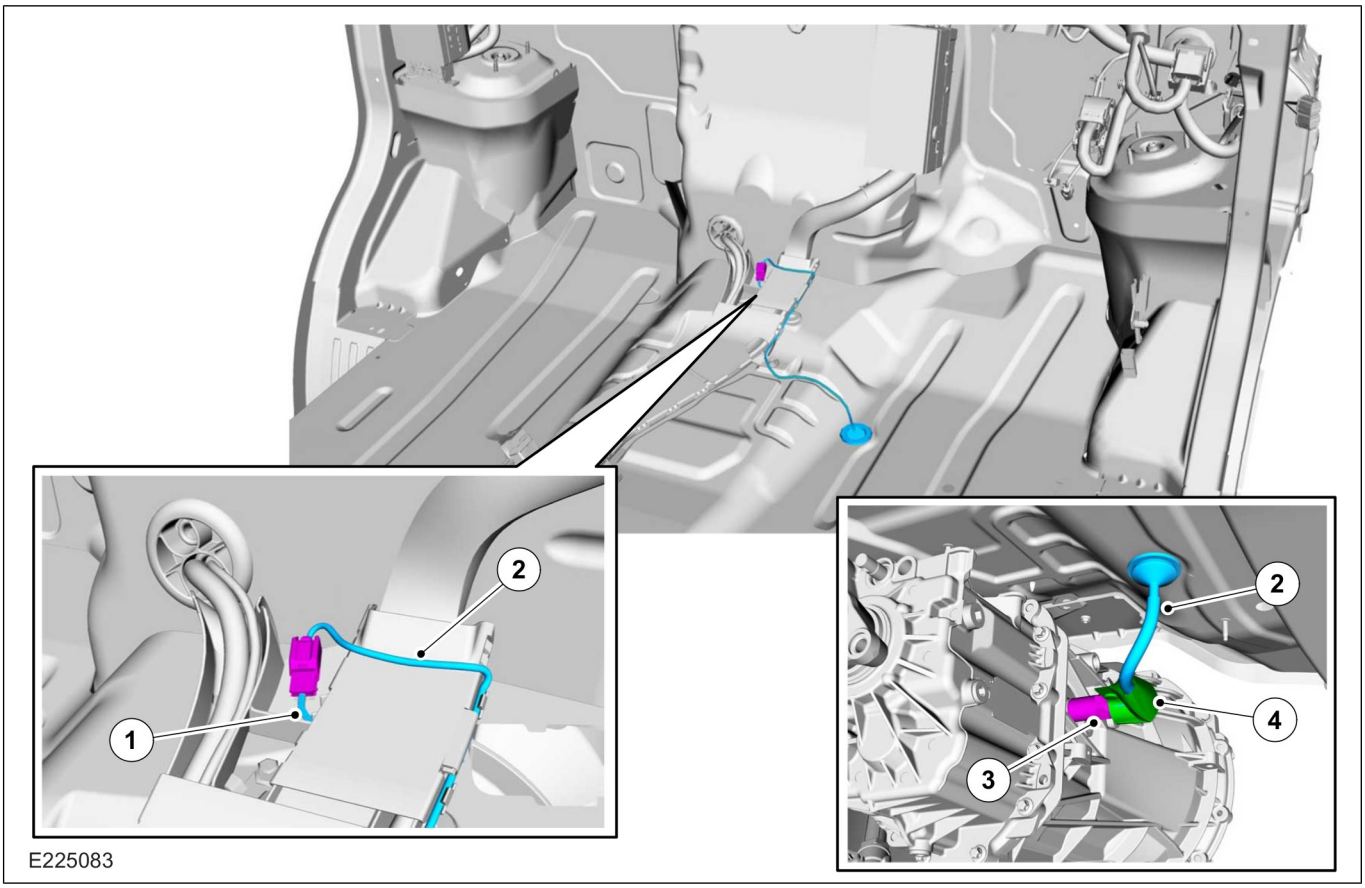


Tachograph Speed Sensor Harness Routing - FWD



Item	Description
1	Main Harness
2	Tachograph Speed Sensor Harness
3	Clips
4	Sensor into Transmission

Tachograph Speed Sensor Harness Routing - RWD



Item	Description
1	Main Harness
2	Tachograph Speed Sensor Harness through floor
3	Sensor into Transmission
4	Heat Shield

4.9.3 Fitting a Tachograph to vehicles built with out Digital Tachograph Option

NOTE: It is not always possible to retrofit a tachograph. If a tachograph is required, it is recommended that this is ordered on the base vehicle. For further information please contact vcas@ford.com

NOTE: The base vehicle ordered must have an overhead console and the correct level of trim (head liner) to support fitting a Tachograph.

NOTE: The Tachograph units are not supplied by Ford service and are only available by the Continental/VDO Calibration Center. Formerly known as Siemens/VDO.

Parts required to support aftermarket fitting of a Digital Tachograph

Prefix	Base	Suffix	Name
Tachograph Units			
BK2T	17A266	A*	Digital
Speed Sensor			
BK2T	17K321	A*	VMT6 - Front Wheel Drive
BK3T	17k321	A*	MT82 - Rear Wheel Drive
Wiring Harness			
GK2T	14K141	B*	Speed Sensor Harness - Front Wheel Drive
GK3T	14K141	H*	Speed Sensor Harness - Rear Wheel Drive
GK3T	14K141	J*	Roof Tachograph Harness - Front and Rear Wheel Drive

Fitting the Speed Sensor — See figure E167576

1. Locate the sensor housing
2. Remove the protective cap
3. Fit the speed sensor
4. Fit the supporting wiring harness

Fitting the Tachograph Unit — See figure E167575

NOTE: The Tachograph head unit will be fitted by the Continental Calibration Center.

For further information on fitting instructions of a Tachograph unit please contact the Vehicle Converts Advisory Service at VCAS@ford.com

4.9.4 Vehicle Configuration Change

For the cluster to obtain the vehicle speed from the Tachograph the central car configuration parameter 118 needs to be changed to 0x03 – this will be done at the Dealer.

118 Tachograph			
Less Tachograph	HDKAA	0x01	Block 17 byte 7 - Parameter 118
Digital Tachograph	HDKAD	0x03	Block 17 byte 7 - Parameter 118

4.9.5 Calibration and Tachograph Fitting

The Continental Calibration Center will order the Tachograph and fit the unit to the vehicle. EU Legal legislation requires that before the vehicle can be used on the road, the DTCO Tachograph must be calibrated. The Digital Tachograph activation **must** be completed by an authorized VDO workshop. The Ford Dealer will organize the Tachograph Calibration.

When the Tachograph is in an un-calibrated state the vehicle speed indicator in the cluster may not function or may indicate the incorrect vehicle speed. The cluster within the vehicle will use the speed signal from the Tachograph to drive the speed gauge and an un-calibrated Tachograph will not report the correct vehicle speed.

4.10 Information and Entertainment System - General Information—Specifications

4.10.1 Audio Head Unit (AHU) - Multimedia In Car Entertainment (ICE) Pack Summary

The Multimedia System you have, as a standard fit, will depend on the market region, body style and model of the vehicle.

NOTE: Depending on the vehicle upgrade you are planning it is important to order the right level parts that include new Instrument Panel Harness, Instrument Panel Bezel and Hood.

NOTE: Pre Equipment Pack (less speakers) does not have wiring between the roof-mounted AM/FM/DAB antenna and the co-axial cable that connects to the AHU. If planning to retrofit an AHU you will need to order the Pre Equipment Pack.

AHU/Multimedia ICE Packs

AHU/ICE Pack	Description
*	Pre Equipment Pack (less speakers) - no audio
**	Pre Equipment Pack - no audio
2	MyConnection Radio
3	MyConnection Radio with DAB
6	Low Radio Less SYNC Gen 1
7	Low Radio Less SYNC Gen 1 with DAB
8	Mid Radio with SYNC Gen 1
9	Mid Radio with DAB/SYNC Gen 1
14	SYNC Gen 2 Navigation
15	SYNC Gen 3 Navigation

AHU/Multimedia ICE Pack Content

Description	*	**	2	3	6	7	8	9	14	15
Less ICE	X	X	-	-	-	-	-	-	-	-
MyConnection Radio AHU/AM/FM + USB + Blue tooth	-	-	X	-	-	-	-	-	-	-
MyConnection Radio AHU/AM/FM + DAB + USB + Blue tooth	-	-	-	X	-	-	-	-	-	-
ICE - Low Audio (LOC)	-	-	-	-	X	-	X	-	-	-
ICE - Low Audio (LOC) with DAB	-	-	-	-	-	X	-	X	-	-
ICE - Low Audio (LOC) with DAB + TMC	-	-	-	-	-	-	-	-	X	X
Less Multi Function Display (MFD)	X	X	X	X	-	-	-	-	-	-
Mid MFD - 4" TFT	-	-	-	-	X	X	X	X	-	-
DM6 6" Touch Screen	-	-	-	-	-	-	-	-	X	X
Less Integrated Control Panel (ICP)	X	X	X	X	-	-	-	-	-	-
ICP Mid - Extended Less SYNC	-	-	-	-	X	X	-	-	-	-
ICP Mid - Extended	-	-	-	-	-	-	X	X	-	-
Less Speakers	X	-	-	-	-	-	-	-	-	-
4 Front Speakers (2 woofer/2 Tweeters) + 2 Rear Speakers*	-	-	-	-	X	X	X	X	X	X
10 Speakers (Tourneo Only)	-	-	-	-	O	O	O	O	-	-
Single AM/FM Antenna	X	X	X	-	X	-	X	-	-	-
AM/FM DAB + TMC with Active Splitter	-	-	-	-	-	-	-	-	X	X
Single AM/FM/DAB Antenna	-	-	-	X	-	X	-	X	-	-
Less GPS Antenna	X	X	X	X	X	X	X	X	X	X
GPS Antenna	-	-	-	-	-	-	-	-	-	X
Less GPSM	X	X	X	X	-	-	-	-	-	X
GPSM	-	-	-	-	X	X	X	X	X	X
Less NAV Data	X	X	X	X	X	X	X	X	X	X
Less Radio Controls	X	X	-	-	-	-	-	-	-	-
Radio Controls on Steering Wheel	-	-	X	X	X	X	X	X	X	X
Less SYNC	X	X	X	X	X	X	-	-	-	-
SYNC GEN 1	-	-	-	-	-	-	X	X	-	-
SYNC GEN 2	-	-	-	-	-	-	-	-	X	-
SYNC GEN 3 (Replaces SYNC 2 at Wave 3)	-	-	-	-	-	-	-	-	-	X
Less Microphone	X	X	-	-	X	X	-	-	-	-
Microphone	-	-	X	X	-	-	X	X	X	X
Less Auxiliary Heater	-	X	-	-	-	-	-	-	-	-
Aux Input Jack (AIJ)	-	-	X	X	X	X	X	X	X	-
Single USB Port	-	-	X	X	-	-	-	-	X	-
Accessory Media Hub 1 x USB	-	-	-	-	-	-	X	X	-	X
RVC	-	-	-	-	O	O	O	O	O	X

* Rear Speakers are dependent on body style.

X = Included / O = Optional

4.10.2 MyConnection Radio and MyConnection Radio with DAB

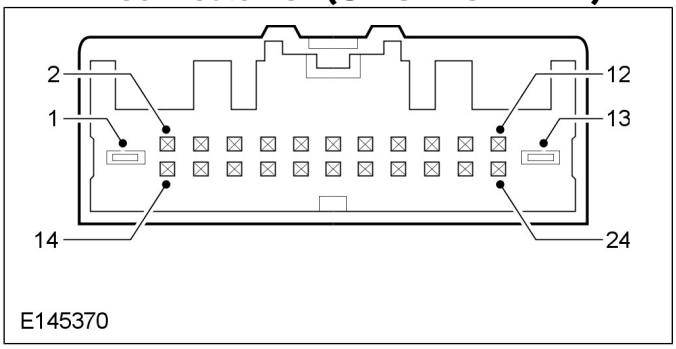
Audio Head Units (AHU) are connected to the instrument panel wiring via a single 24 pin connector, see figure E145370 and table.

NOTE: There is a black co-axial cable for the roof-mounted AM/FM/DAB antenna that goes to the side of the AHU.

NOTE: MyConnection Radio variants do not accept Multi Function Display (MFD) or Integrated Control Panel (ICP)

NOTE: Power for radio - **do not** switch the permanent battery feed (KL 15) and ignition feed (KL 30) on the radio connection. The ignition feed 15 is only used to 'wake up' the radio.

24 Pin Connector ICE (8475-1 / 544127-1)



E145370

24 Pin Connector ICE

Pin	Description	Type	Pin	Description	Type
1	Battery	Input	13	Audio Ground	Input
2	Switched B+ Power	Output	14	Illumination + (PWM VIH)	Input/ Output
3	Ignition SW Crank Position	Input	15	Illumination -	Input/ Output
4	Run/Accessory	Input	16	Audio Shield (AIJ)	Output
5	Starter Motor Control Sense	Input	17	AIJ Left +	Input
6	Aux IN Jack (AIJ) Common	Input	18	AIJ Right +	Input
7*	Microphone +	Input	19*	Microphone -	Input
8	Steering Wheel Control +	Input	20	Steering Wheel Control -	Input
9	Left Rear Speaker -	Output	21	Left Rear Speaker+	Output
10	Left Front Speaker -	Output	22	Left Front Speaker +	Output
11	Right Front Speaker -	Output	23	Right Front Speaker +	Output
12	Right Rear Speaker -	Output	24	Right Rear Speaker +	Output

* Pins 7 and 19 are for external microphone. Check availability with your Local Ford Dealer.

4.10.3 Mid-Radio and Mid-Radio with DAB

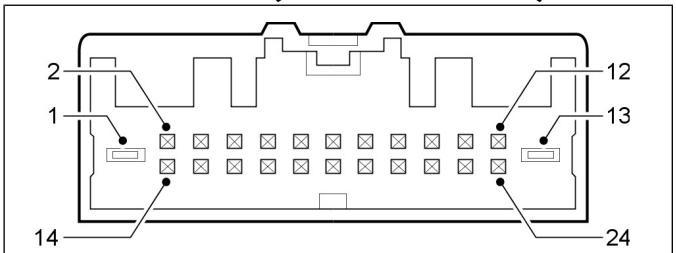
NOTE: AHU/ICE Pack 4,5 and 11 are connected to the instrument panel wiring via a 24 and 26 way connector, see figures E145370 and E146212.

NOTE: There is a black co-axial cable that connects the roof-mounted AM/FM/DAB antenna to the back of the AHU. If the vehicle has a navigation display, the black co-axial cable goes into the back of the navigation display and a second co-axial cable connects the navigation display to the AHU. There is also a thin black co-axial cable for the global positioning system antenna that goes to the navigation display.

NOTE: All vehicles, except those ordered with a Pre Equipment Pack or Pre Equipment Pack (less speakers) and all MyConnection Radios, have 3 variants of a Multi Function Display (MFD) and Integrated Control Panel (ICP).

NOTE: Power for radio - **do not** switch the permanent battery feed (KL 15) and ignition feed (KL 30) on the radio connection. The ignition feed 15 is only used to 'wake up' the radio.

24 Pin Connector (8475-1 / 544127-1)

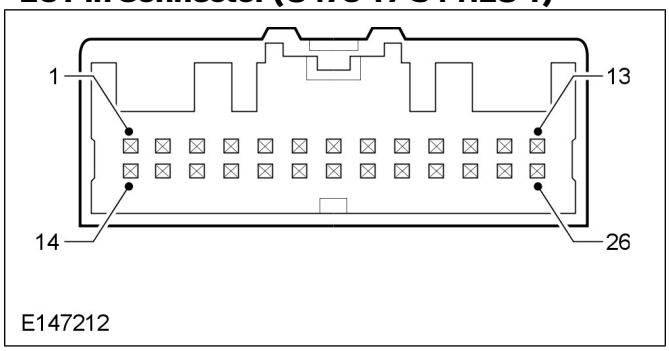


E145370

24 Pin Connector

Pin	Description	Type	Pin	Description	Type
1	Battery	Input	13	Ground	Input
2	Switched B+ Power	Output	14	CAN - High	Input/ Output
3	Not used	-	15	CAN - Low	Input/ Output
4	Navigation Audio In +	Input	16	Audio Shield for AIJ	Output
5	Navigation Audio In -	Input	17	AIJ Left +	Input
6	Auxiliary Input Jack (AIJ) - common	Input	18	AIJ Right +	Input
7	Not used	-	19	Audio Shield for Aux 2	Output
8	Not used	-	20	Not used	-
9	Left Rear Speaker -	Output	21	Left Rear Speaker+	Output
10	Left Front Speaker -	Output	22	Left Front Speaker +	Output
11	Right Front Speaker -	Output	23	Right Front Speaker +	Output
12	Right Rear Speaker -	Output	24	Right Rear Speaker +	Output

26 Pin Connector (8476-1 / 544128-1)

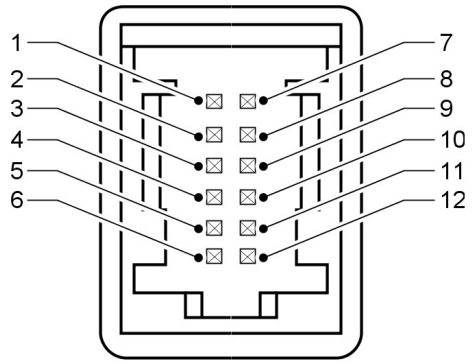


E147212

26 Pin Connector

Pin	Description	Type	Pin	Description	Type
1	Not used	-	14	Not used	-
2	Not used	-	15	Not used	-
3	Not used	-	16	Audio Shield Aux 1	Output
4	Auxiliary Out 1 +	Output	17	Auxiliary Out 1 -	Output
5	Not used	-	18	AE_CD 1	Input/Output
6	Not used	-	19	Not used	-
7	Not used	-	20	Not used	-
8	Alert In +		21	Alert In -	Input
9	Not used	-	22	Not used	-
10	Not used	-	23	Not used	-
11	Not used	-	24	Not used	-
12	Stereo In 1 Left +	Input	25	Stereo In 1 Left -	Input
13	Stereo In 1 Right +	Input	26	Stereo In 1 Right -	Input

Multi Function Display (MFD) 12 Pin Connector

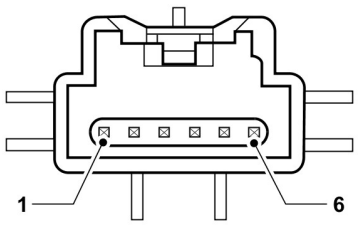


E147213

12 Pin MFD Connector

Pin	Description	Type	Pin	Description	Type
1	Battery	Input	7	Stalk Switch	-
2	MS Body CAN +	Input/ Output	8	MFD — LIN Bus	Input/ Output
3	MS Body CAN -	Input/ Output	9	Ground	Input/ Output
4	CAN — High	Input/ Output	10	Stalk Switch Return/Alarm Sense	-
5	CAN — Low	Input/ Output	11	Ground	Input/ Output
6	Audio Out +	Output	12	Audio Out -	Output

Integrated Control Panel (ICP) 6 Pin Connector



E167585

Item	Description
1	Battery +
2	PADI Voltage Ignition
3	PADI ON
4	PADI OFF
5	LIN
6	Ground

4.10.4 Additional Rear Speakers

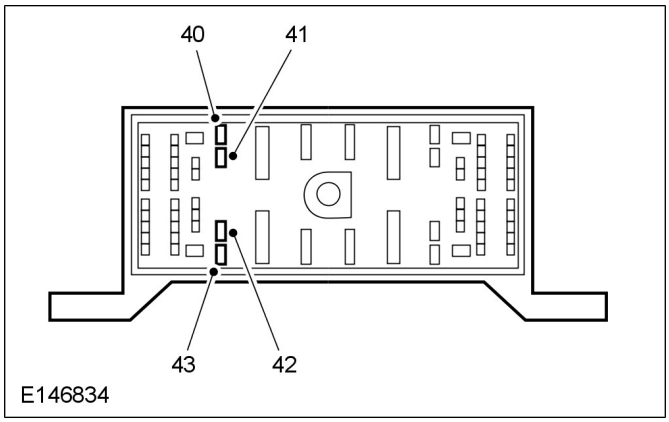
Rear speaker wiring is always present in the instrument panel harness 14K024, but not necessarily in the harnesses 14401 and 14405/14A005 that then take the signals to the rear speaker locations.

When the rear speakers are not present at the body harness 14401/IP harness 14K024 in-line connector on low series variants the rear speakers may be spliced into the Audio Jumper Harness at the rear of the Audio Head Unit, see next table for details.

Rear Speakers - Spliced into the Audio Jumper Harness

Pin	Speaker	Wire Color
24	Right Rear +	Brown/White
12	Right Rear -	Brown/Blue
21	Left Rear +	White/Green
9	Left Rear -	Brown/Yellow

Rear Speakers - In-line connector 14401/14K024



Item	Description
Pin 40	Rear Speaker Left + (White/Green)
Pin 41	Rear Speaker Left - (Brown/Yellow)
Pin 42	Rear Speaker Right - (Brown/Blue)
Pin 43	Rear Speaker Right + (Brown/White)

4.11 Cellular Phone

WARNING: Installation of any non-Ford-approved system is not recommended and operation with associated systems cannot be guaranteed. Any resultant damage will not be covered under warranty.

Ford offer hands-free and wireless technology (Bluetooth) phone systems (including voice recognition) as factory-fit options, these will also be available as aftermarket accessory kits from your Ford dealership.

These use the Ford MS CAN multimedia bus to operate in conjunction with the Ford audio and navigation systems.

4.12 Exterior Lighting

WARNINGS:

Make sure that the modified vehicle complies with all relevant legal requirements.

Do not tamper with the base system (controlled by Body Control Module and multiplex architecture) and any feeds taken from the associated wiring or controller.

4.12.1 Reversing Lamps

Reversing lamps are activated by the Body Control Module (BCM) which is controlled by the BCM high side driver. Accessories that add additional load, such as back up sounders, connected to the reverse lamp circuit, should be connected by a relay. Connecting such loads directly to the reverse lamp circuit could damage the BCM.

The load on the reversing lamps should not exceed a total of 3A (42W).

4.12.2 Additional External Lamps

All power for additional exterior lamps must be taken through the Auxiliary Fuse Panel with a suitable switch and/or relay as required.

Refer to: 4.17 Fuses and Relays (page 172).
Refer to: 4.19 Electrical Connectors and Connections (page 178).

When fitting additional Markers it is recommended to use LED lamps.

Lighting Loads

BCM Outputs	Controlling Device	Max. Load	Vehicle
Licence Plate and Marker Lamp Supply ^	High Side Driver	27W	2 x 5W^^
Position/Parking Lamp Front - each side	High Side Driver	10W	5W
Position/Parking Lamp Rear - each side	High Side Driver	20W	5W
Direction Indicator Front - each side	High Side Driver	27W^^^	21W
Direction Indicator Rear - each side	High Side Driver	27W^^^	21W
Direction Indicator Side Repeater - each side	High Side Driver	32W	5w or 16W*
Daytime Running Lamps - each side	High Side Driver	30W	15W
Front Fog Lamps	Relay	110W	110W
Rear Fog Lamps	High Side Driver	42W	42W

^ Licence Plate and Marker Lamps not to exceed 27W LED Markers are recommended where available.

^^ +14W if side , Roof or End Marker Lamps are already fitted.

^^^Turn Indicator Supply, smaller load will cause double flashing (bulb outage detection).

* CAT5 = 5W, CAT6 = 16W

The BCM exterior lighting outputs have shutdown protection in the event of an overload condition. If the overload condition is not addressed, the output will be shutdown permanently to protect the driver hardware. A dealer visit and/or BCM replacement may be required if overload condition is not removed.

4.12.3 Lamps – Hazard / Direction Indication

NOTE: If LED indicators are used on the rear of a Camper conversion, the wattage needs to simulate the 21W expected by the bulb outage detection circuit. If LED indicators are supplemental to existing system, then the load resistor may not be required. When adding extra lamps, the converter must check they comply to the legal requirements and that functionality is maintained.

NOTE: For various vehicles CAT 6 repeater lamps must be fitted. See legislation for full details. Check with your local Ford Dealer or National Sales Company representative.

The standard system configuration each side:

- 1 x Front Indicator 21W - max load 27W.
- 1 x Rear Indicator 21W - max load 27W.
- 1 x Side Repeater (Mirror Mounted) either CAT5 (5W) or CAT6 (16W). The whole mirror assembly needs to be changed if moving from CAT5 to CAT6.

4.12.4 Lamps – Front and Rear Fog Lamps

National Regulations regarding inter-connection with other front and rear fog lamps must be checked before designing the wiring circuit. The maximum permissible load with the standard system is:

- Front fog lamp - 2 x 55W (relay controlled).
- Rear fog lamp - 2 x 21W (high side driver controlled).

For trailer tow, rear fog lighting, relating to that system.

Refer to: 4.18 Special Conversions (page 176).

4.12.5 Lamps for Wide Vehicles

Lamps – End Outline and Side Marker Lamps

The maximum permissible load with the standard system is:

- 6 x 0.5W - Side Marker.
- 2 x 0.5W - End Outline Marker.
- 2 x 4W - Roof Marker.
- 2 x 16W - CAT 6 - Indicators Side Repeater

Parking Lights

In order to maintain compliance with Lighting Regulations ECE R48 (Parking lamp), based on the finished vehicle dimension, certain vehicles are not allowed to have the single or two side parking light function. Where necessary the parking light function must be disabled. This can only be carried out by your local Ford dealer.

Vehicle Configuration

When parking lights are disabled, single side parking light function will not be available. When the light switch is set to POS, the position lights and the licence plate and side/roof markers will be ON.

When fitting additional marker it is recommended to use LED's.

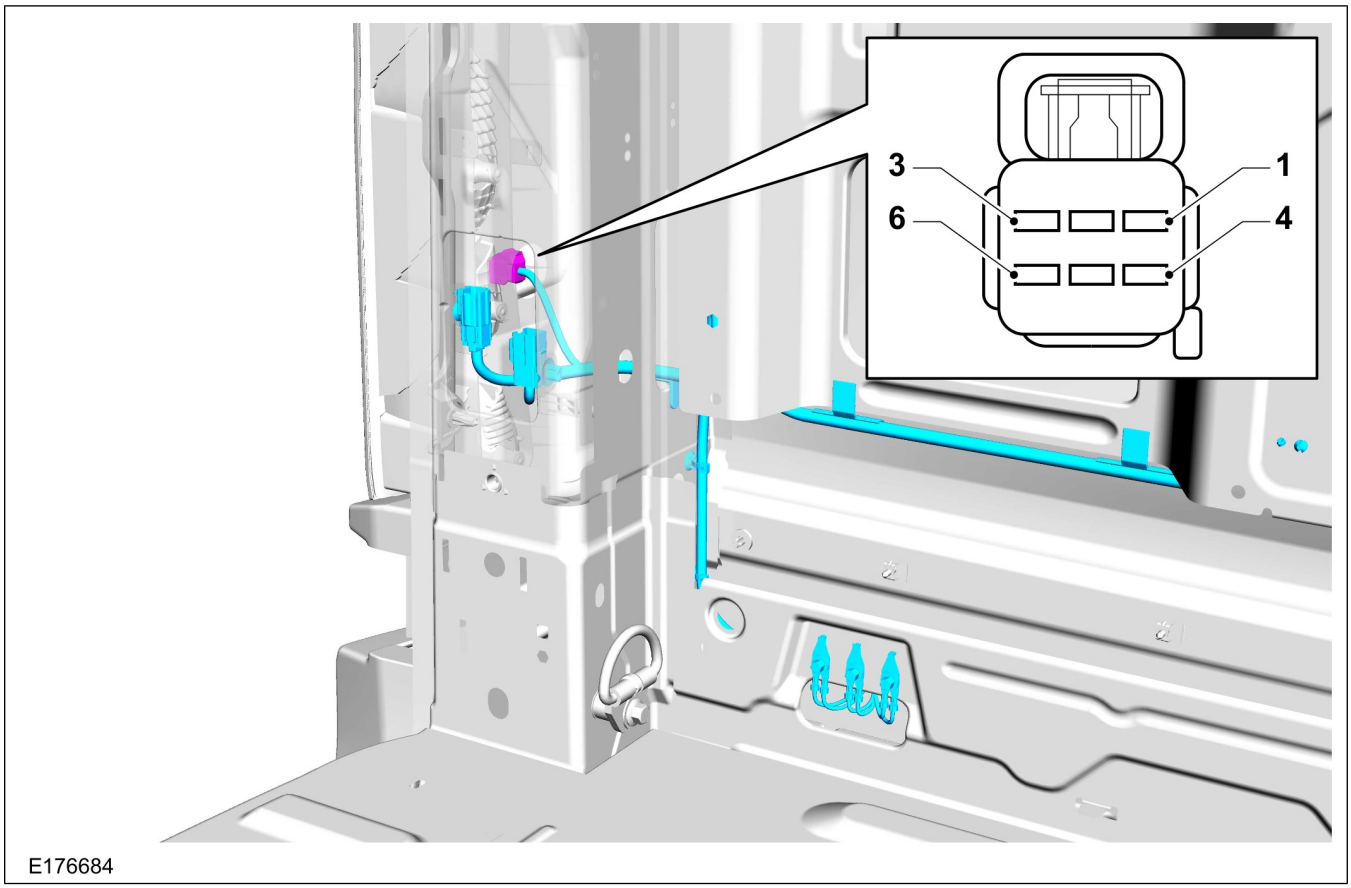
4.12.6 Electrically Operated Door Mirrors

WARNING: Do not tamper with the base system (controlled by Body Control Module and multiplex architecture) and any feeds taken from the associated wiring or controller.

NOTE: These options are not suitable for aftermarket or converter fit.

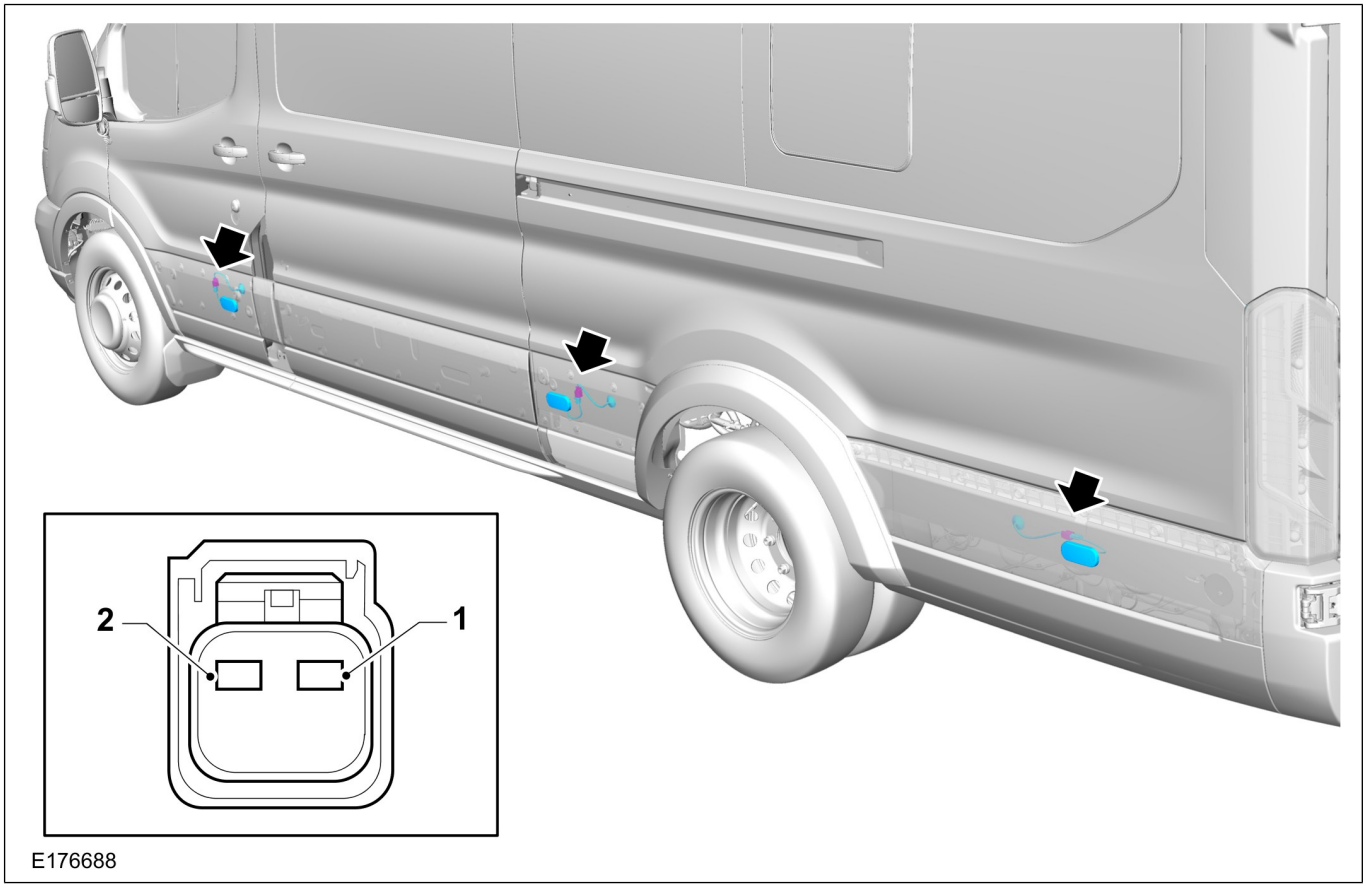
4.12.7 Additional External Lamps

Rear Lamp Connector - Van, Bus and Kombi (Left Hand Side Shown)



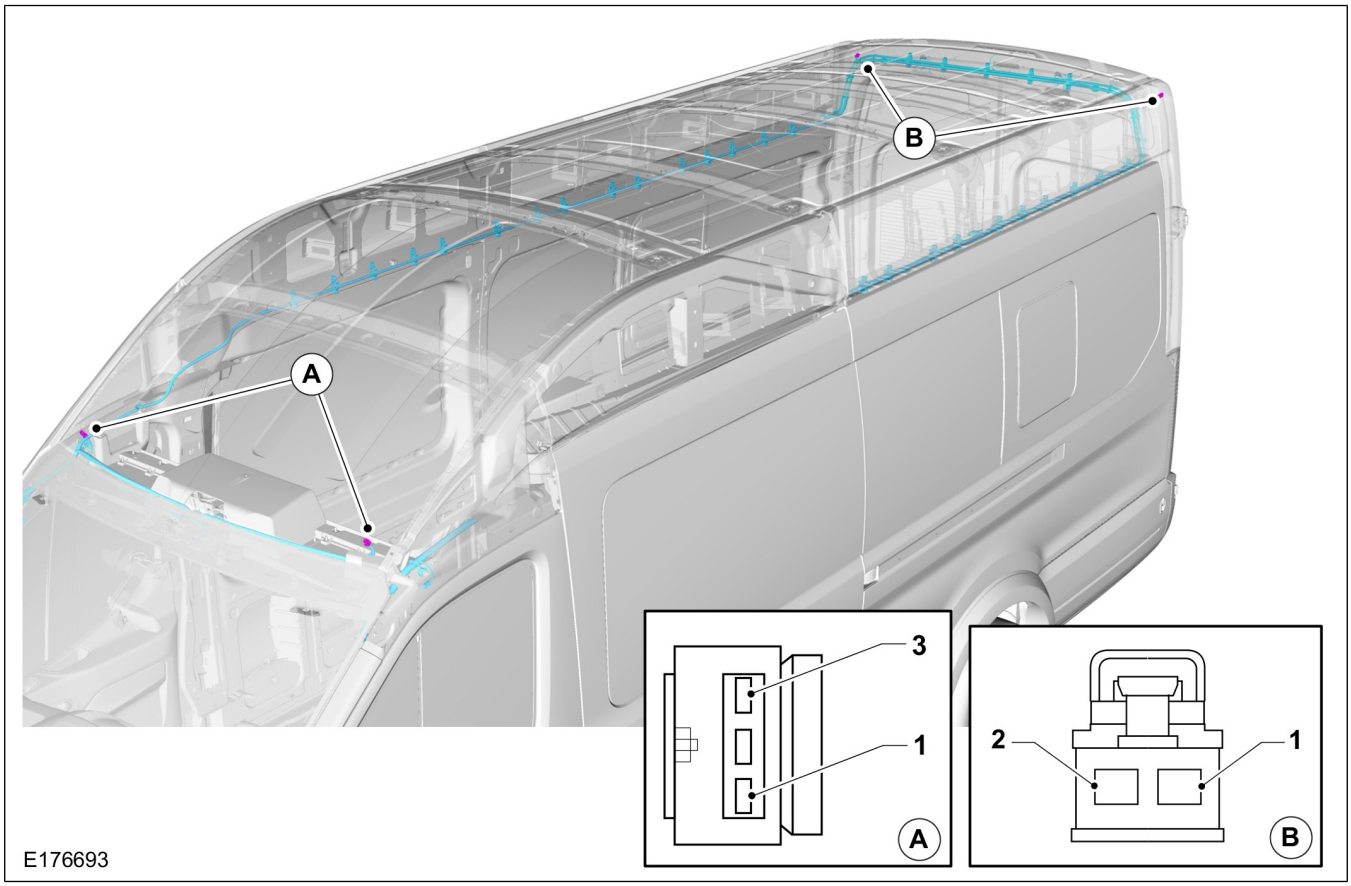
Rear Lamp Connectors - Van, Bus and Kombi			
Lamp Assembly Tail Right		**Lamp Assembly Tail Left**	
GK3T-13A409-**	Harness	GK3T-13A409-**	Harness
4S7T-14489-V*	Connector	4S7T-14489-V*	Connector
4S7T-14A459-V*	Mating Connector	4S7T-14A459-V*	Mating Connector
Pin 1	Turn Lamp Right Rear	Pin 1	Stop/Turn Right Outboard
Pin 2	Stop/Turn Right Outboard	Pin 2	Park Rear Left
Pin 3	Park Rear Right	Pin 3	Turn Lamp Left Rear
Pin 4	Ground - Pillar D Right 2nd Point	Pin 4	Fog Lamp Rear Left
Pin 5	Reverse Left or Common	Pin 5	Reverse Left or Common
Pin 6	Fog Lamp Rear Right or Common	Pin 6	Ground - Pillar D Left

Side Marker Lamps - Van, Bus and Kombi



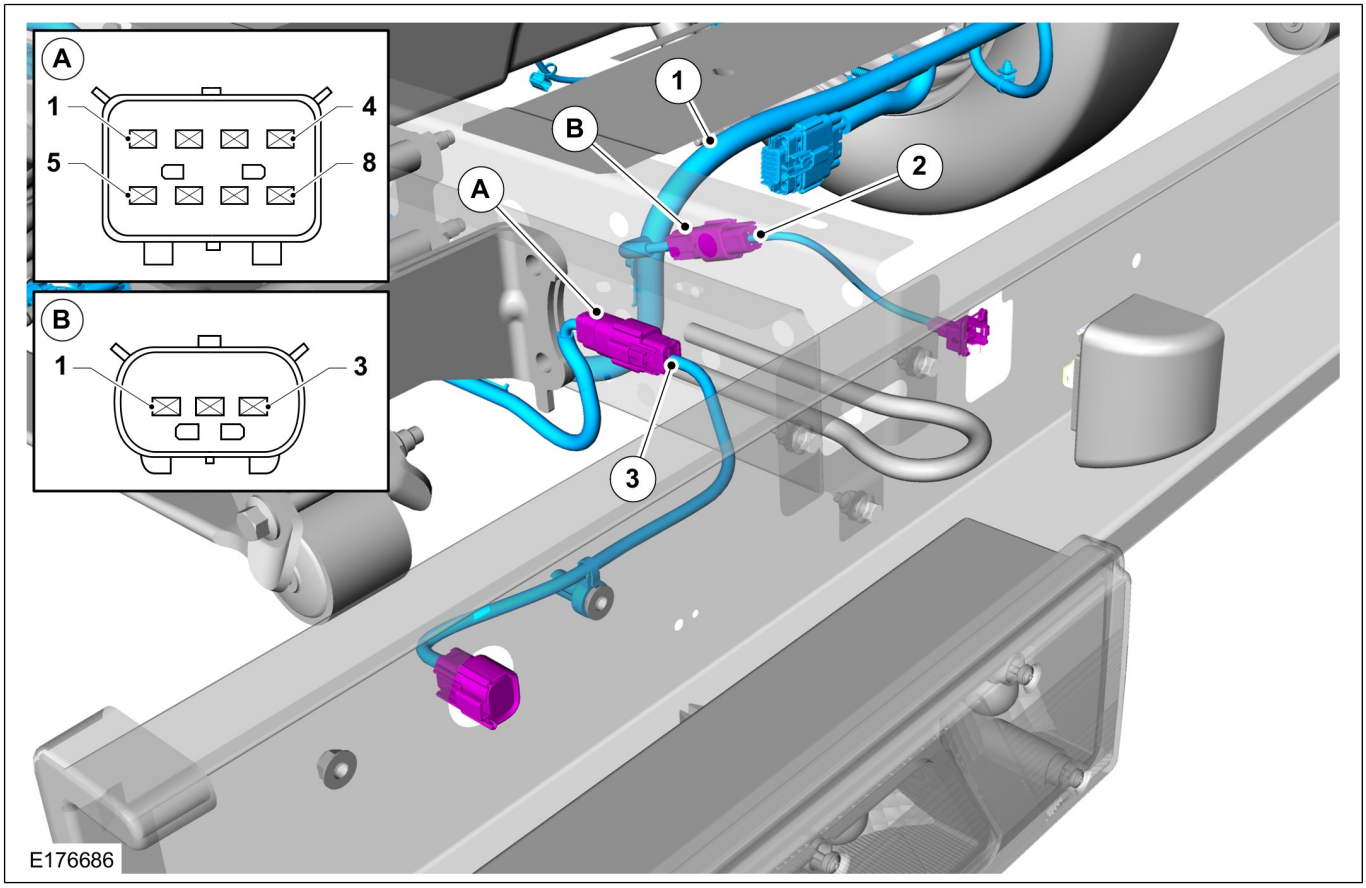
Side Marker Lamps - Van, Bus and Kombi	
GK3T-14A333-**	Harness
AU5T-14A464-P*	Connector
AU5T-14A624-T*	Mating Connector
Pin 1	Licence Plate Lamp
Pin 2	Ground - Pillar D Right

Roof Marker Lamps - Van, Bus and Kombi



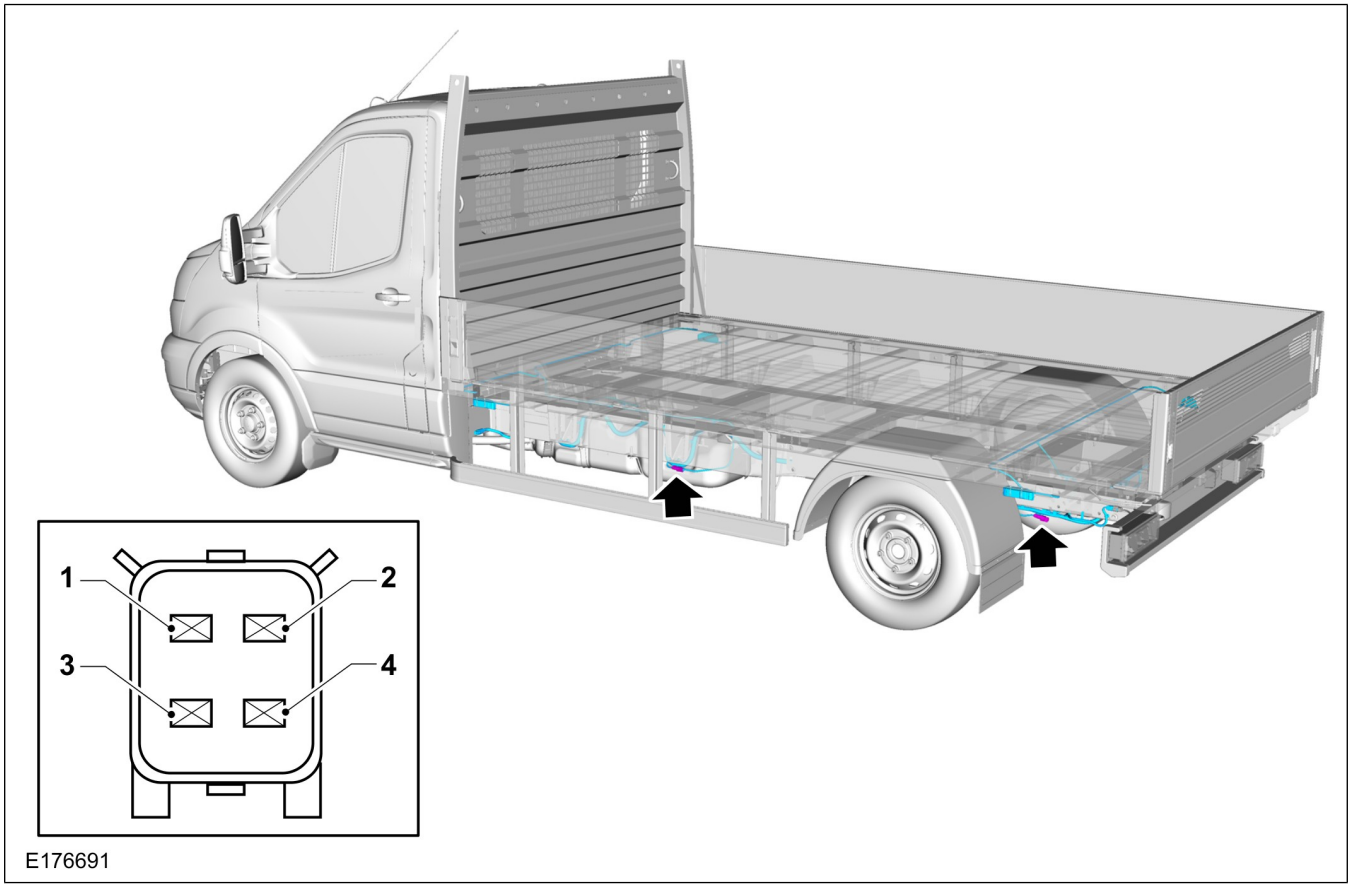
Roof Marker Lamps			
'A' Front Roof Markers		**'B' Rear Roof Markers**	
GK3T-13A409-**	Harness	GK3T-13A409-**	Harness
F3LB-14489-M*	Connector	3M5T-14489-B*	Connector
Pin 1	Licence Plate Lamps/Marker Lamps	Pin 1	Licence Plate Lamps/Marker Lamps
Pin 2	-	Pin 2	Ground - Pillar D Right/Left
Pin 3	Ground - Pillar D Right/Left	-	-

Rear Lamps - Chassis Cabs (Left Hand Side Shown)



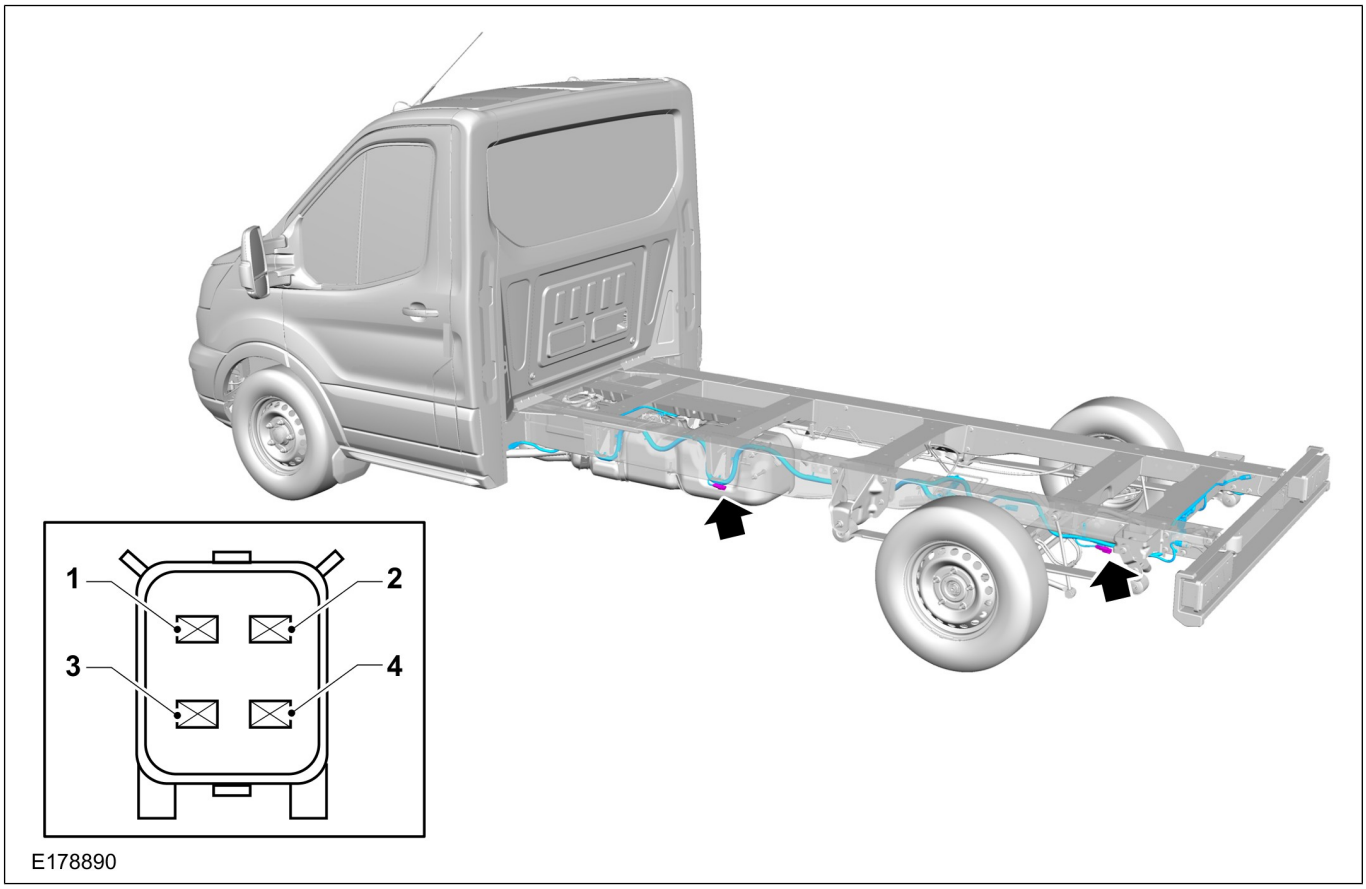
Rear Lamps - Chassis Cabs (Left and Right Hand Side)	
1	Main Harness - GK3T-14406 -**
2	Mating Connector - 7T4T-14A646-A* on Harness BK31-13550 - A*
3	Mating Connector - AU5T-14A464-G* on harness BK31-12663-A*
'A' Rear Lamp Connector AU5T-14A624 -H* on Main Harness 14406	
Pin 1	-
Pin 2	Turn Lamp Rear
Pin 3	Stop Lamp
Pin 4	Park Lamp Rear
Pin 5	Ground - Frame Middle
Pin 6	-
Pin 7	Fog Lamp Rear
Pin 8	Reverse Lamp
'B' Licence Plate Lamp Connector 7T4T-14A624-A* on Main Harness 14406	
Pin 1	Licence Plate Lamp
Pin 2	-
Pin 3	Ground - Frame Middle

Side Marker Lamps - Chassis Cabs With Float



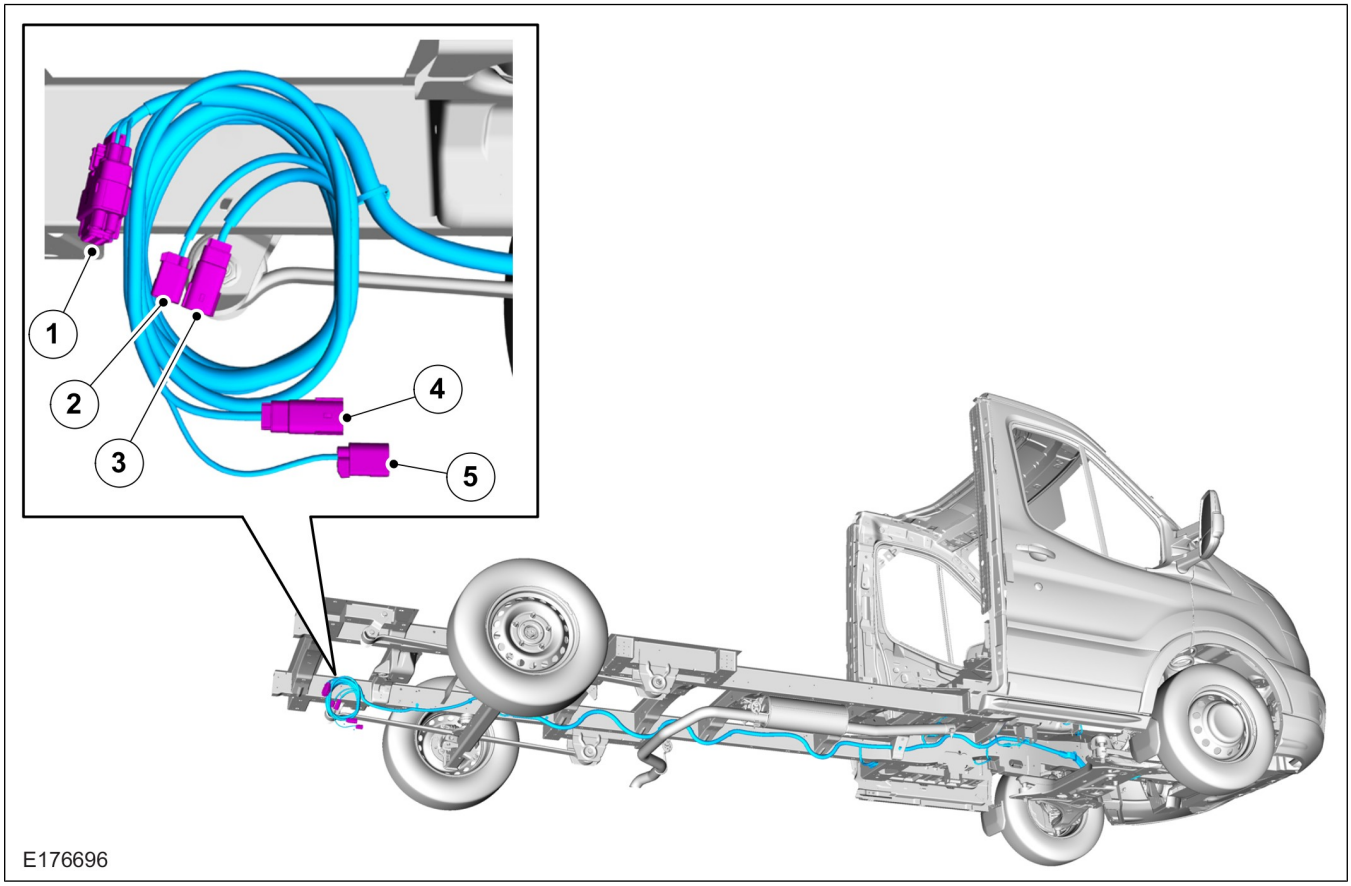
Side Marker Lamps - Chassis Cabs	
GK3T-14406-**	Harness
5W7T-14A624-B*	Connector
5W7T-14A464-C*	Mating Connector
Pin 1	Licence Plate Lamp Left
Pin 2	-
Pin 3	-
Pin 4	Ground - Frame Middle Left

Side Marker Lamps - Chassis Cab Without Float



Side Marker Lamps - Chassis Cabs	
GK3T-14406-**	Harness
5W7T-14A624-B*	Connector
5W7T-14A464-C*	Mating Connector
Pin 1	Licence Plate Lamp Left
Pin 2	-
Pin 3	-
Pin 4	Ground - Frame Middle Left

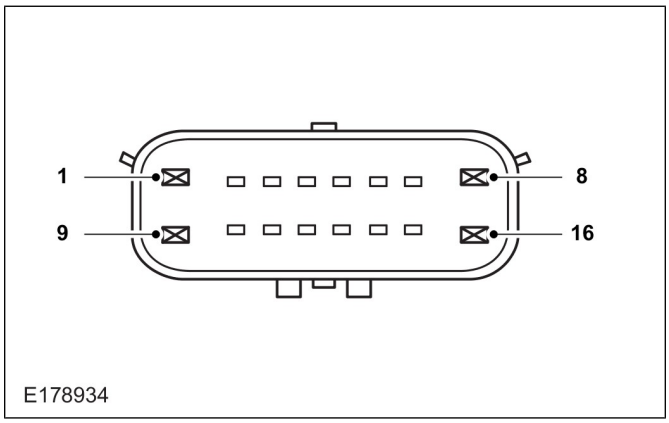
Transit Motorhome Chassis Harness



Transit Motorhome Chassis	
GK3T-14406-**	Harness
1	16 pin Connector, See figure E178934
2,5	Licence Plate Lamps^
3,4	Rear Lamps^

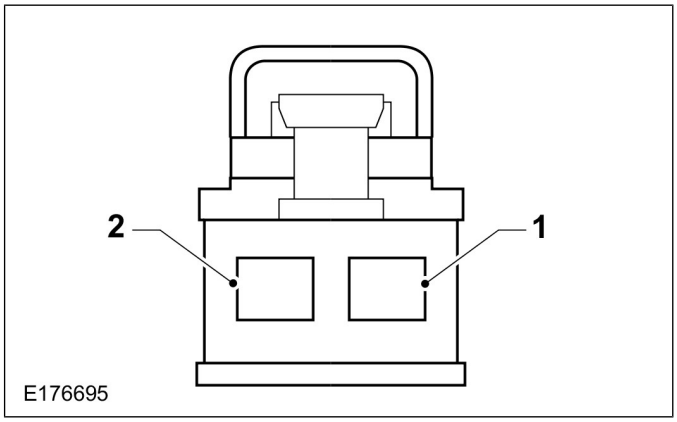
^ See Rear Lamps - Chassis Cab table for further details

Transit Motorhome Chassis 16 Pin Connector



Transit Motorhome Chassis - 16 Pin Connector			
4R3T-14A624-A*	Connector	4R3T-14A464-B*	Mating Connector
Pin 1	Ground - Headlamp Panel/ GOR Right 2nd Point	Pin 9	Fuse - 43 or Circuit Breaker
Pin 2	-	Pin 10	Control Module - Trailer Tow Power Ignition On
Pin 3	Control Module - Trailer Tow Turn Signal Left	Pin 11	Control Module - Trailer Tow Backup Lamps
Pin 4	-	Pin 12	Control Module - Trailer Tow Stop Lamps
Pin 5	Control Module - Trailer Tow Rear Fog lamp	Pin 13	Control Module - Trailer Tow Park Lamps
Pin 6	Control Module - Trailer Tow Turn Signal Right	Pin 14	Control Module - Trailer Tow Park Lamps
Pin 7	-	Pin 15	-
Pin 8	Ground - Headlamp Panel / GOR Right 2nd Point	Pin 16	Ground - Headlamp Panel / GOR Right 2nd Point

Third Brake/Stop Lamp (Van)



Third Brake/Stop Lamp Connector	
Pin 1	Third Brake/Stop Lamp on 13A409 Harness - Yellow/Grey
Pin 2	Ground - Black/Grey

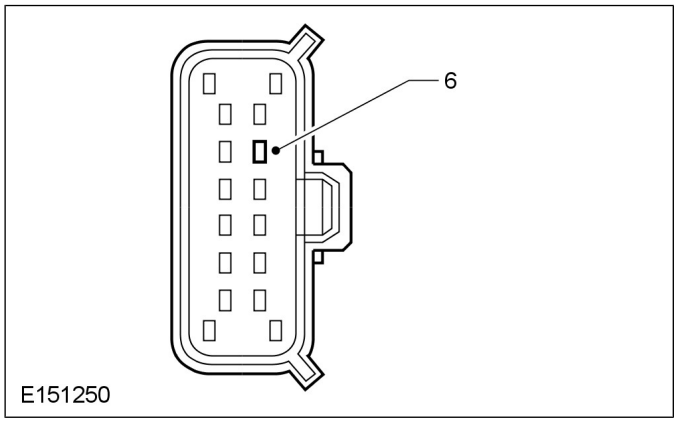
A signal for a Third Brake/Stop Lamp is also available on the Rear Lamp connector.

In order to avoid electrical issues due to leakage, and to ensure connector compatibility, a mating connector with seals/plugs and pre-crimped wire and terminal should be used.

For connectivity, see figure E176695. The Third Brake lamp feed can be accessed from the Third Brake Lamp Connector on 13A409 harness. This connector is centrally located at the rear of the vehicle, above the rear door. For Camper Chassis Cab connectivity

Refer to: 4.19 Electrical Connectors and Connections (page 178).
Camper Central Connectors' section of this manual. For Chassis Cab connectivity contact your Local Ford Dealer or email vcas@ford.com

Trailer Tow Connector



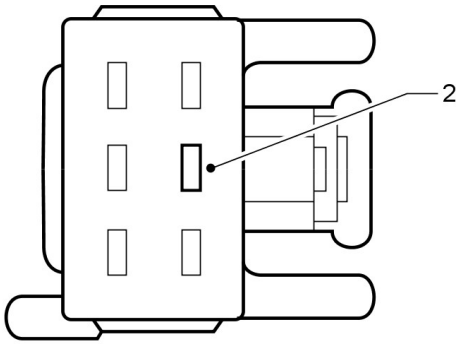
Item	Description
Pin 6	Stop Lamp Feed

The use of the trailer tow connector is not recommended. In situations where it is necessary, please see the following figure E151250. This connector can be found at the 14406 interface with the 13B576 harness. Pin 6 is the stop lamp feed. The trailer tow module GK2T-13B576-A* will need to be fitted to get the system active. For full trailer tow kit, BK2T-13B576-D* is also required. For additional information on electrics for tow bars:

Refer to: 4.1 Wiring Installation and Routing Guides (page 76).

Additional Position Lamps at the Rear of the Vehicle

Lighting Connector



E151251

Item	Description
Pin 2	Position Lamps

The feed for position lamps can be taken from the lighting connector, at the rear left hand side of the vehicle on 13A409 harness, pin 2 (violet/green), see figure E151251 or direct from the licence plate feed connector, see figure E176686. The maximum spare load is 10W per side. The dealer will need to reconfigure this output for the maximum rating.

NOTE: Lighting connector shown in E151251 will require a local ground.

The position and parking functions operate independently.

Where applicable, when the position lamps are extinguished, the side marker and end-outline markers turn off simultaneously, in line with Inter Regs No 48, which states the following:

The electrical connections must be such that the front and rear position lamps, the end-outline marker lamps (if they exist), the side-marker lamps (if they exist) and the rear registration plate lamp can only be switched on and off simultaneously. This condition does not apply when using front and rear position lamps, as well as side-marker lamps when combined or reciprocally incorporated with said lamps, as parking lamps and when side-marker lamps are permitted to flash.

Fog Lamp Connector

Connectors are already part of the wiring if the vehicle is medium or high specification, (for example with electrical side mirrors). Low spec vehicles do not have wiring within the main harness. The main light switch will need to be changed for one that includes this feature. (There are switches with and without front fog lamp function). When retrofitting fog lamps the BCM will need to be reconfigure to enable the feature, please contact your local Ford dealer to do this.

Connecting to Lighting Information

Additional turn indicators must be powered through relays (max 300mA), driven by existing turn lamps. The maximum load that the Body Control Module (BCM) can drive is 3 x 21W per side (front, rear and CAT6 turn indicators).

4.13 Interior Lighting

4.13.1 Additional Internal Lamps

Electrical supply for additional cabin interior lighting may be obtained by directly accessing the connector inside the dome lamp.

Electrical supply for additional load space interior lighting may be obtained by directly accessing the connector inside the load space lamps.

For additional information on BCM

Refer to: 4.2 Communications Network (page 90).

The battery saver system provides power for the interior lighting for a limited time.

Power supply for the interior lights.

The BCM provides power to the interior lights by three outputs, two for courtesy and one for demand:

- Cabin light courtesy function - BCM pin C3-13 with maximum load of 5A
- Cargo light courtesy function - BCM pin C3-26 with maximum load of 5A
- Combined cabin and cargo light demand function - BCM pin C3-14 with maximum load of 7A

Each interior light circuit is grounded locally to the lamp. The lamps fitted to the cabin or cargo circuit depends on the vehicle type. To determine the lamps on the rear or cargo circuit:

- Set any lights with a switch to courtesy.
- Close all the doors and allow the lights to switch off.
- Open the door or lift gate at the rear of the vehicle.
- Any interior lights that switch on are in the rear cargo or rear zone.

If fluorescent lighting is required it must not be connected to the existing interior cabin or cargo lighting as it is not compatible with the pulse width modulated (PWM) lighting circuit and may cause premature failure of the Fluorescent lighting. If Florescent lighting is required, it should be connected to the Auxiliary Fuse Panel.

If enhanced bright lights are required for the cargo area of a van, it is recommended to fit the Ford Enhanced Load Space Lighting. Option A080 and LED lamp part numbers BK2V-13776-A*, 4x on medium (L2) and long (L3) wheelbase vehicles and 5x on extra long (L4) wheelbase vehicles. These are controlled from the side load or rear door being ajar or manual demand from the dome lamp in the front cabin. For further information on required parts and configurations to order contact your Local Ford Dealer.

4.13.2 Additional Lighting for rear of vehicle interior

Where higher wattage installations are required, these should be taken through the Auxiliary Fuse Panel with a suitable switch and/or relay as required. For additional information

Refer to: 4.19 Electrical Connectors and Connections (page 178).

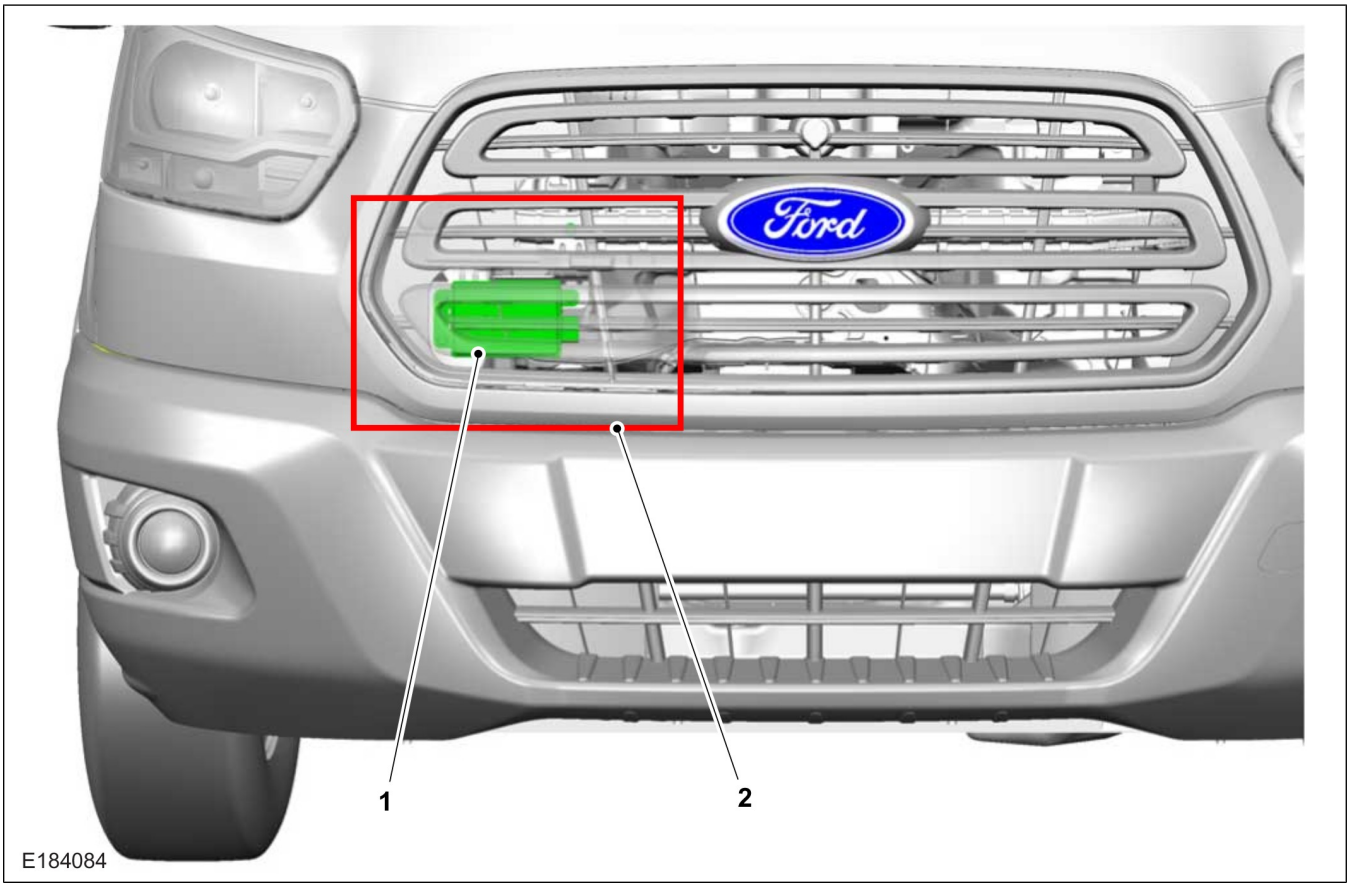
4.14.1 Adaptive Cruise Control

CAUTION: For converted vehicles fitted with adaptive cruise control, where vehicle mass or geometry is significantly altered it is recommended that the radar vertical alignment and system functionality is checked by a Ford dealer. For further information refer to Workshop Manual or Owner's Manual.

NOTE: Do not obstruct the cruise control radar, see clearance zone 2 in Figure E184084

NOTE: Do not paint the front grill of the vehicle as this may affect the functionality of the cruise control radar.

Adaptive Cruise Control Radar

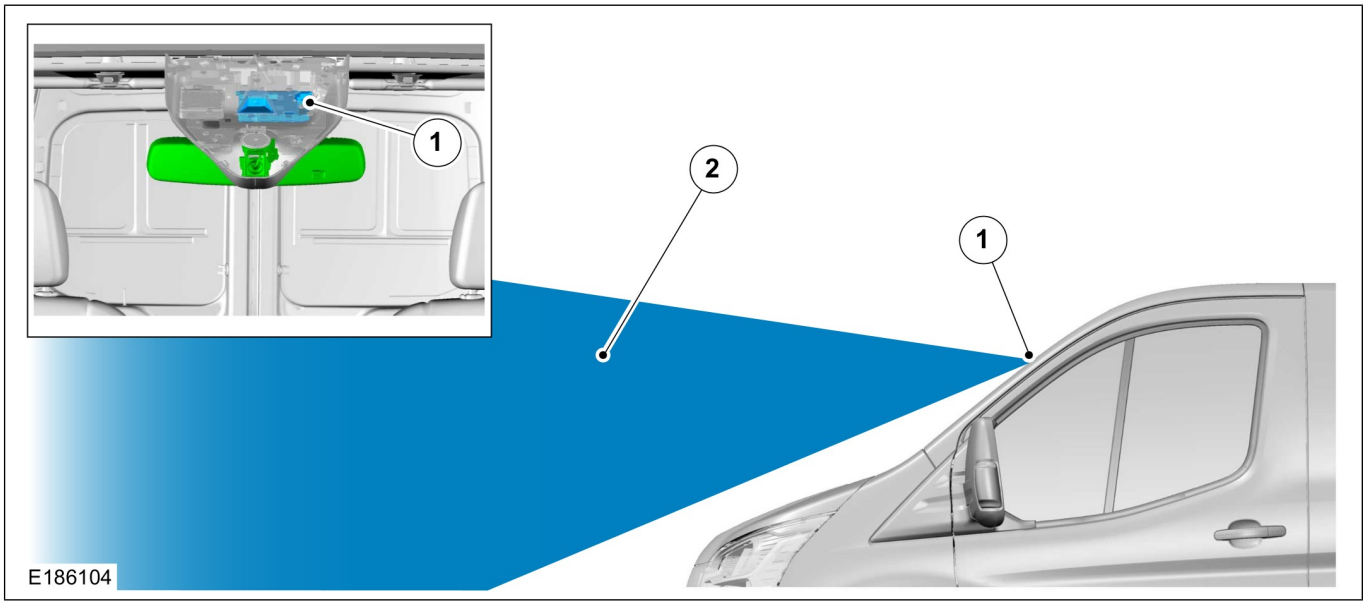


Item	Description
1	Adaptive Cruise Control Radar
2	Adaptive Cruise Control Radar clearance zone

4.15 Lane Keeping System

NOTE: The lane keep alert feature will not function if any conversion or installation is in the field of view from the lane keeping system camera.

NOTE: For converted vehicles fitted with lane keeping system, where vehicle mass or geometry is significantly altered, a new calibration for the camera sensor needs to be made.



Item	Description
1	Lane keeping system camera located behind the interior rear view mirror trim
2	View cone from camera, horizontal direction and downwards to the hood edge of the vehicle

For additional information for vehicles with large overhangs

Refer to: 4.18 Special Conversions (page 176).

4.16.1 Door Removal or Modification

In the event of the requirement to remove the doors for derivatives requiring no doors, certain circuits will need to be linked to ensure door ajar warnings do not appear on the Instrument Cluster. The interior light will also stay on if this is not done.

It is possible to maintain a certain state by configuring the Body Control Module (BCM) C3 in the following way.

- C5-33 Front Left -ground
- C5-21 Front Right - ground
- C5-34 Ajar lift gate switch - not connected
- C5-46 Ajar left side cargo switch - not connected
- C5-19 Ajar left side cargo switch - not connected

4.16.2 Central Locking

Locking is controlled by the BCM. There is current sensing on certain locking circuit pins as part of the security system – if these are tampered with, locking cannot be guaranteed.

However, it is possible to add an additional lock(s) – see also the section covering the 'third button on key fob' – but only by utilizing relays (the electric locks are operated by surface mounted relays in the BCM – these are only capable of powering one lock each, in addition to which the output of these devices is current-sensed to check it is within minimum and maximum limits: I) to verify operation, and ii) as part of the security system).

Depending on functionality required, the pins used will emulate the basic locking/unlocking operation of an existing door. Note, however, that any additional locks will not be covered by the vehicle alarm or operate BCM controlled lighting. It would be necessary to splice into either the BCM connector or the in-line connector for the door jumper harness. The coil of the relay (max. 300mA) should be added across the relevant pin and ground (i.e. one relay for lock all, one relay for driver door unlock etc).

The use of Ford Transit lock mechanisms is strongly recommended as the BCM is designed to drive these latches for the correct amount of time.

BCM	14A631 in-line Drive Side	14A631 in-line Passenger Side	Function
C3-35	A16	A16	Central Lock
C3-27	A17	-	Drivers Door Unlock
C3-32	B17	B17	Double Lock
C3-05	-	A17	Passenger Door Unlock

BCM	19L540	Function
C3-24	1	Unlock RH Sliding Rear Door
C3-33	1	Unlock LH Sliding Rear Door

Junction Box	18C394	Function
R11-3	6	Unlock Lift Gate/Cargo

Locking Configurations The following list details specific locking scenarios that have been noted by customers:

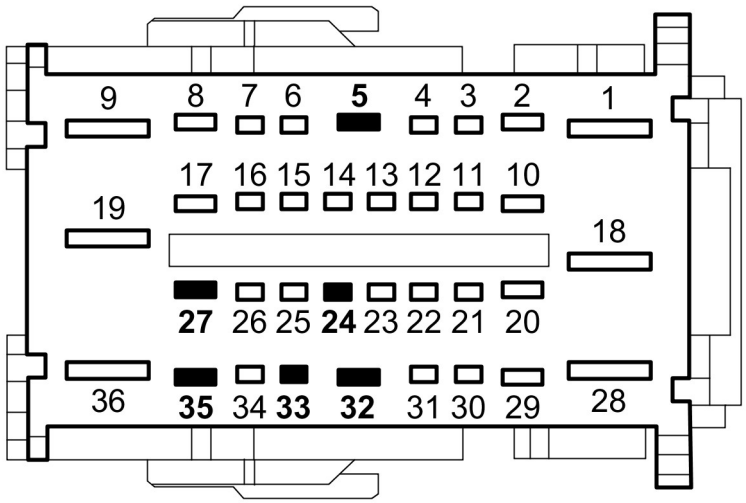
1. Raid locking or drive away locking for taxi and parcel van usage – this is a configurable parameter in the BCM (Ford Dealerships can set this). There is also the option to configure via the instrument cluster once the configurable parameter has been set.
2. Slam locking – this is a configurable parameter in BCM (dealerships can only switch off this feature, but not switch on).
3. N1 lock reconfiguration into no deadlocks – this can be reconfigured to be central-locking only by a Ford Dealer (via Dealership hotline).
4. Auto unlock - There is an option to configure central unlock where the drivers door, when opened, will automatically unlock all doors except any doors controlled by the third button on the key fob.

Drive-Away Locking Disable

The following parameter (automatic locking by speed) is configured as follows:

- IDS parameter 32 - Change 0x02 [on] to 0x01 [off].

Pins to Control Additional Door Locks



E225108

Item	Description
C3-05	Passenger Door Unlock
C3-27	Diver Door Unlock
C3-24	Unlock RH Sliding Rear Door
C3-35	Central Lock
C3-33	Unlock LH Sliding Rear Door
C3-32	Double Lock

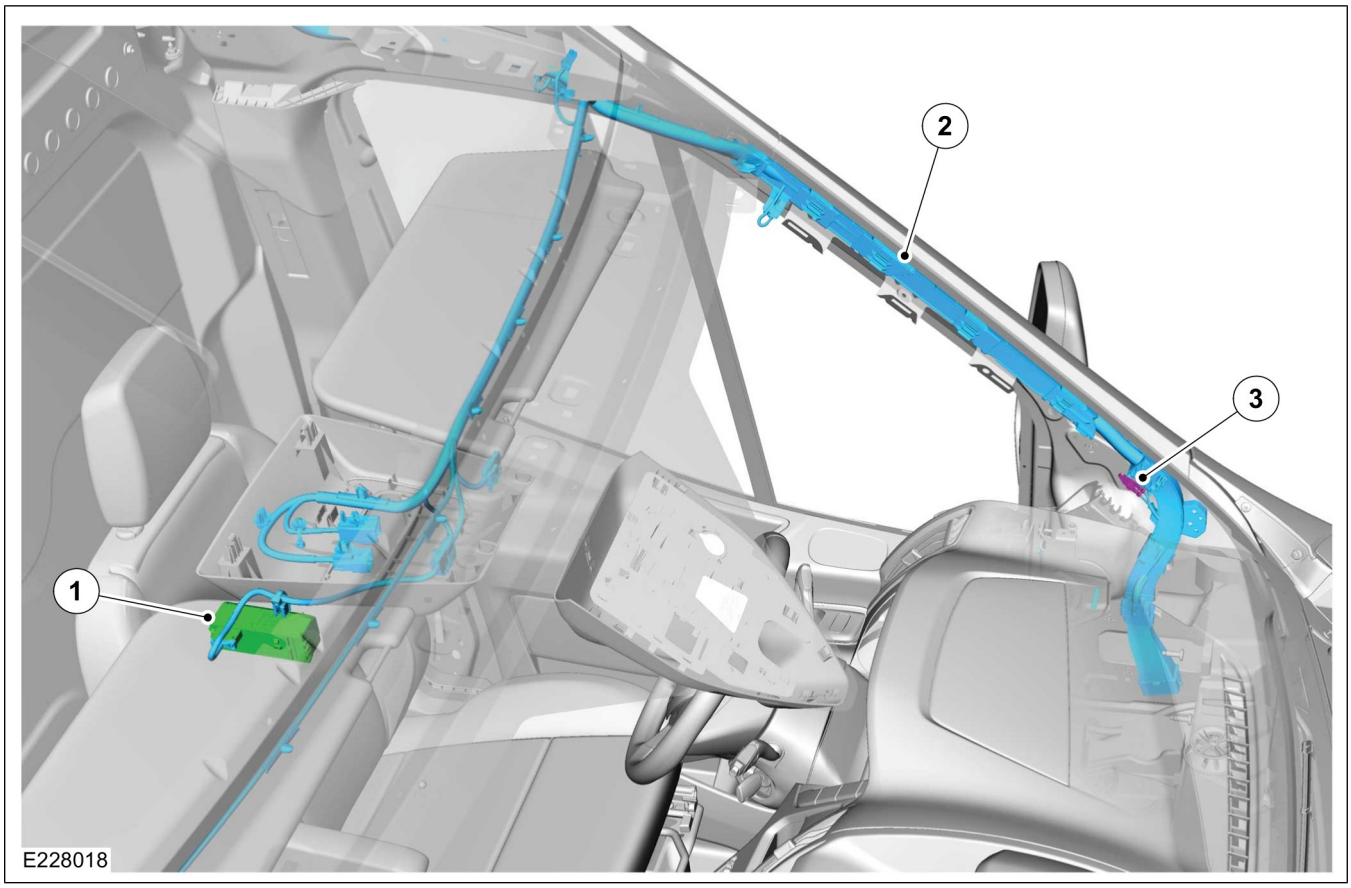
4.16.3 Third Button on Key Fob - Single Chassis Cab and Transit Motorhome Chassis Only

Pin 3 on R11 of the Junction Box is controlled by the third button on the key fob. This provides a 12V pulse when pressed. The signal can be used for a variety of converter applications, subject to load required.

Pin R11-3 is part of the circuit protected by a 15A fuse (F19).

NOTE: There are no micro switches, no current sensing, or any alarm system functionality associated with this pin, or any lock set driven by it.

4.16.4 Remote Keyless Entry/Tire Pressure monitoring System Receiver (RKE/TPMS Receiver)



Item	Description
1	RKE/TPMS Receiver
2	Harness 14A005
3	Ground Point Location

WARNING: For best performance, the RKE/TPMS receiver must be a minimum distance of 25mm away from any metal objects and 100mm away from high switch loads.

NOTE: It is recommended that the RKE/TPMS has a dedicated ground wire and ground stud, do not splice with other modules.

The RKE/TPMS receiver is fed via a connection to the 14A005 harness and then earthed at the ground point located on the A-Pillar. For ground point location

Refer to: 4.20 Grounding (page 206).
For additional information
Refer to: 2.4 Wheels and Tires (page 53).

4.17 Fuses and Relays

4.17.1 Fuses

WARNING: No increase in existing vehicle standard fuse capacity is allowed under any circumstances. There are no spare fuses in the Engine Junction Box (EJB), Standard Relay Box (SRB) or Body Control Module (BCM). The vehicle converter/modifier must provide additional fuses as required. Please refer to Ford Fuse table in this section.

NOTE: Only use Ford fuses as shown in the next table. Other fuses may interfere with the validated fusing strategy.

Ford Fuses

Part Number	Ampere Rating	Color
Mini Fuse		
1L3T-14A094-A*	2A	Grey
1L3T-14A094-B*	3A	Violet
1L3T-14A094-C*	4A	Pink
1L3T-14A094-D*	5A	Tan
1L3T-14A094-E*	7.5A	Brown
1L3T-14A094-F*	10A	Red
1L3T-14A094-G*	15A	Blue
1L3T-14A094-H*	20A	Yellow
1L3T-14A094-J*	25A	Clear
1L3T-14A094-K*	30A	Green
Micro Fuse		
DG9T-14A094-F*	5A	Tan
DG9T-14A094-G*	7.5A	Brown
DG9T-14A094-H*	10A	Red
DG9T-14A094-J*	15A	Blue
DG9T-14A094-K*	20A	Yellow
DG9T-14A094-L*	25A	White
DG9T-14A094-M*	30A	Green
M-Case Fuse		
DG9T-14A094-A*	15A	Grey
DG9T-14A094-B*	20A	Light Blue
DG9T-14A094-C*	25A	White
DG9T-14A094-D*	30A	Pink
DG9T-14A094-E*	40A	Green
J-Case Fuse		
F8SB-14A094-A*	20A	Blue
6E5T-14A094-A*	20A	Blue
2L5T-14A094-A*	25A	Natural
F8SB-14A094-B*	30A	Pink
6E5T-14A094-B*	30A	Pink
7T4T-14A094-D*	40A	Green
F8SB-14A094-C*	40A	Green
6EST-14A094-C*	40A	Green
7T4T-14A094-E*	50A	Red
F8SB-14A094-D*	50A	Red
6E5T-14A094-D*	50A	Red
7T47-14A094-F*	60A	Yellow
XS21-14A094-A*	60A	Yellow

4.17.2 Relays

Ford Relays

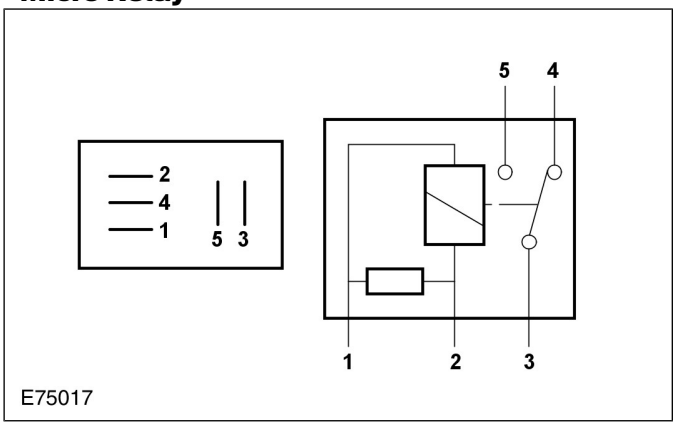
Part number	Ampere Rating	Color
5M5T-14B192-A*	20	Black
5M5T-14B192-C*	40	Black
5M5T-14B192-D*	40	Black
5M5T-14B192-E*	70	Grey
8T2T-14B192-C*	20	Black
8T2T-14B192-A*	40	Black
8T2T-14B192-B*	40	Black
FU5T-14B192-A*	40	Blue

NOTE: Only use the Ford Relays shown in table.

Ford standard relays have a nominal coil current of 300mA (max) at 25°C. Relays with higher loads should not be used.

For maximum switching currents please refer to Relay Figures E75017—E75021.

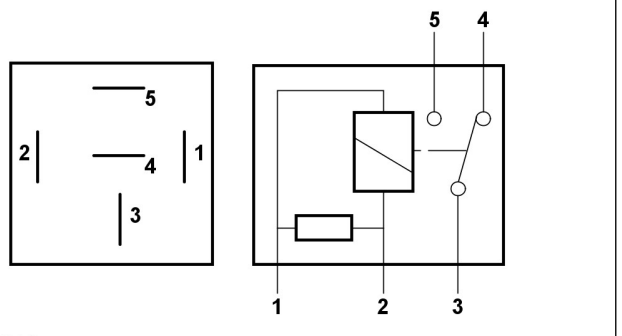
Micro Relay



E75017

Micro Relay Parameters	
Open contacts	20 Amps
Closed contacts	16 Amps
Nominal coil current	300 mA (max)
Medium current changeover relay - Part number: 6G9T-14B192-B*	
Medium current normally open relay - Part number: 6G9T-14B192-A* (pin 4 not present)	

Mini Relay



E75018

Mini Relay Parameters	
Normally open contacts	40 Amps
Normally closed contacts	20 Amps
Nominal coil current	300 mA (max)
Medium current changeover relay — Part number: 6G9T-14B192-D_	
Medium current normally open relay — Part number: 6G9T-14B192-C_ (pin 4 not present)	

4.17.3 Windscreen Wipers

The base wiper system should not be tampered with (controlled by BCM and multiplex architecture with LIN technology).

NOTE: Power to wiper motors is limited by the size of the wiring and associated relays. If any alternative wiper installation is made, it must have a specification equivalent to Ford components.

Refer to: 5.10 Glass, Frames and Mechanisms (page 259).

4.18 Special Conversions

4.18.1 Special Vehicle Options (SVO) Harnesses and Aftermarket Kits

WARNING: Only Ford release wiring should be used to support added vehicle functionality. If the implementation of wiring other than this is required, Ford guidelines must be followed.

NOTE: The Auxiliary Fuse Panel (A526) should be ordered

Refer to: 4.17 Fuses and Relays (page 172).
Refer to: 4.20 Grounding (page 206).

In addition to the Auxiliary Fuse Panel, a number of other kits are available to meet customer needs, see the 'Special Vehicle Option Harnesses and Aftermarket Kits' table.

Special Vehicle Option Harnesses and Aftermarket Kits

Part Number	Description
GK2V-14517-A*	Auxiliary Fuse Panel Harness LHD
GK3V-14517-C*	Auxiliary Fuse Panel Harness RHD
KTBK2V-14A411-A*	C1 Connector Jumper Harness (for Auxiliary Fuse Panel)
KTBK2V-14A411-B*	C2 Switch Connector Jumper Harness (for Auxiliary Fuse Panel)
KTGK2V-14A411-C*	Vehicle Interface Connector
KTBK2V-14A411-D*	High Specification Vehicle Interface Connector Jumper Harness
KTBK2V-14A411-F*	Utility Pack Connector Jumper Harness
KTBK2V-14A411-G*	Beacon Connector Jumper Harness
BK3V-10A933-B*	Beacon Preparation Pack Jumper Harness
GK3V-14659-B*	Beacon Preparation Pack LHD
GK3V-14659-C*	Beacon Preparation Pack RHD
GK3V-14659-D*	Utility Vehicle Switch Pack LHD
GK3V-14659-E*	Utility Vehicle Switch Pack RHD
GK3V-14649-N*	Beacon Preperation Pack LHD (Chassis Cab or Front Beacon Only)
GK3V-14649-P*	Beacon Preperation Pack RHD (Chassis Cab or Front Beacon Only)
GK2T-13B576-A*	Trailer Tow Jumper Harness (Connector A)^
BK3T-13B576-E*	Trailer Tow Socket Jumper FWD
BK3T-13B576-F*	Trailer Tow Socket Jumper RWD - Van, Kombi and Bus
BK3T-13B576-G*	Trailer Tow Socket Jumper - Chassis Cabs only
GK2T-19H378-A*	Trailer Tow Module
GK3T-14406-**	Fuel Tank Harness
GK3T-14401-**	Main Harness (Connectors B & C)^

^

Refer to: 4.1 Wiring Installation and Routing Guides (page 76).
Figure E185972 Trailer Tow Module Connectors

4.18.2 Additional Vehicle Signals/Features

WARNING: When interfacing with specific lighting high side driver outputs, additional supplemental signal access, relays and peripherals fitted, must be compatible with a Pulse Width Modulation (PWM) frequency of 200Hz.

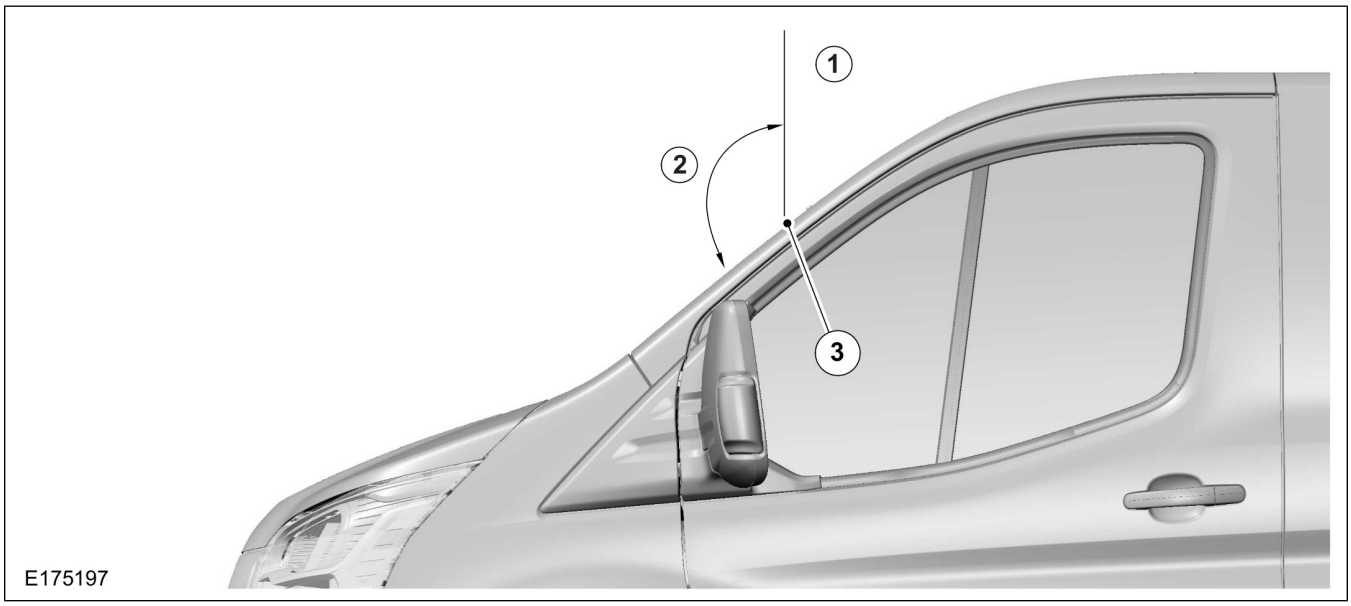
For list of lighting circuits that are PWM supplied:

Refer to: 4.2 Communications Network (page 90).
BCM Output Information table.

For additional information on lighting loads

Refer to: 4.12 Exterior Lighting (page 155).

4.18.3 Auto Wipe and Auto Light for vehicles with large overhangs



Item	Description
1	Zone 1 - Conversion or Installation rearward where Auto Light and Wipe feature will function correctly.
2	Zone 2 - Conversion or Installation forward (132°) where Auto Light and Wipe feature will NOT function correctly — The feature is not to be specified with the donor or configured OFF by the Ford dealer.
3	Auto sensor location.

NOTE: The Auto Wipe, Auto Light feature should not be ordered for vehicles that are to be built where the installation covers any part shown forward of the vehicle see figure E175197. This will affect the auto sensors ability to detect light or moisture to the defined calibration and will not function correctly.

In the event that a donor vehicle has been supplied with these features, the dealer can configure the vehicle to manual light and wipe with the following settings.

- Set Central Car Configuration parameter 24 – With Rain sensor to 01: (Without Rain Sensor)
- Parameter 88 for Auto Light should be set to 01: (Without Auto Lights)

It is also recommended that the Auto Light main switch is changed for a non auto switch. If not changed when selecting auto position (A), the dipped beam will remain on (due to a not valid condition) and the system will run in fail safe mode. Dipped beam will be operated at Ignition on and with Engine RUN. If the wiper is selected with the light switch in (A) the wiper will work as if intermittent mode has been selected. A Ford Dealer can help advise which switch should be ordered and fitted, starting with part number BM5T-13A024-** (depending on the specification of the vehicle).

4.19 Electrical Connectors and Connections

4.19.1 Connectors

Cutting into the Original Wiring System

WARNINGS:

Under no circumstances should the CAN Bus be tampered with. This may lead to failure of safety critical components such as Anti-Lock Brake System.

Do not use connectors which cut through the outer covering and into the core wire.

CAUTION: Only use Ford approved connectors.

NOTE: Ford approved jumper harnesses should be used.

It is not recommended to cut into vehicle wiring because:

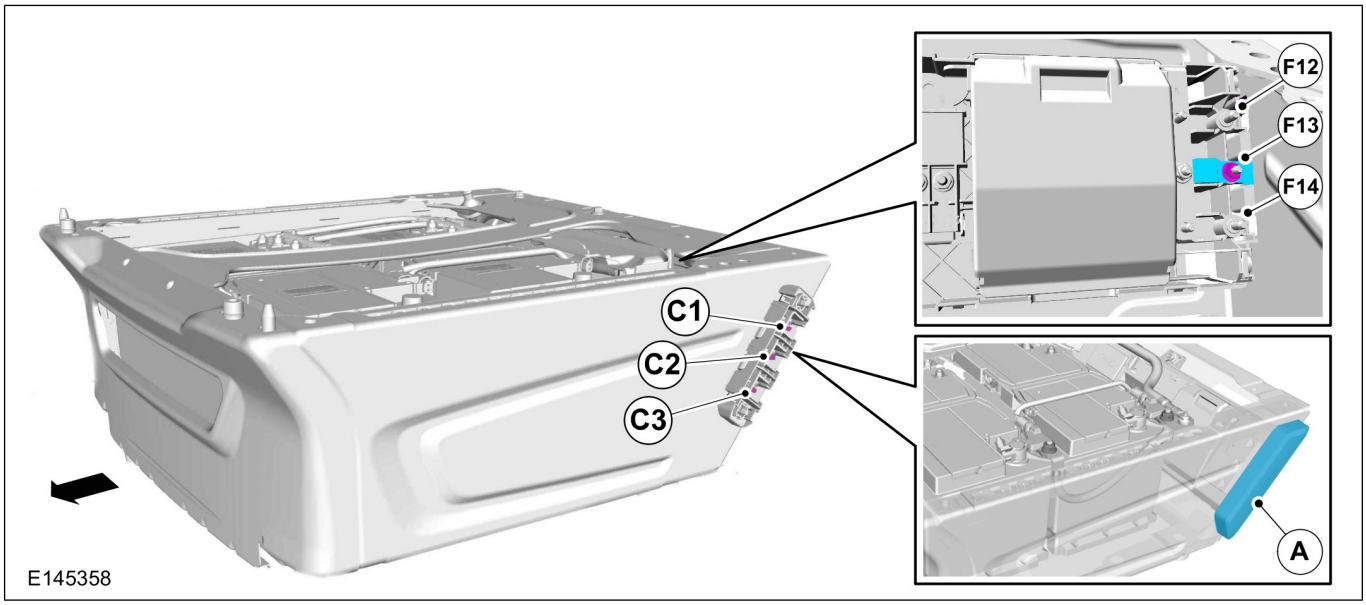
- The base vehicle specification is unsuitable for incremental loads except in conjunction with Special Vehicle Option (SVO) Auxiliary Fuse Panel or the High Specification Interface Connector.
- Long term risk of a faulty connection developing.
- Potential fire risk from over-loading.

All connections into existing wiring must be permanently insulated. Exterior connections must be water-proof and with a drip loop.

Where wires are required to be extended, break in points should only be at existing connector points. If splicing into existing wiring is unavoidable, see wiring splicing procedures in this manual.

Refer to: 4.1 Wiring Installation and Routing Guides (page 76).

4.19.2 Customer Connection Points (CCP) - Except Camper Vehicles



Battery/Batteries	F12	F13	F14	C1	C2	C3
Single Battery - Without Aux Fuse Panel	Spare	60A Fuse	Spare	Spare	CCP	Spare
Single Battery - With Aux Fuse Panel	60A Fuse	60A Fuse	60A Fuse	CCP	CCP	CCP
Twin Battery - Without Aux Fuse Panel	60A Fuse	60A Fuse	60A Fuse	CCP	CCP	CCP
Twin Battery - With Aux Fuse Panel	60A Fuse	60A Fuse	60A Fuse	CCP	CCP	CCP
A	Customer Connection Point Cover					

WARNING: Only use the Ford approved kit for adding fuses to the customer connection points.

CAUTION: When connecting to the customer connection points, it is recommended to disconnect the battery ground so as to avoid a short circuit. The fixing torque (M5) is 3.5–4.5 Nm.

NOTE: When fitting additional power wiring feeds the protective cover will need to be revised to allow routing for the extra wires. The cover is pre marked with the relevant areas so that they can be easily removed.

NOTE: There is a maximum of three customer connection points, each capable of supplying a max current of 60 Ampere (A). These points are always located on the driver's seat pedestal and are protected by a cover.

NOTE: Vehicles with Single Battery without Aux Fuse Panel will only have one customer connection points fitted, the remaining two can be used after fitting the customer connection point kit KTBK2T-14B475-A*.

NOTE: Camper vehicles have no pre-installed CCP. One can be used after fitting the CCP kit KTBK2T-14B475-A*; the other two are internally used and should not be touched.

Contact your local Ford dealer or National Sales Company representative for details of the kit.

E145358 shows the left hand drive situation. On a right hand drive vehicle the pre fuse box is rotated 180 degrees. Therefore C1/F12 will be at the bottom and C3/F14 at the top connections.

For High Current Supply and Ground Connections

Refer to: 4.4 Battery and Cables (page 102).

4.19.3 Camper Central Connectors

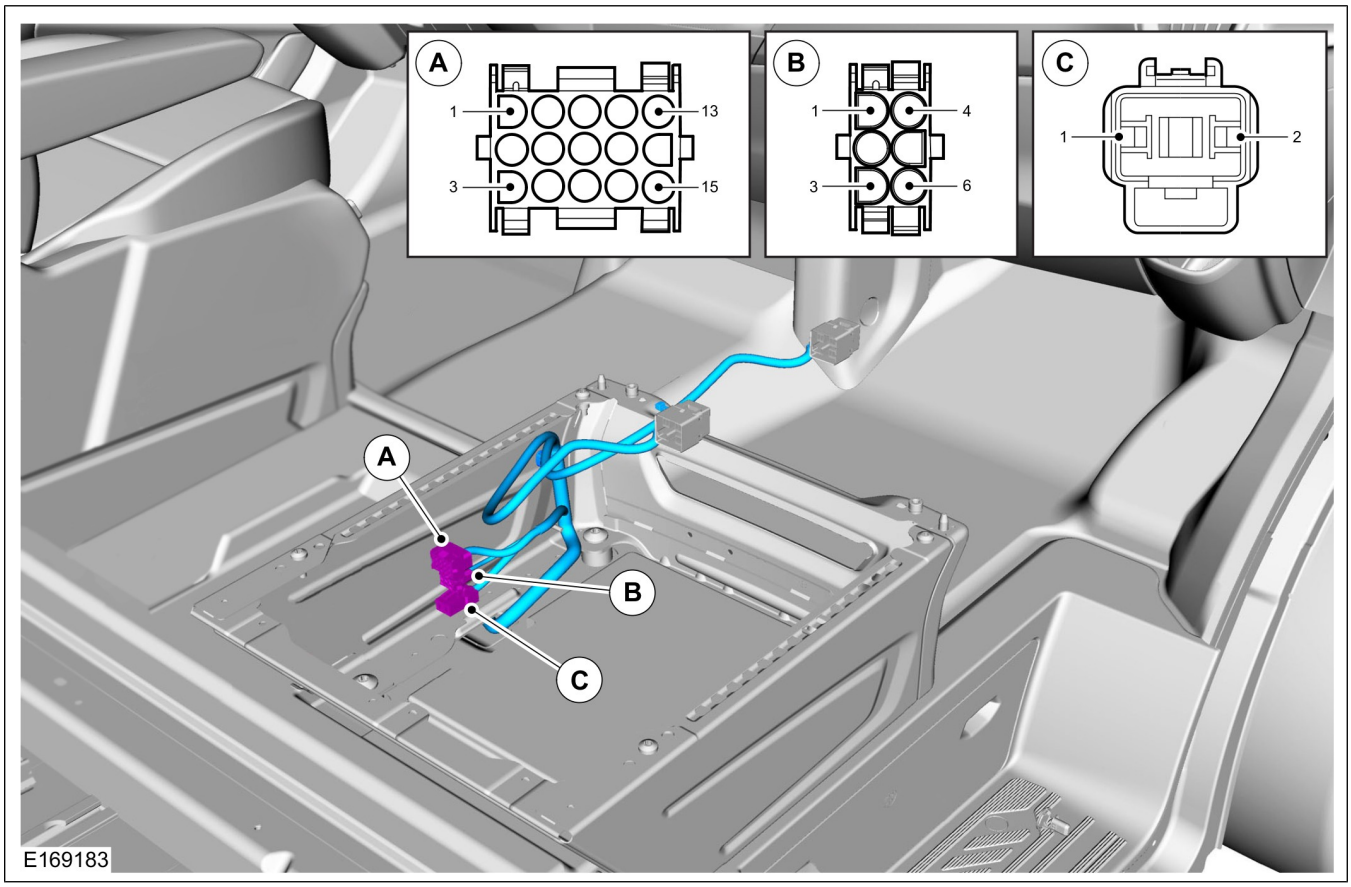
WARNING: If multiple systems are to use this supply, the total system load must not exceed the 60A short term loading.

NOTE: There is no supply (60A) from the Customer Connection Points on the drivers seat pedestal, instead there are dedicated Camper Connectors which are located in the passenger seat, see figure E169183. This includes a 60A supply and ground.

For additional information

Refer to: 4.1 Wiring Installation and Routing Guides (page 76).

Wiring Specification table for characteristics on continuous loads versus temperature.



Item	Description
A	C2-1 - 15 way connector (face view)
B	C2-2 - 6 way connector (face view)
C	C2-3 - KL30 connector (face view) 60A Fed from Pre Fuse Box + Ground

Tyco and Ford part numbers that are used for vehicle connectors, and suggested mating connectors.

Vehicle Connectors			Mating Connectors	
Connector	**Tyco Connector**	**Tyco Terminal**	**Tyco Connector**	**Tyco Terminal**
15 way (C2-1)	0-926647-1	926882-1 (socket)	1-480710-0	926883-1 (pin)
6 way (C2-2)	0-480705-0	926882-1 (socket)	1-480704-0	926883-1 (pin)
Connector	**MTA Connector**	**MTA Terminal**	**MTA Connector**	**MTA Terminal**
2 way (C2-3)	44.40400	11.07658	44.40300	17.07660

Pin	Function	Wire CSA	Color	Comments
Connector C2-1 (Figure E169183 - Item A)				
1	Stop lamp (CHMSL)	0.5	Yellow/Grey	PWM +12V 16W max (LED recommended)
2	Engine Run	0.5	Brown/Yellow	300mA, Ground switched output when engine running
3	Vehicle Speed Output	0.75	Violet/Orange	138Hz@100KPH, 50% duty cycle
4	Interior Lock Switch Input^	0.5	Grey/Yellow	Lock switch - Momentary signal to ground
5	Interior Unlock Switch Input^	0.5	Violet/Grey	Unlock switch - Momentary signal to ground
6	Rear Door Ajar	0.5	Brown/Violet	Local switch to ground (Circuit Closed = Door Closed)
7	Interior light feed^^	0.5	Green/Violet	+12V 300mA max
8	Auto Trans Output - PARK	0.5	Grey/Brown	160mA Ground switched (100 Ohm min external resistance. Logic sense only - NOT suitable for standard relays)
9	Lock Motor Output^	1.0	Grey/Brown	+12V 15A Total load for vehicle including all latches (~3A per latch)
10	Unlock Motor Output^	1.0	Violet/Grey RHD White/Orange LHD	+12V 15A Total load for vehicle including all latches (~3A per latch)
11	Courtesy Light Dimming High Side Rear	0.75	White/Blue	PWM +12V 5A max including all existing rear interior lights
12	Auto Trans Output - NEUTRAL	0.5	Green/White	160mA Ground switched (100 Ohm min external resistance. Logic sense only - NOT suitable for standard relays)
13	Ignition (KL15)	0.75	Grey/Yellow	10A/F21 (SRB)
14	SRC/Start-Stop Inhibitor	0.5	Violet/Grey	Grounded = SRC/Start-Stop disabled
15	Reverse signal	0.75	Green/Brown	+12V 300mA max
Connector C2-2 (Figure E169183 - Item B)				
1	Not used			
2	Rear Speaker Left +	1.5	White/Green	Twisted pair
3	Rear Speaker Left -	1.5	Brown/Yellow	
4	Rear Speaker Right +	1.5	Brown/White	twisted pair
5	Rear Speaker Right -	1.5	Brown/Blue	
6	Instrument Panel Illumination^^^	0.5	Brown	PWM +12V 300mA (nominal)
Connector C2-3 (Figure E169183 - Item C)				
1 (A)	B+ (KL30)	6.0	Yellow	60A Fed from Pre Fuse Box
2 (B)	B-	6.0	Black/Grey	Ground

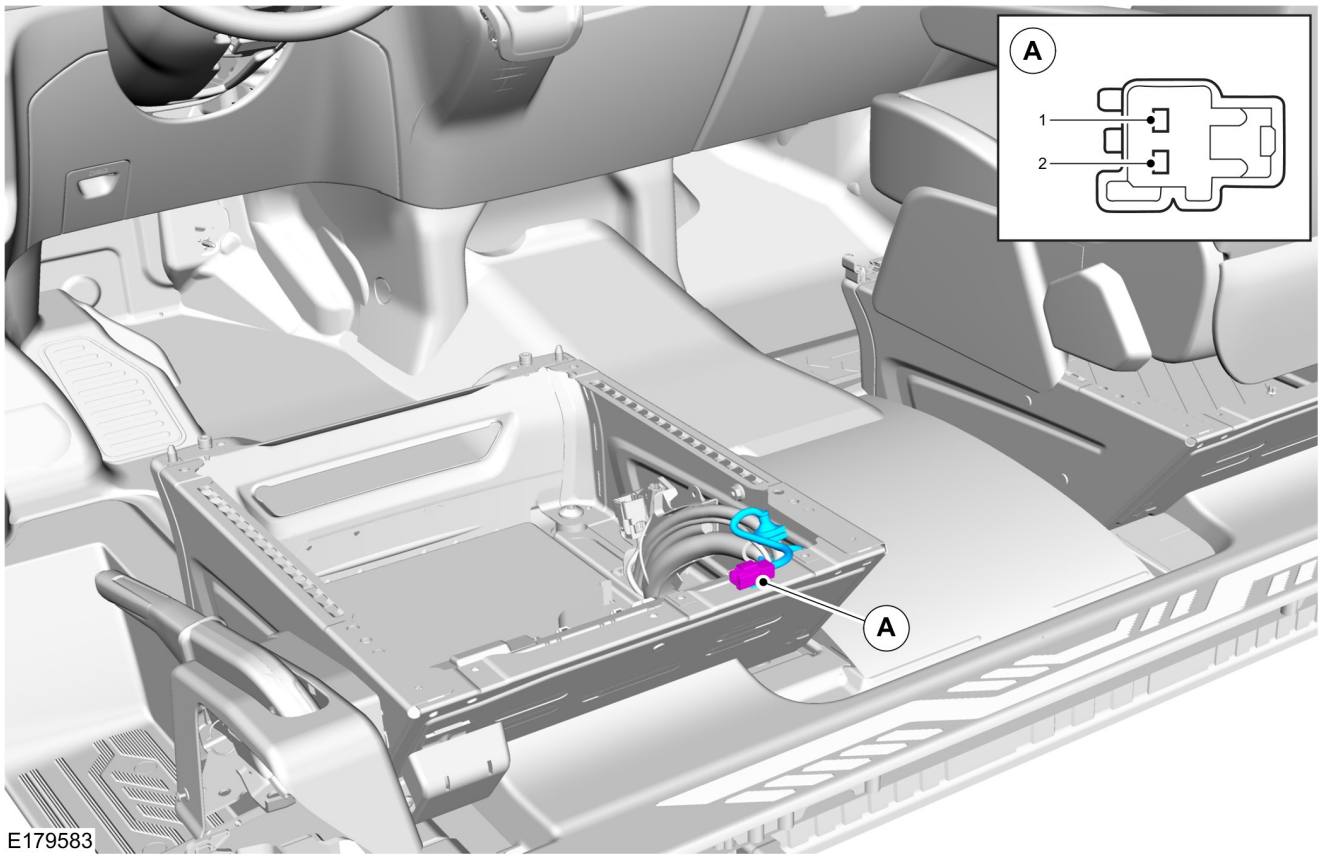
^ The lock and unlock signals are intended to operate with Ford lock sets, or components with equivalent function and operational characteristics: – Central Locking and unlocking are a 120ms high side pulse. There is no double locking available via this connector.

^^ Interior light feed is a high side output used for demand lighting. It is battery saver timed to switch off after 30 minutes. Do not use this high demand load which will re-energize every time the door is opened.

^^^ Pulse Width Modulation (PWM) output optimised for LED switch back lighting & dimmable when vehicle has I.P. dimmer fitted. Do not fit relays to this output.

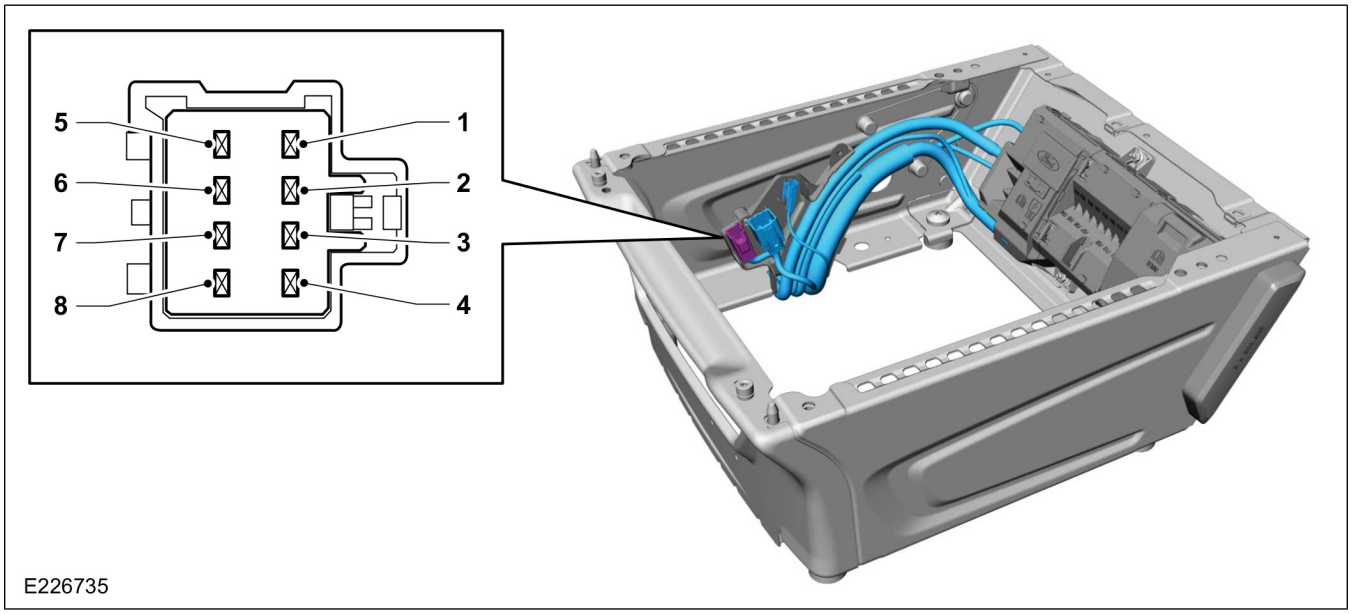
Note: There are no additional ground wires in either C2-1 or C2-2 auxiliary devices and systems; local grounds should be used.

4.19.4 Drivers Swivel Seat



Drivers Swivel Seat Sensor Seat Buckle - 2 Way Connector (Figure E169183 item A)				
Pin	**Function**	**Wire CSA**	**Color**	**Comments**
1	Central Module - Sensor Seat Belt Buckle	0.5	Black/Grey	-
2	Sensor Seat Belt Buckle - Front Drivers Side	0.5	Green/Blue	-

4.19.5 Vehicle Interface Connector



Item	Description
1	Ground
2	Engine Run
3	SRC Inhibit (Start Stop disabled)
4	Not used
5	Vehicle Speed
6	Ignition
7	IP Switch Illumination
8	Ford Programmable Battery Guard

The Vehicle Interface Connector provides a direct interface to signals. See figure E226735 for location

WARNINGS:

Signals 3, 5 and 7 on the Vehicle Interface Connector are for sensing purposes only and not to be loaded by high current consumers. The max current rating for signal 6 is 10A and not to be exceeded in any situation, this includes the total of the Ford System and Third Party System requirements.

Unused wires in the service kit must have cable ends insulated to avoid shorting on any ground points.

A service kit (KTGK2V-14A411-C*) can be ordered from your local Ford Dealer, the kit contains the mating connector (4S7T-14489-VH*) to access these signals, and 3 meters of wiring.

When the Auxiliary Fuse Panel is fitted to the vehicle, the Interface Connector is occupied by the attached wiring harness. In this case these signals and some additional features are available through the C1 connector. For more details refer to Auxiliary Fuse Panel section.

Vehicle Speed

Square Wave Characteristics

Specifications	
Max High Signal	Battery Voltage
Min High Signal	3.67 Volts
Max Low Signal	1.1 Volts
Min Low Signal	- 1.1 Volts
Max Ground Offset	+/- 1.0 Volts
Rise Time	10µ sec <= tr <= 250µ sec
Fall Time	10µ sec <= tf <= 250µ sec
Duty Cycle	50% +/- 10%
Pulse Rate	2.2 Hz/MPH (1.3808 Hz/KPH)

WARNING: Do not interface with the CAN (Controller Area Network) for vehicle speed.

Pin 5 - Vehicle Speed signal is a direct current coupled square wave that varies in frequency in proportion to vehicle speed. This provides a square wave-form (50% duty cycle) signal, where a frequency of 138Hz equates to 100km/h.

Ignition

Pin 6 - Ignition signal is protected by a 10A fuse. It is +12V active at ignition positions: Accessory (1) and Run (2). It is not active at Ignition OFF (0) or Crank (3). Whilst it can drive equipment directly it is recommended to use this feed to control a converter fitted relay, especially for high current applications.

Switch Illumination

Pin 7 - Switch Illumination signal is only to be used for sensing or to control a relay. It is a PWM signal only for low current illumination 300mA max, that can be dimmed and not to drive a relay.

Engine Run

WARNING: Do not cut into the alternator wires or use the alternator as a source to obtain a 'D+ Signal'.

Pin 2 - Engine Run signal will only support a sense line or relay control.

This engine run signal is ground switching (max current sink 250mA), it provides no positive output (open circuit) and is only active when the engine is running regardless of vehicle variant, for example Start-Stop or SRC.

The signal will not be present when:

- Key states - OFF (0), Accessory (1), Run but Engine OFF (2), Crank (3).
- Key in Run position, where Start-Stop vehicle has auto stopped the engine.
- Engine running but load is greater than 250mA (driving two or more relays in error).

Due to Start-Stop vehicles, the signal may switch up to 300,000 times. Provision is required for control relays switched by this signal to meet this durability cycle.

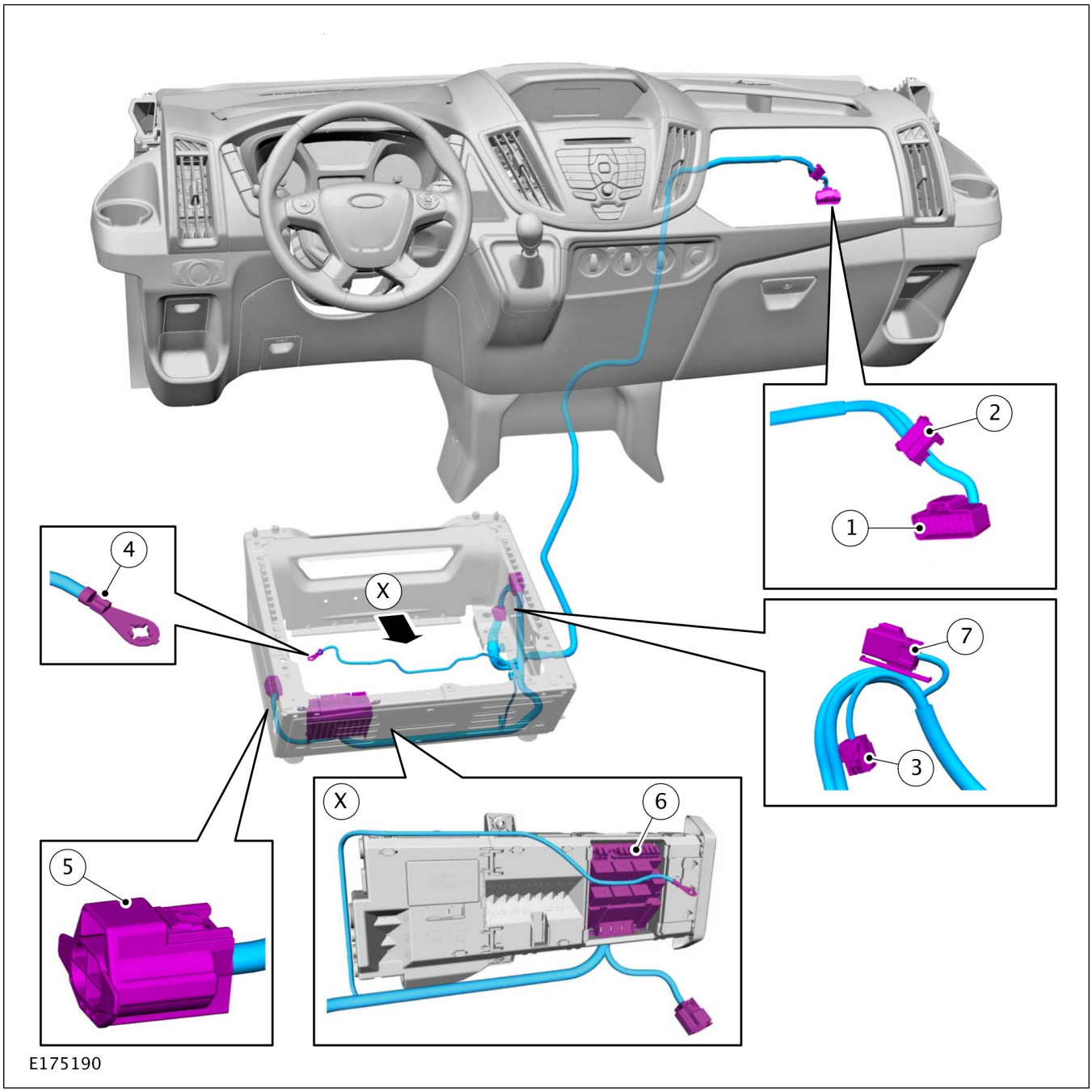
The fitment of the Auxiliary Fuse Panel will provide a power +12V side for the relay (although connection to the engine run pin is still required). This allows up to 15A output on the C1 connector with the manual demand switch Aux 2, see SVO Auxiliary Fuse Panel circuit diagram later in this section

If a positive (+12V) engine run signal is required, it can be done by using the switched ground to control an ignition fed relay, to give this output.

4.19.6 Auxiliary Fuse Panel (A526)

The Auxiliary Fuse Panel is recommended for vehicle converters where access to fused power connections are required (for example, additional lighting), see figures E175190 and E175191. A dedicated wiring harness (BK2V-14517-A* for left hand drive and BK3V-14517-C* for right hand drive) is used to implement the Auxiliary Fuse Panel to the vehicle. This fuse panel is located within the drivers seat pedestal as part of the Pre Fuse Box (PFB). The Auxiliary Fuse Panel uses the Vehicle Interface, shown in figure E226735 and provides an advanced customer access point (C1) connector as well as a (C2) interface connector to further switch installations and a power and ground supply.

Auxiliary Fuse Panel (A526) - Left Hand Drive

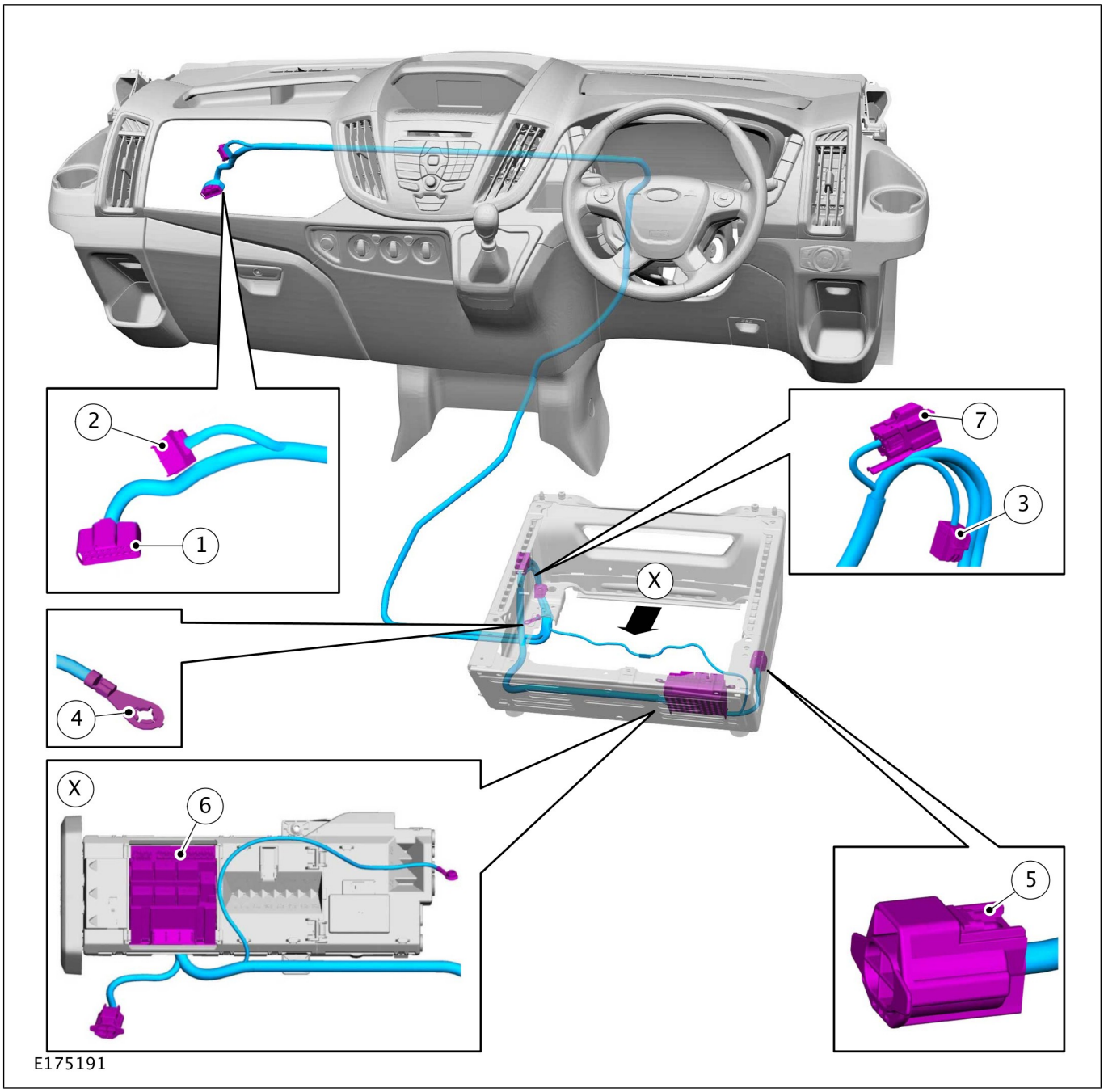


E175190

Item	Description
1	C1 Connector
2	C2 Switch Connector
3	Vehicle Interface Connector 1
4	Ground
5	C3 — 2 Way Radio Connector
6	Auxiliary Fuse Panel within the Pre-Fuse Box (lid not shown)
7	Vehicle Interface Connector 2*

* Only suitable to be used with Ford Programmable Battery Guard (A540). No other connections to be made via this connector.

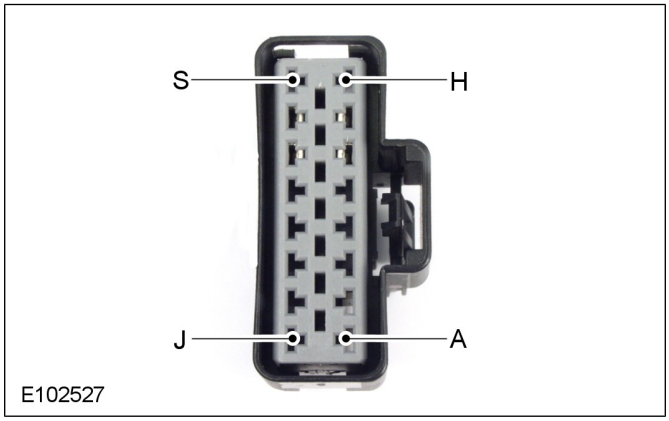
Auxiliary Fuse Panel (A526)- Right Hand Drive



Item	Description
1	C1 Connector
2	C2 Switch Connector
3	Vehicle Interface Connector 1
4	Ground
5	C3 — 2 Way Radio Connector
6	Auxiliary Fuse Panel within the Pre-Fuse Box (lid not shown)
7	Vehicle Interface Connector 2*

* Only suitable to be used with Ford Programmable Battery Guard (A540). No other connections to be made via this connector.

C1 Connector

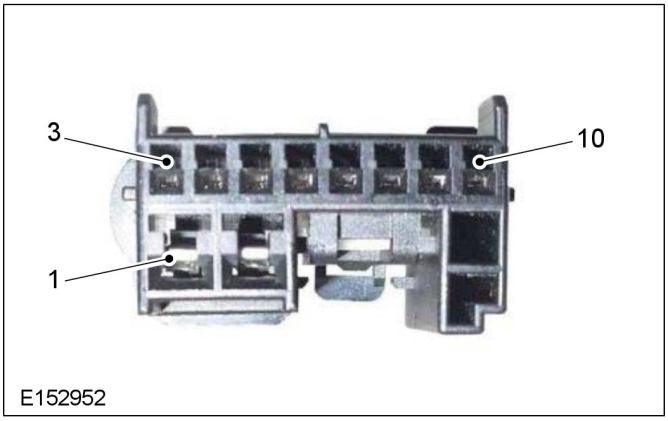


E102527

Item	Description
A	Relay 2 Output (5A)
B	Relay 7 Coil OUT
C	Relay 7 Coil IN
D	Relay 7 Output (10A)
E	Ground
F	Relay 6 Coil IN
G	Relay 5 Coil IN A
H	Relay 3 Output 1 (15A - F5 Fuse Shared)
J	Relay 2 Output 2 (15A)
K	KL30 20A
L	Relay 4 Output (15A)
M	KL15 Ignition Switch
N	Relay 2 Coil IN A
P	Relay 6 Output (15A - F7 Fuse Shared)
R	Relay 5 Output (15A - F7 Fuse Shared)
S	Vehicle Speed Signal

The C1 connector is a major interface to the vehicle, providing various signals and control circuits. It is wired to the Auxiliary Fuse Panel, see figures E175190 and E175191. The mating connector for the C1 is DELPHI 15326956. The fuse ratings, relays and circuits are shown in figure E152950 and table. A service kit (KTBK2V-14A411-A*) can be ordered from your local Ford dealer, this kit contains the mating connector, and 3 meters of wiring.

C2 Switch Connector

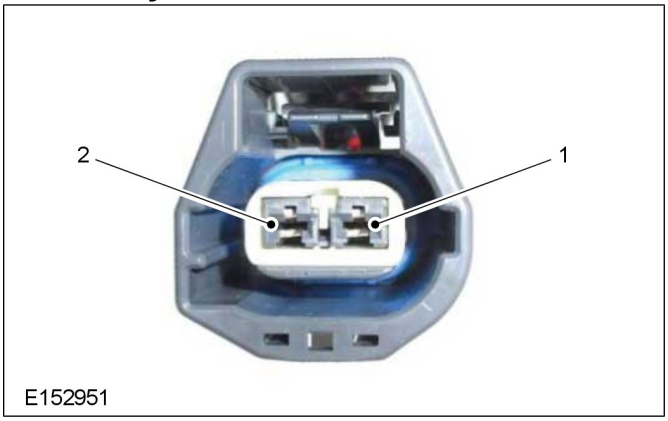


E152952

Item	Description
1	Relay 1 Output (20A)
2	Ground
3	Switch Illumination Supply
4	Relay 3 Coil IN
5	Relay 4 Coil IN
6	Relay 1 Coil IN
7	Relay 3 Output 2 (F5 Fuse Shared)
8	Relay 2 Coil IN B
9	KL30 (3A)
10	Relay 5 Coil IN B

C2 Mating Kit — KTBK2V-14A411-B*

C3 - 2 Way Radio Connector

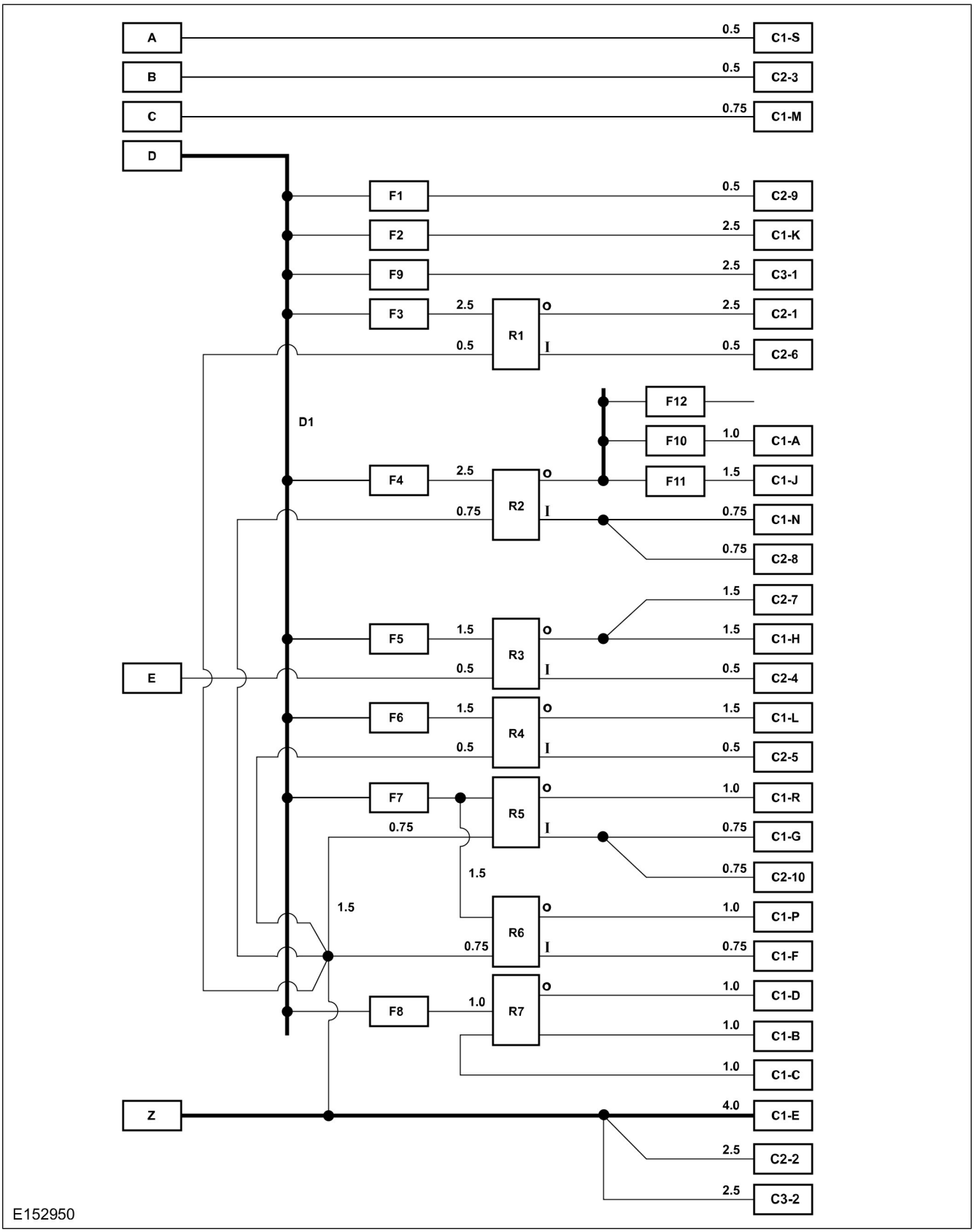


E152951

Item	Description
1	KL30 20A
2	Ground

C3 Mating Connector - 6S6T-14A459-HK*

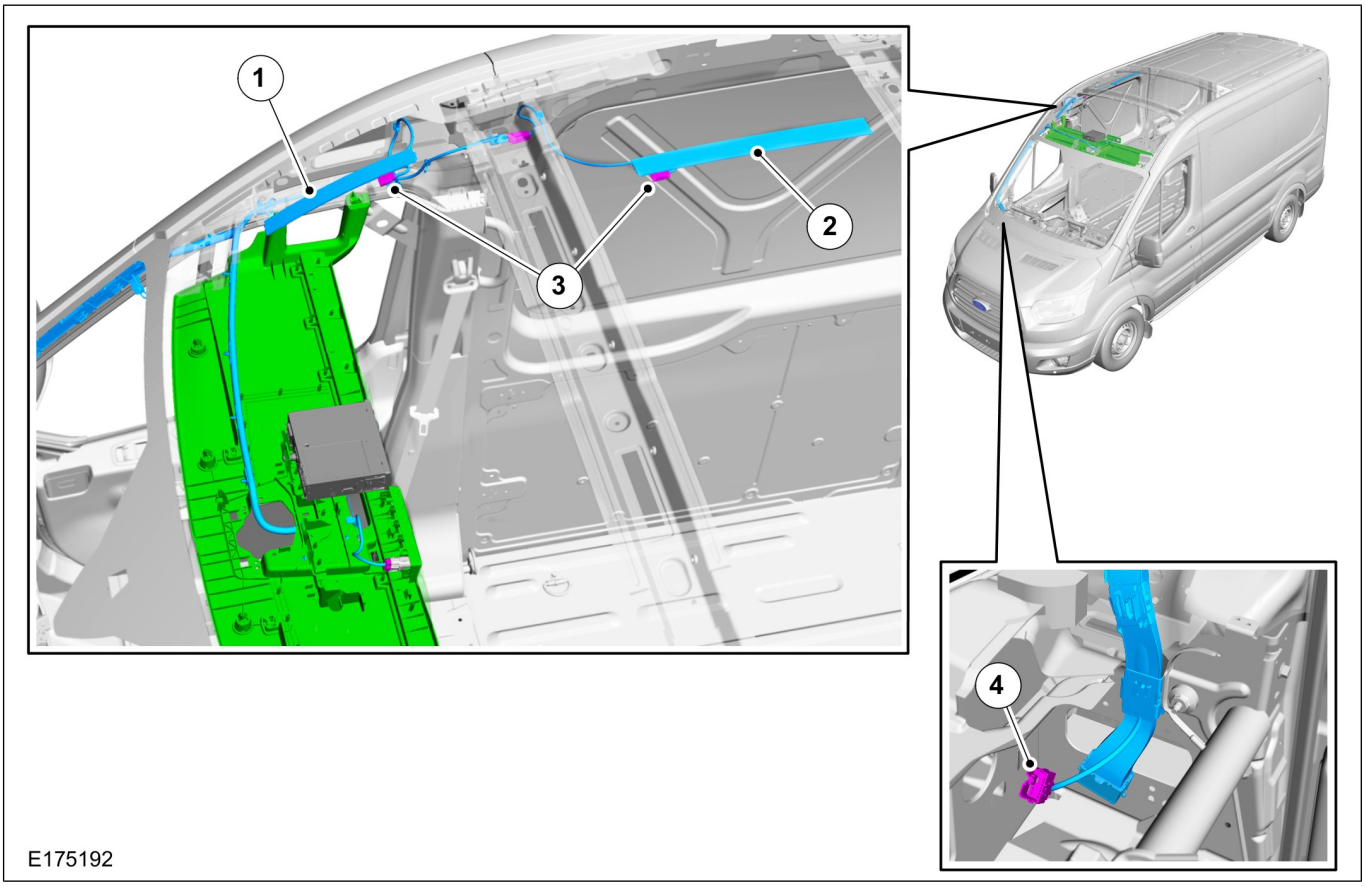
Auxiliary Fuse Panel Circuit Diagram



Item	Description	Item	Description
A	Vehicle Speed	C1-B	R7 Coil OUT
B	Switch Illumination	C1-C	R7 Coil IN
C	Ignition Switch	C1-D	R7 Output
D	KL30	C1-E	Ground
E	Engine Run Signal - Ground	C1-F	R6 Coil IN
D1	Busbar	C1-G	R5 Coil IN A
Z	B-	C1-H	R3 Output 1
F1	3A Fuse	C1-J	R2 Output 2
F2	20A Fuse	C1-K	KL30
F3	20A Fuse	C1-L	R4 Output
F4	20A Fuse	C1-M	Ignition Signal / KL15
F5	15A Fuse	C1-N	R2 Coil IN A
F6	15A Fuse	C1-P	R6 Output
F7	15A Fuse	C1-R	R5 Output
F8	10A Fuse	C1-S	Vehicle Speed
F9	20A Fuse	C2-1	R1 Output
F10	5A Fuse	C2-2	Ground
F11	15A Fuse	C2-3	Switch Illumination
F12	Not Used	C2-4	R3 Coil IN
R1	20A Relay (Beacon^)	C2-5	R4 Coil IN
R2	20A Relay (Ignition^)	C2-6	R1 Coil IN
R3	20A Relay (Aux 2/Water Heater^)	C2-7	R3 Output 2
R4	20A Relay	C2-8	R2 Coil IN B
R5	20A Relay (LHS Indicator/Aux 1^)	C2-9	KL30
R6	20A Relay (RHS Indicator^)	C2-10	R5 Coil IN B
R7	20A relay	C3-1	KL30
C1- A	R2 Output 1	C3-2	Ground

^When specified on Ford options

4.19.7 Beacon Preparation Pack (A606)



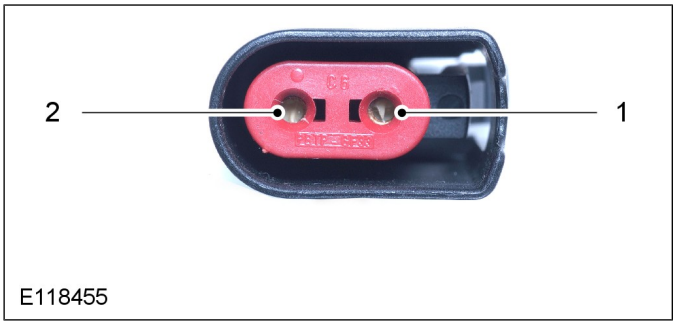
Item	Description
1	Front Beacon Harness LHD BK3V-14659-B* (shown) and RHD BK3V-14659-C*
2	Rear Beacon Harness on BK3V-10A933-B*
3	Front and Rear Beacon Connectors
4	C2 Mating Connector

Figure E176192 shows the routing for front and rear beacon wiring installations and location of connectors for the beacons, which should be viewed in conjunction with the fitment of the beacon switch, BK2V-13D768-A* , see figures E175194 and E175195 for Switches and see figure E152950 for Auxiliary Fuse Panel Circuit Diagram, shown in this section.

The beacon wiring circuit is fused at 20A. Any increase in this current demand should be met with the use of an external relay.

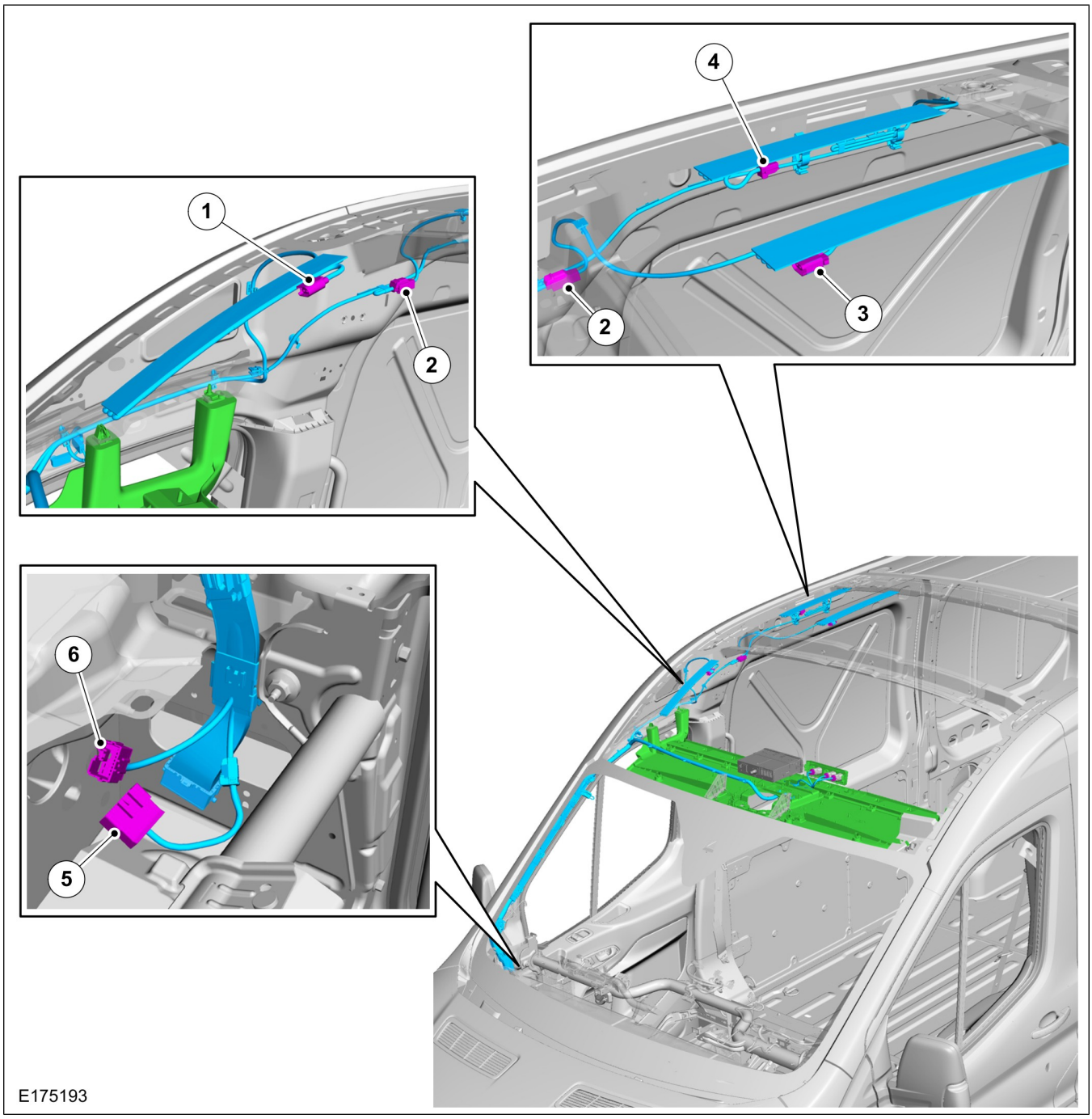
Contact your National Sales Company representative or Local Ford Dealer for availability and options.

Beacon Connector - Front and Rear



Item	Description
1	Ground
2	Beacon Supply

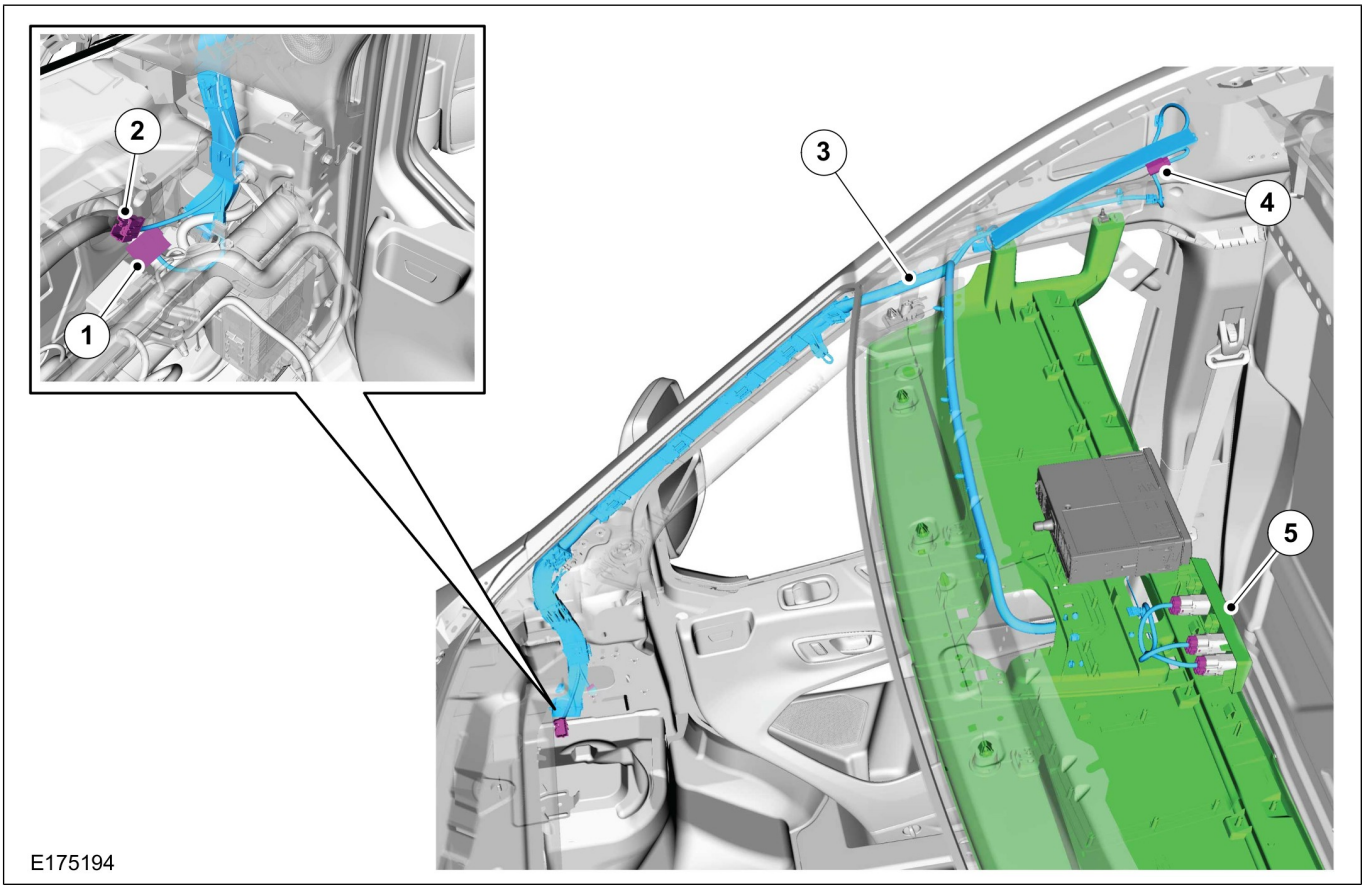
4.19.8 Utility Vehicle Switch Pack (A607) - Left Hand Drive Shown



Item	Description
1	Front Beacon Connector
2	In-line Connector for Rear Beacon Harness
3	Rear Beacon Connector
4	Aux 2 Connector
5	C1 Mating Connector
6	C2 Mating Connector

The Utility Vehicle Switch Pack harness is always on the passenger side of the vehicle and connects via the C1 and C2 mating connectors into the C1 and C2 connectors. See figure E152950 for Auxiliary Fuse Panel, shown in this section.

4.19.9 Auxiliary Switches



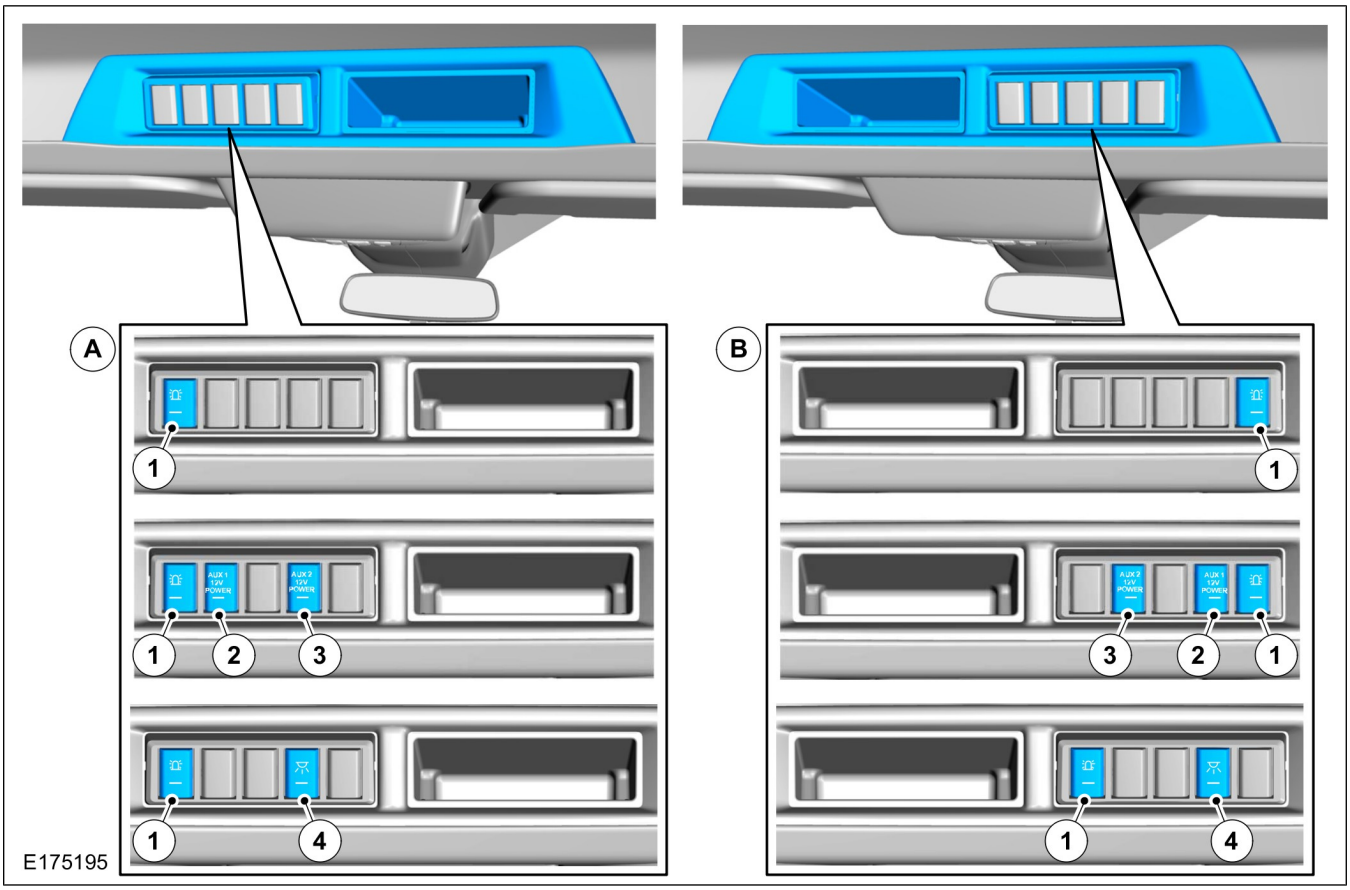
Item	Description
1	C1 Mating Connector
2	C2 Mating Connector
3	Utility Vehicle Switch Pack Front Harness
4	Front Beacon Connector
5	Over Head Console - Containing Switches

There are a combination of switch packs available to order for specific conversions. The 'Beacon Preparation Pack' or 'Utility Vehicle Switch Pack' are high current latched switches that control relays in the Auxiliary Fuse Panel. When the switches are pressed (light on) the switches provide a +12V/20A output.

NOTE: The Aux 2 switch must have the engine running before it will give an output. The output will be switched off during an engine auto-off (Start-Stop vehicle). The other switches (Beacons and Aux 1) are fed directly from the battery. It is important to switch these off when not required, as the battery charge level will be depleted.

If heavy loads are required, controlled via these switches (especially at engine off) it is recommended to install the High Performance Deep Cycle AGM battery option (A738). The switches are illuminated red when the lights are: side, dipped, full beam or auto lights on. They switch +12V and can switch up to 8A directly.

Switch Locations



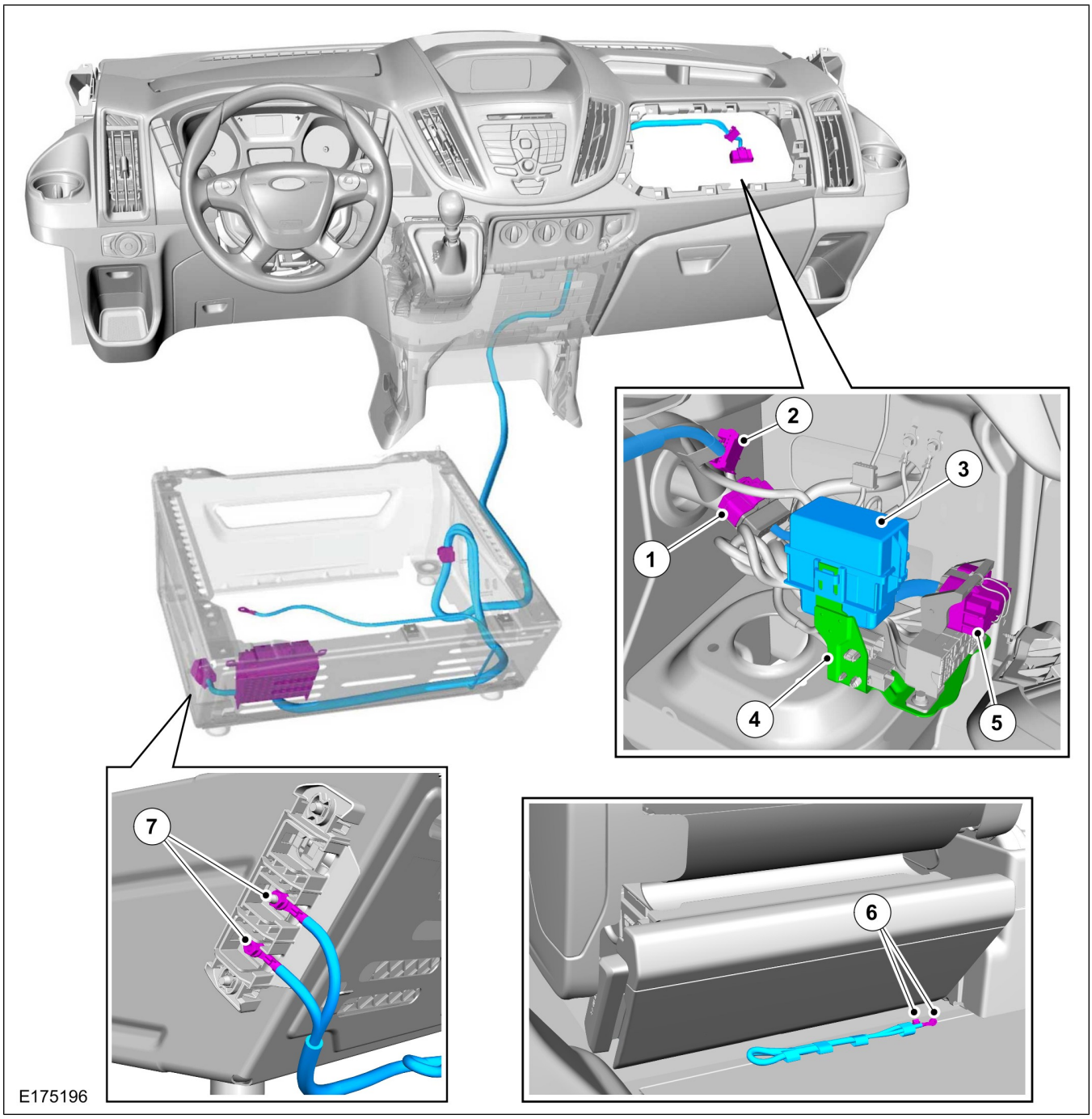
Item	Description
A	Left Hand Drive Switch options
B	Right Hand Drive Switch options
1	Beacon
2	Aux 1 — Part of Utility Vehicle Switch Pack (A607)
3	Aux 2 — Part of Utility Vehicle Switch Pack (A607)
4	Interior Light Switch - M2 Bus with Beacon Prep Pack (A606)

Switches and Harness Part Numbers

Harness	Beacon -BK2V-13D768-A*	Aux 1 (12V)	Aux 2 (12V)	Interior Light
GK3V-14659-B*	LHD Van,Bus,Kombi	-	-	-
GK3V-14659-N*	LHD Chassis Cab Only	-	-	-
GK3V-14659-C*	RHD Van,Bus,Kombi	-	-	-
GK3V-14659-P*	RHD Chassis Cab Only	-	-	-
GK3V-14659-D*	LHD Utllity Pack - Except Chasis Cabs	BK2V-13D734-A*	BK2V-13D734-B*	-
GK3V-14659-E*	RHD Utility Pack - Except Chassis Cabs	BK2V-13D734-A*	BK2V-13D734-B*	-
GK3V-14659-B* see note	LHD BK2V-13D768-A*	-	-	BK3V-13D756-B*
GK3V-14659-C* see note	RHD BK2V-13D768-A*	-	-	BK3V-13D756-B*

Note: If Beacons are required on an M2 Bus then BK3V-V045L70-B* must be ordered instead of BK2V-V045L70-A* or BK2V-V045L70-D* and fitted in place of the Interior Light Switch Assembly supplied with the vehicle. GK3V-14659-B*or GK3V-14659-C* will still be needed to supply the Beacon Switch. The Interior Lighting Switch Loom is provided on all M2 Buses. For switch location see figure E175195 item 4.

4.19.10 High Specification Vehicle Interface Connector (A608)



Item	Description
1	C1 Connector
2	C2 Connector
3	Fuse Box
4	Fuse Box Bracket
5	High Specification Vehicle Interface Connector
6	Connectors are taped back on the harness under the carpet, behind the drivers seat pedestal
7	60A fuse connections on drivers seat pedestal - final installation completed by vehicle convertor

The standard system includes the Auxiliary Fuse Panel and a Supplementary Fuse Box, it is powered by two fuses from the Customer Connection Points at the driver's seat pedestal. The Ford production fit location of these feeds are under the carpet at the rear of the drivers seat pedestal, see figure E175196 - item 6 and they need to be installed by the Converter as shown in figure E175196 -item 7. Therefore on these high-specification vehicles there will only be one remaining customer connection point available for customer to use. See also Fuse Rating table.

The High Specification Vehicle Interface Connector (43 way connector), see E145357, is an order only option (A608) for production fit and can not be updated after the vehicle is built. The connector is located behind the glove box as shown in E175196. It provides access to multiple signals, power and ground. These signals include those required for Police /Emergency Service conversions. The part numbers of the dedicated harnesses are BK2V-14401-A*/D* and BK2V-14K024-A*/D*.

A standard mating connector, with only a link wire between cavity 36 and 39, is provide (no other wires). A mating 43 way connector with three meters of wiring (with all wires) is available as a kit (KTBK2V-14A411-D*) from your local Ford dealer.

WARNING: This link wire provides a 'no start function'. If the connection becomes 'Open Circuit' by removing the mating connector or link wire the vehicle will not Crank/Start.



E145357

High Specification Vehicle Interface Connector

Cavity	Wire	Signal	Comments	Fuse	Fuse Rating	Nominal Rating
1	2.00	KL58	Licence Plate Supply	-	-	-
2	2.50	KL31-20A max.	Ground	17	20A	16A
3	2.50	KL31-20A max.	Ground	13	20A	16A
4	2.50	KL31-20A max.	Ground	14	20A	16A
5	2.50	KL31-20A max.	Ground	15	20A	16A
6	2.50	KL31-20A max.	Ground	16	20A	16A
7	1.00	KL30	Battery Supply	1	10A	8A
8	0.50	KL30	Battery Supply	2	5A	4A
9	1.00	KL30 1 Standard	Battery Supply	3	15A	12A
10	1.00	KL30 2 Standard	Battery Supply	4	15A	12A
11	1.00	KL30 3 Standard	Battery Supply	5	10A	8A
12	1.00	KL30	Battery Supply	6	7.5A	6A
13	1.00	KL30	Battery Supply	7	10A	8A
14	0.75	KL30	Battery Supply	8	7.5A	6A
15	1.00	KL15	Ignition	9	5A	4A
16	0.75	KL15 Standard	Ignition	10	5A	4A
17	0.75	KL15	Ignition	11	10A	8A
18	1.00	KL15	Ignition	12	5A	4A
19	-	Rear Door Ajar Switch	Ground = Door Open	-	-	-
20	0.75	IP+Switch Illumination	Pulse Width Modulation Signal from BCM	-	-	300mA
21	-	Not Used	-	-	-	-
22	0.75	Stop Lamp Signal	C = 13VDC>PWD Signal from BCM	-	-	3A
23	0.50	SRC/Start-Stop Inhibit	Ground = SRC/Start-Stop deactivated. Not available until 2013	-	-	-
24	0.50	LHS Sliding Door Ajar	Door Open = Ground (<50 ohms)	-	-	NA
25	0.50	Passenger Door Ajar	Door Closed = Ground (<50 ohms)			NA
26	0.50	Parking Lights	Pulse Width Modulation Signal from BCM	-	-	300mA
27	0.50	RHS Sliding Door Ajar	Door Open = Ground (<50 ohms)	-	-	NA
28	1.00	Turn Indicator LHS	Fuse and Relay located in Aux Fuse Panel in seat pedestal	-	-	12A
29	1.00	Turn Indicator RHS		-	-	
30	0.50	Horn Signal	Relay Output from Smart Relay Box 1	-	-	300mA
31	0.75	Vehicle Speed	To be used as input to Electronic Control Units only	-	-	NA
32	0.75	Reverse Signal	Pulse Width Modulation Signal from BCM	-	-	300mA
33	0.75	High Beam	Output from BCM	-	-	300mA
34	0.75	Low Beam	Output from BCM	-	-	300mA
35	0.75	Fog Lamps (Front)	Output from BCM	-	-	300mA
36	0.50	KL50	Bridged with 39 - Open Circuit will inhibit Crank ^	-	-	300mA
37	0.50	Handbrake Signal	Handbrake Activated = Ground (<50 ohms)	-	-	NA
38	0.50	Engine Run	Engine Running = Ground(<50 ohms)	-	-	NA
39	0.50	No Start Function	Bridged with 36 - Open Circuit will inhibit Crank ^	-	-	NA
40	1.00	Key in ^^	Key In = 12V	-	-	30mA

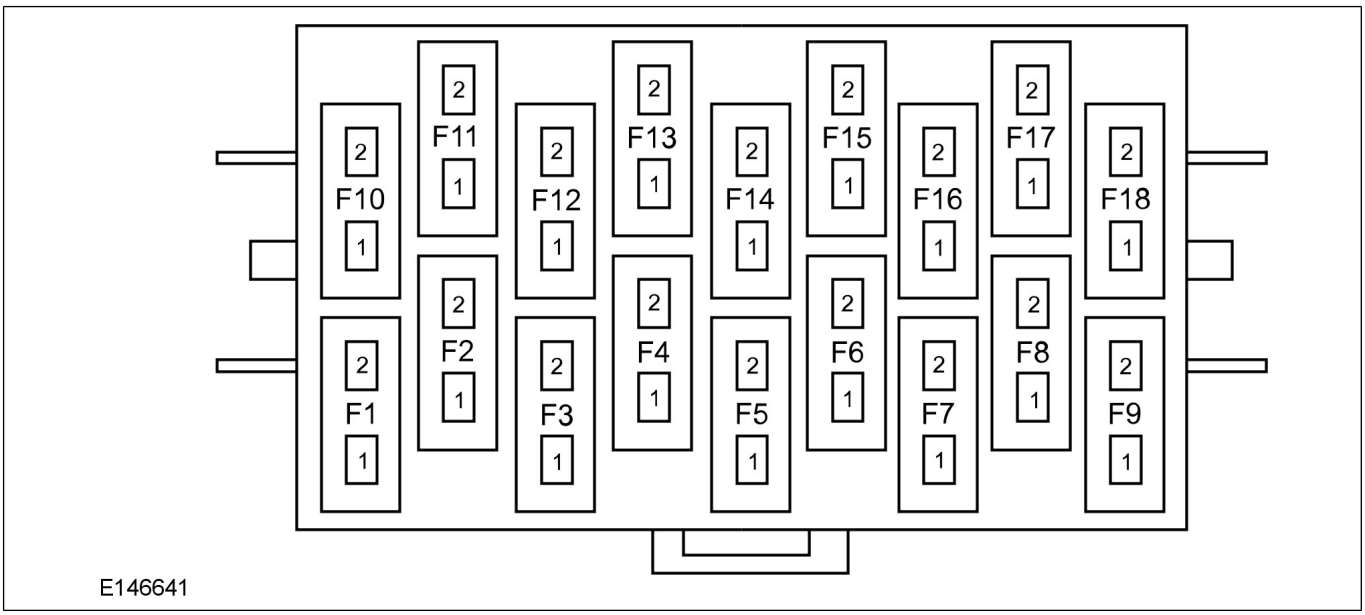
Cavity	Wire	Signal	Comments	Fuse	Fuse Rating	Nominal Rating
41	0.50	Driver Door Ajar	Door Closed = Ground (<50 ohms)	-	-	NA
42	0.50	Lock	Lock Request = Ground 500mS	-	-	NA
43	0.50	Unlock	Unlock Request = Ground 500mS	-	-	NA

^ Bridged via circuit on mating connector to enable crank/start. If mating connector is removed, vehicle will not start

^^ Ignition switch 3M5T-11572-A* is required for key in signal.

KL Terminology	
KL15	Ignition - Position 2
KL30	B+ (Always +12V)
KL31	Chassis or Body Ground
KL50	Crank/Start Position 3
KL58	Side Marker and Licence Plate Lighting
KL75	Accessory - Position 1

Supplementary Fuse Box - for High Specification Interface Connector



Fuse Ratings

Fuse	Type	Rating (A)	Color	Function	Part Number
F1	Mini	10	Red	Battery KL30	1L3T-14A094-F*
F2	Mini	5	Tan	Battery KL30	1L3T-14A094-D*
F3	Mini	15	Blue	Battery KL30 STD	1L3T-14A094-G*
F4	Mini	15	Blue	Battery KL30 STD	1L3T-14A094-G*
F5	Mini	10	Red	Battery KL30 STD	1L3T-14A094-F*
F6	Mini	7.5	Brown	Battery KL30	1L3T-14A094-E*
F7	Mini	10	Red	Battery KL30	1L3T-14A094-F*
F8	Mini	7.5	Brown	Battery KL30	1L3T-14A094-E*
F9	Mini	5	Tan	Ignition KL15	1L3T-14A094-D*
F10	Mini	5	Tan	Ignition STD	1L3T-14A094-D*
F11	Mini	10	Red	Ignition KL15	1L3T-14A094-F*
F12	Mini	5	Tan	Ignition KL15	1L3T-14A094-D*
F13	Mini	20	Yellow	Fused Ground	1L3T-14A094-H*
F14	Mini	20	Yellow	Fused Ground	1L3T-14A094-H*
F15	Mini	20	Yellow	Fused Ground	1L3T-14A094-H*
F16	Mini	20	Yellow	Fused Ground	1L3T-14A094-H*
F17	Mini	20	Yellow	Fused Ground	1L3T-14A094-H*
F18	-	-	-	Spare	-

WARNINGS:

The fuse ratings and nominal ratings within the table should be followed strictly. Any deviation could insecurely interfere with the validated fusing strategy and wiring architecture. Some inputs are provided via electronic modules and any overloading could cause serious vehicle malfunction and may conflict with legal requirements.

No increase in existing vehicle standard fuse capacity is allowed under any circumstances.

On high-spec vehicles the C1 connector is not available as a customer interface and only the 43 way connector should be used. The connector to add wiring for switches and beacons is still available.

125kb/s MS CAN Access Interface

WARNING: It is not allowed to transmit DATA on any of the CAN lines. The system provided to splice into the 125kb/s MS CAN Bus is for modules that will read only. If messages are transmitted from a third party fit module, vehicle functionality can be compromised and lead to serious failure. It is vital that any CAN stubs added must comply to the twisted rate, length, correct parity, with routing away from any high EMP devices.

NOTE: Please contact your National Sales Representative or your local Ford Dealer for availability.

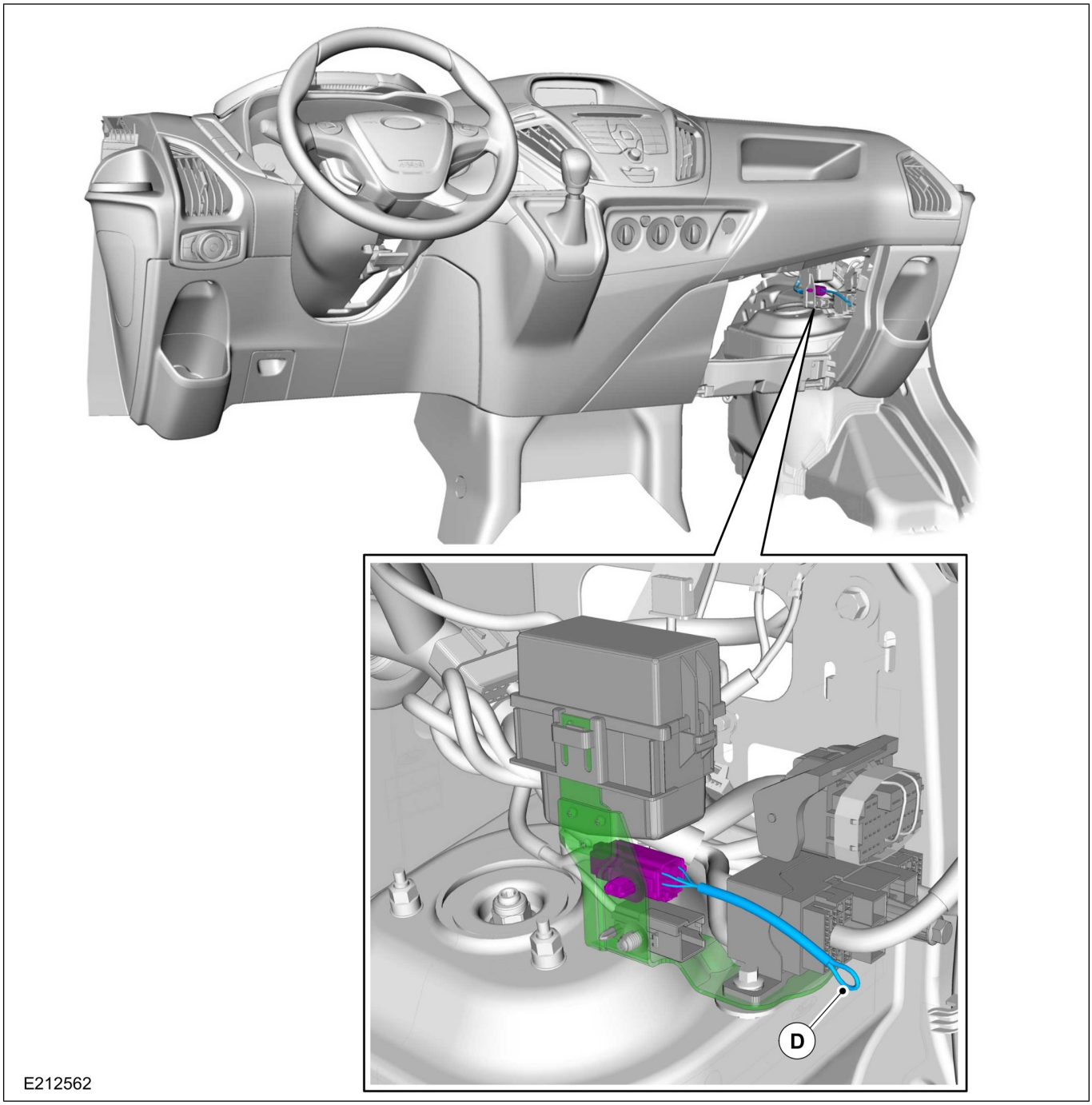
The High Specification Interface Connector option A608 has a 125Kb/s MS CAN interface EDS connection point that can have third party CAN wires spliced into. This is designed to provide Ford CAN Bus interfacing for third party fit module telematics and logic controller systems. For further information on splicing

Refer to: 4.1 Wiring Installation and Routing Guides (page 76).

Modules to be installed are only allowed to be read ONLY of the Ford system CAN Bus data and must be CE marked. After installation, functional testing of Ford systems connected to the same CAN Bus is expected. These include Trailer Tow, Rear Camera, Tachograph, Body Control Systems, Fuel Fired Heater and Cluster Systems. The system should also receive a health check DTC read to ensure no failures are present after the installation and ignition cycle has been performed. The converter is also responsible for legal compliance to EU EMC requirements of the finished system and ensure no adverse impact has been generated to the existing Ford systems. Please refer to Section 1 of the BEMM for responsibility and EMC compliance.

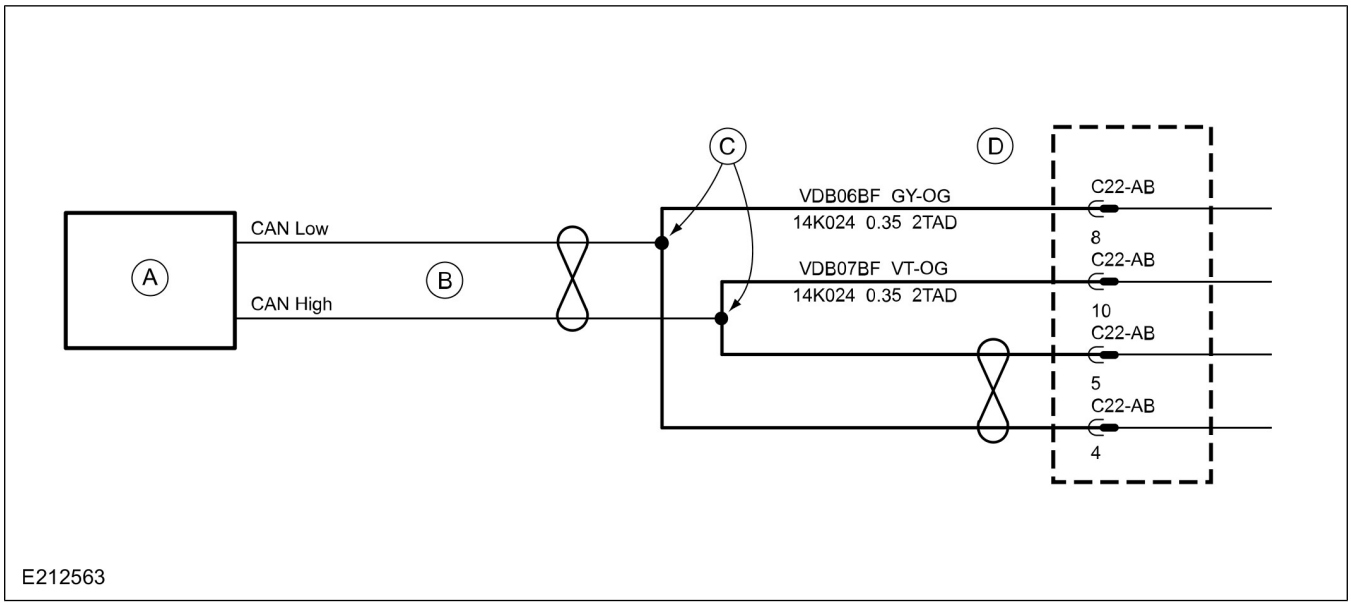
The CAN Interface loop wire, see figure E212562, is located near the 43 WAY interface connector, behind the glove box and outboard to the wheel arch. The half way loop point can be spliced into with third party twisted pairs of at least 3 twists per 50mm and a minimum of 0.3 meters to a maximum of 2 meters stub length to module. CAN Low is the Grey/Orange wire. CAN High is the Violet/Orange wire.

CAN Bus Interface Loop Wire Location



Item	Description
D	Splice into mid point of loop

Third Party Fit CAN Read Module



Item	Description
A	Converter Fit Read Module
B	Converter Fit Stub Wiring
C	Spliced Interface Connection
D	Ford CAN Loop Wire - CAN Low is the Grey/Orange wire. CAN High is the Violet/Orange wire

Stub length added must exceed 0.3 meters but be less than 2 meters, at least 3 twists per 50mm of wire and not be less than 50mm of untwisted wire to the added module or splice.

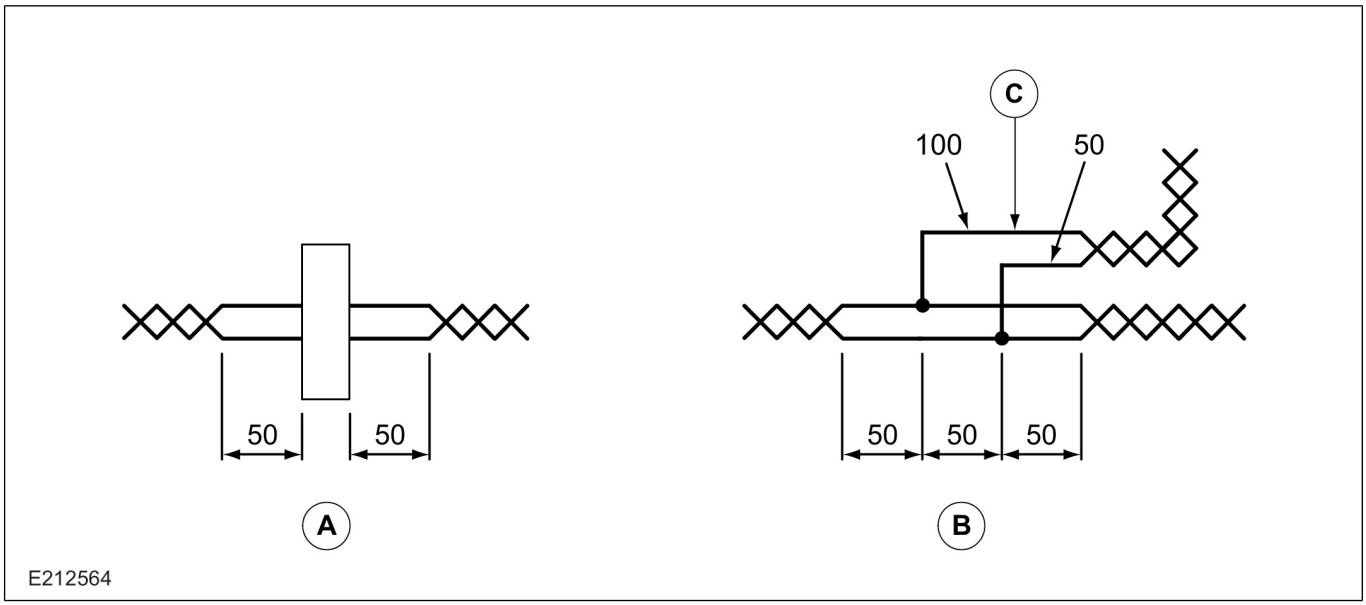
Physical Interface of spliced in EDS Requirements

Parameter	Minimum	Nominal	Maximum	Units
Impedance	108	120	132	Ohm
Resistance	-	-	175	milli Ohm/meter
Signal Speed	-	-	5.5	nano Second/ meter
Twisting	3^	-	-	Twisted/50mm
Phase Shift	-	-	3.4	nano Second
Differential Mode Offset	-	-	0.5	Volts

^ The Twisted circuits shall have a minimum twist rate of 3 twists (4 wire crossovers) per 50 mm. One "twist" or "turn" = 180 deg. Rotation. Twisting shall be maintained to within 50mm of any in-line or component connector.

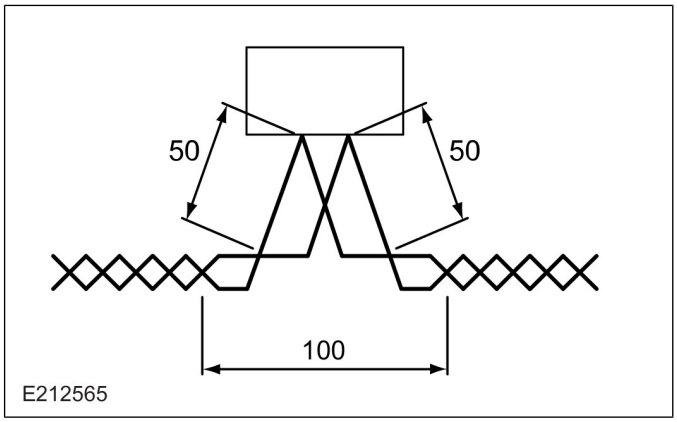
The twisted pair that forms the CAN Bus shall be twisted throughout the total run of the vehicle except for a maximum of 50mm from connectors or harness splices. At splices an additional 50mm of untwisted wire is allowed between the CAN H and CAN L contact points

Twisted Circuits - all values are maximum limits



Item	Description
A	Connector
B	Splice
C	Typically taped to backbone

Maximum CAN Bus Length Series Chain Method - all values are maximum limits



It is allowed to connect modules to the backbone using a series chain method instead of a stub. If the series chain method is selected, the untwisted wire on each side of the double crimp in the connector cannot exceed 50mm. See figure E212565

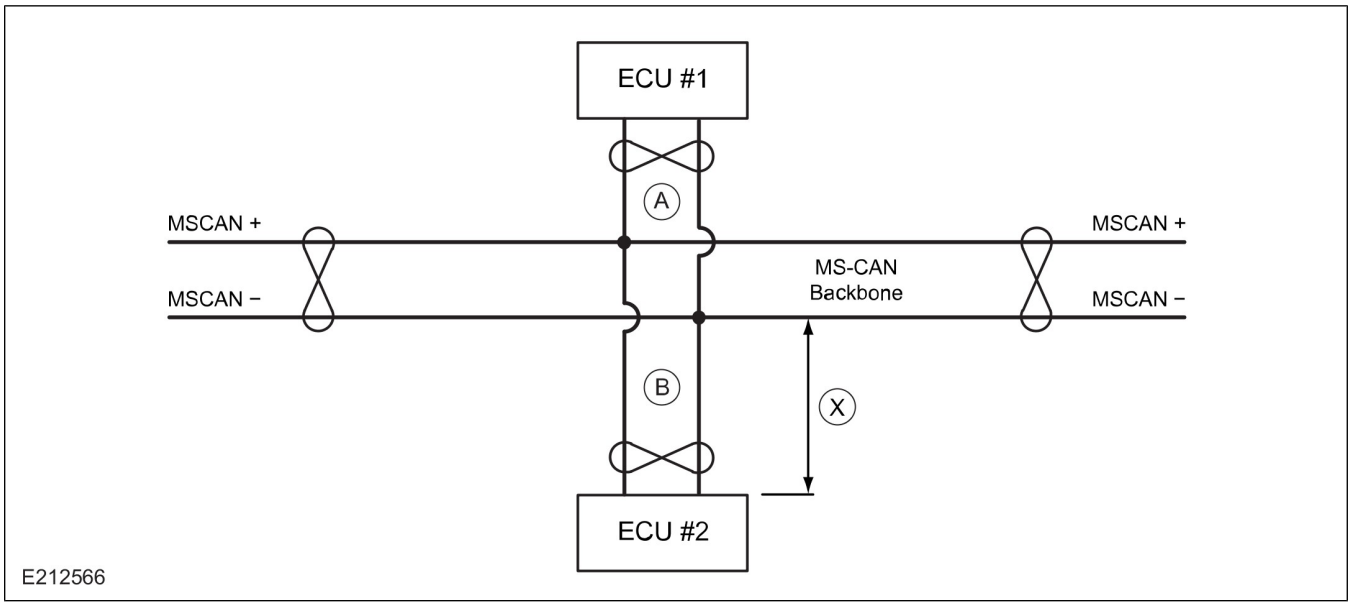
The two terminating ECU's shall be placed the 'furthest' distance apart on the CAN Bus. The maximum wiring length for each type of network is defined in the following table

Network Speed	Between terminating ECU's	SAE J1962 Connector to 'Furthest' Terminating ECU^
125 kbps	50m	45m
500 kbps	33.5m	28.5m

^ This allows for an off-board tester cable of up to 5m.

Cable Stub Length: It is acceptable for any stub, except the terminating ECU stubs, to be open circuit and unterminated, i.e. harness variants are not required to support option fit ECU's. Each stub shall originate at the CAN Bus backbone. Stub shall have a final length of between 0.3m and 2m. See dimension "X" in figure E212566

Cable Stud Circuit



Item	Description
A	Stub 1
B	Stub 2
X	Stub - Final length between 0.3m and 2m

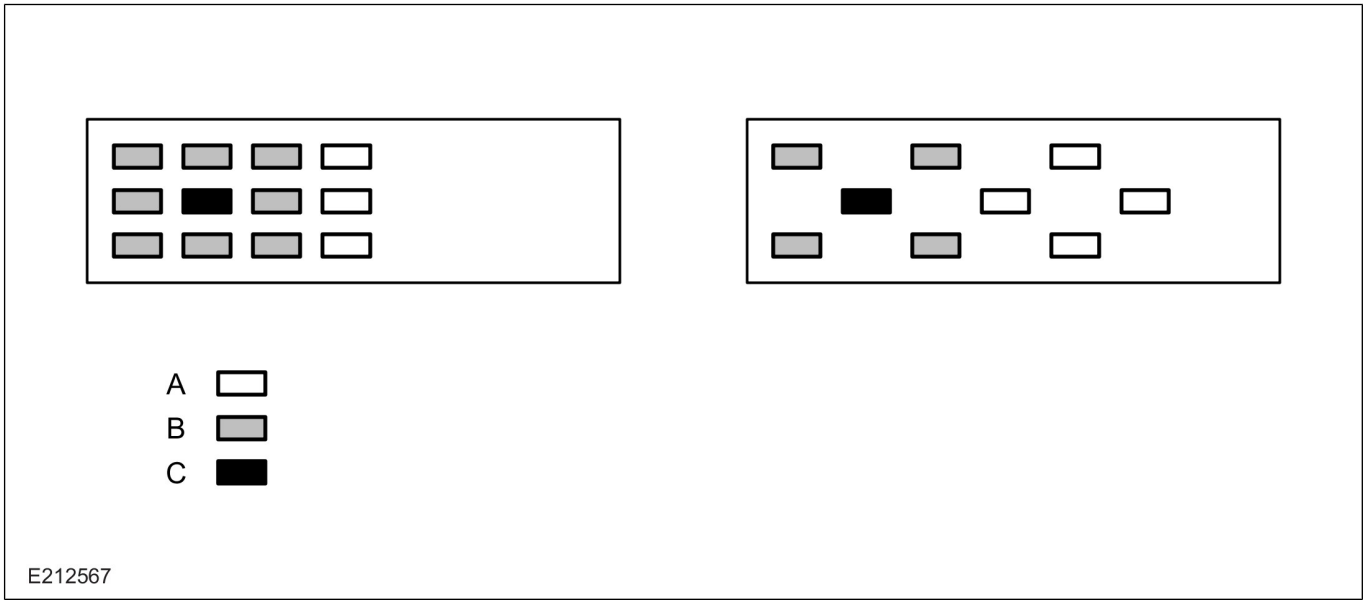
Stub Splices: The general rule is that there shall be at least 50mm of twisted wire between any series of the following connections: splice – splice, connector - splice, connector - connector, Splices include wire to wire splices and splice blocks.

Two stubs may be connected to the same stub connection point at the CAN backbone only on a 125 kb/s (MSCAN) bus. In this case the stubs must differ in length by at least 10%. Example: If one stub is 1 meters long the second can be less than 0.9 meters or between 1.1 meters and 2 meters.

Stud Topologies: Stubs connected to stubs are not allowed. If multiple nodes need to be connected to a single stub then the nodes must be series chained. This can be accomplished by double crimping if only two pins (CAN H & CAN L) are available or making the CAN Bus connection through the module if four pins are available (2 x CAN H & 2 x CAN L).

The maximum number of ECU's on network transmission speed 125 kb/s, including the off-board tester, is 32.

The two wires forming each pair of CAN H and CAN L connections shall be routed via physically adjacent pins as shown in the figure E212567.



Item	Description
A	Non Adjacent Pins
B	Adjacent Pins
C	CAN H or CAN L

Each Bus pair may be routed via separate connectors.

Details of the pin allocation for each node shall be defined in the relevant module specification

The voltage supply used by the network interface must not be directly connected to any external part. That means that the regulated power used by the CAN-circuitry on the printed circuit board shall be used only inside the cover of the ECU. Note: this does not apply to the Vbat connection required for full-sleep functionality in transceivers powered by Vbat.

The CAN network shall be fully functional, as a minimum, over the operating range 9V to 16V, as measured at the modules battery pin. Outside this operating range, it is recommended that modules continue to communicate. However, it is not acceptable for modules to send corrupt messages/error frames/illegal symbols, or disrupt the transmissions of other modules.

NOTE: Module feature requirements may require a larger operating range

Modules shall not drive the CAN bus dominant during module reset.

Common mode EMC chokes shall not be used in terminating nodes. Additionally chokes may only be used in non-terminating ECU's with the agreement of the relevant FMC design authority, for each vehicle program to which the ECU shall be fitted.

Suppliers may Electrostatic Component Discharge components as long as pass tests:

- Conducted Immunity
  - CI 280 Electrostatic Discharge
  - CI 270-C Immunity to Voltage Overstress (24V), applied to CAN H and CAN L

Additionally, the capacitance of the component, measured at 2.5V reverse bias, shall be <30pF

The zener stacks may be removed for modules on CAN links that do not connect to the diagnostic connector as long as it is shown that the unpowered ESD test can be passed without these parts (Powered ESD testing on the CAN pins is not required for modules that do not connect to the diagnostic connector). The circuit board pads for these parts must be present for all designs.

All grounding of the CAN transceiver and capacitors shall be made to ECU signal ground.

All transceiver voltage reference pins shall be left open circuit.

Capacitors shall be monolithic ceramic capacitors or equivalent.

A ground plane is required under the transceiver chip on the component layer of the PCB.

Transceiver shall be located as close to edge connector as possible. Other IC's are not permitted between edge connector and the transceiver

CAN H / CAN L circuits between edge connector and transceiver shall be as short as possible and routed side-by-side. Guard tracks are required for all CAN H / CAN L, TXD and RXD circuits on the same PCB layer. Guard tracks should not be placed between CAN H and CAN L

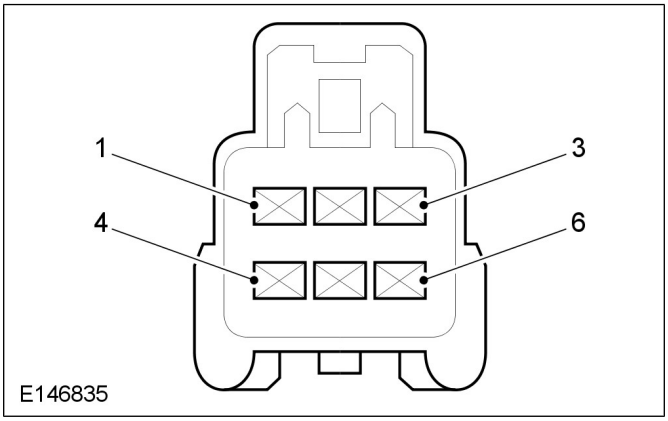
All guard tracks shall be at least 0.5mm wide and grounded at least every 10mm.

The decoupling capacitor shall be placed as close as possible to the transceiver.

Transceivers that are battery powered are required to have a Flexi safe capacitor.

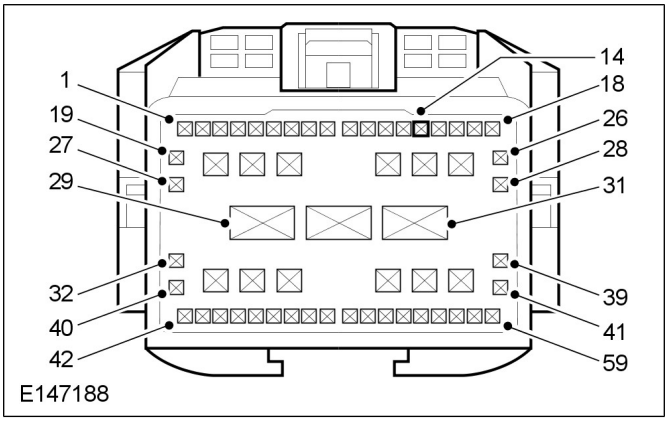
4.19.11 Adding Connectors

Additional 'Theater Lighting' for rear of vehicle interior



Item	Description
Pin 1	Supply through Battery Saver
Pin 5	Ground - Dimming

Marker Lights



Item	Description
Pin 14	Side Marker Supply - Yellow/Violet

WARNING: The Position and Marker Lights of the vehicle are collectively powered via F15 in the Body Control Module at a rating of 25A. A nominal current rating of 20A (full load including all potentially fitted additional lights) must not be exceeded.

Additional Rear Speakers

NOTE: The connectors on the Instrument Panel harness (14K024) and the main harness (14401) are reversed between Left Hand Drive (LHD) and Right Hand Drive (RHD) vehicles, hence different sets of terminals/wires are required to cover all the markets.

For information on rear speakers:

Refer to: 4.10 (page 148).

Unused Connectors

The harnesses may have a number of unused connectors – these are dedicated to other features and options, e.g. heated seats, but are **not** always present depending on level of harness fitted. Ford **do not** recommend the use of these connectors for any other purpose than that intended by design.

Power Inverter / Cigar Lighter

Both features adopt a 20A fusing strategy. With a single battery system, continued loading of these features will lead to battery drain, and risk vehicle starting. If continuous power is required, a second battery option should be installed and the customer connection points, where fitted, utilized. At engine OFF, all three power outlets are connected to the battery saver system, where the supply will switch off at 30 minutes. Battery saver can be ordered or reconfigured to a longer duration of 180 minutes.

4.20 Grounding

4.20.1 Ground Points

WARNING: It is recommended to only use one eyelet per stud for high current applications. If more than one eyelet per stud is unavoidable, the highest current eyelet feed should be connected closest to the supply terminal. Do not exceed two eyelets or crimp terminals per stud connection. See figures E228188, E228189 and the following table for recommended ground points that can be used.

CAUTIONS:

Only use the ground points indicated. Using alternative points may affect the vehicle integrity.

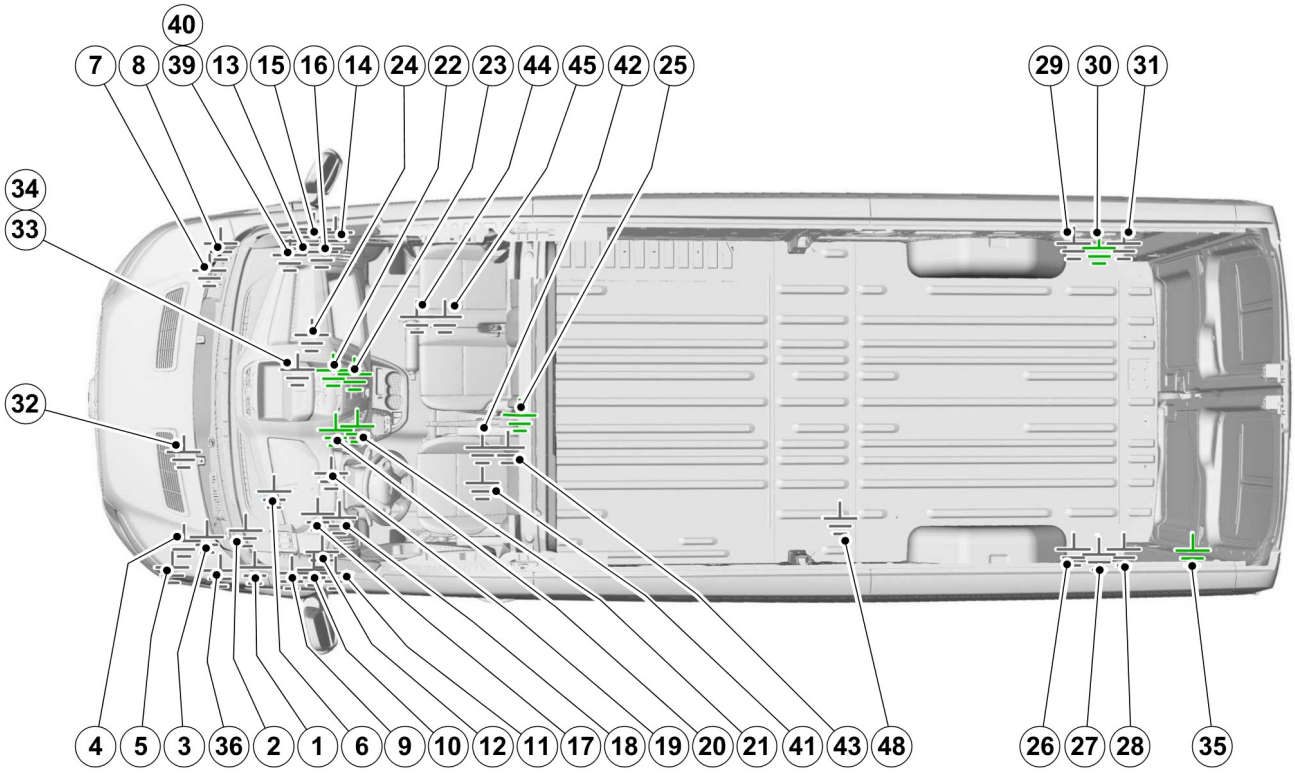
Make sure that all ground points are tightened to the correct torque.

NOTE: The Ground Point (GP) numbers are only for reference to show the location of the GP.

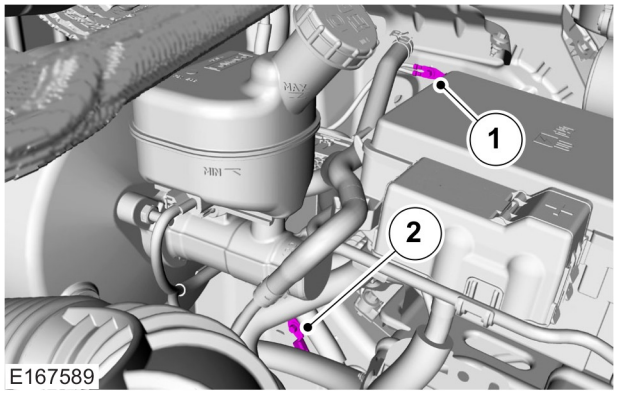
Ground wires should be brought back to the Ford ground points provided, please refer to the following figures. For very high current users, it is recommended that the ground connection is made directly to the ground point close to the battery ground point. An auxiliary ground stud eyelet can be ordered

Refer to: 4.4 Battery and Cables (page 102).
Additional Loads and Charging Systems section for additional information.

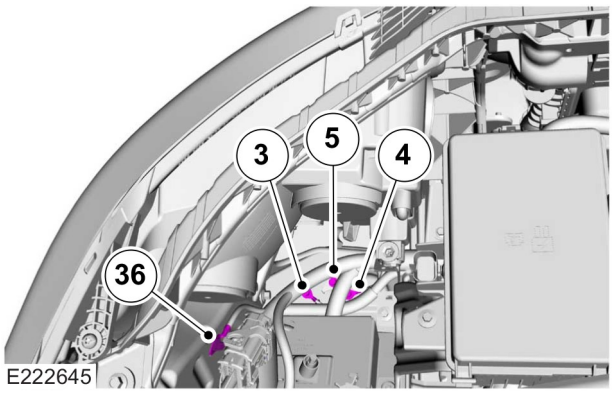
Van, Bus, Kombi Ground Points



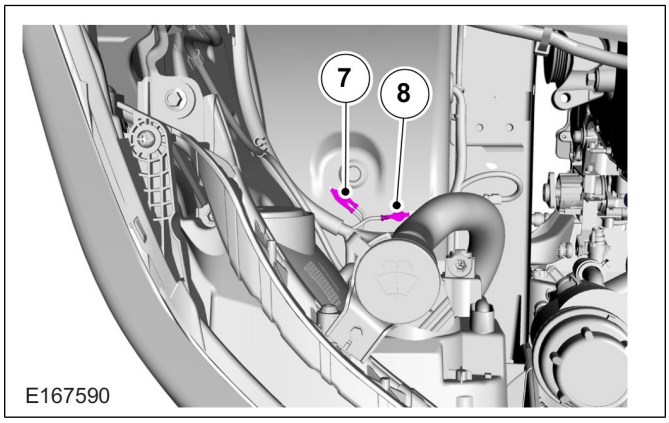
E228188

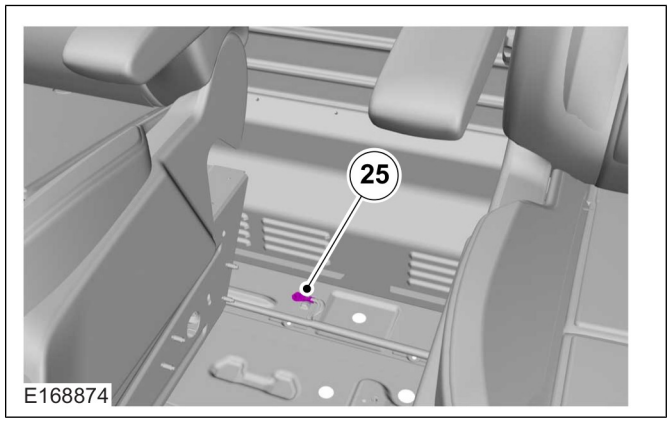


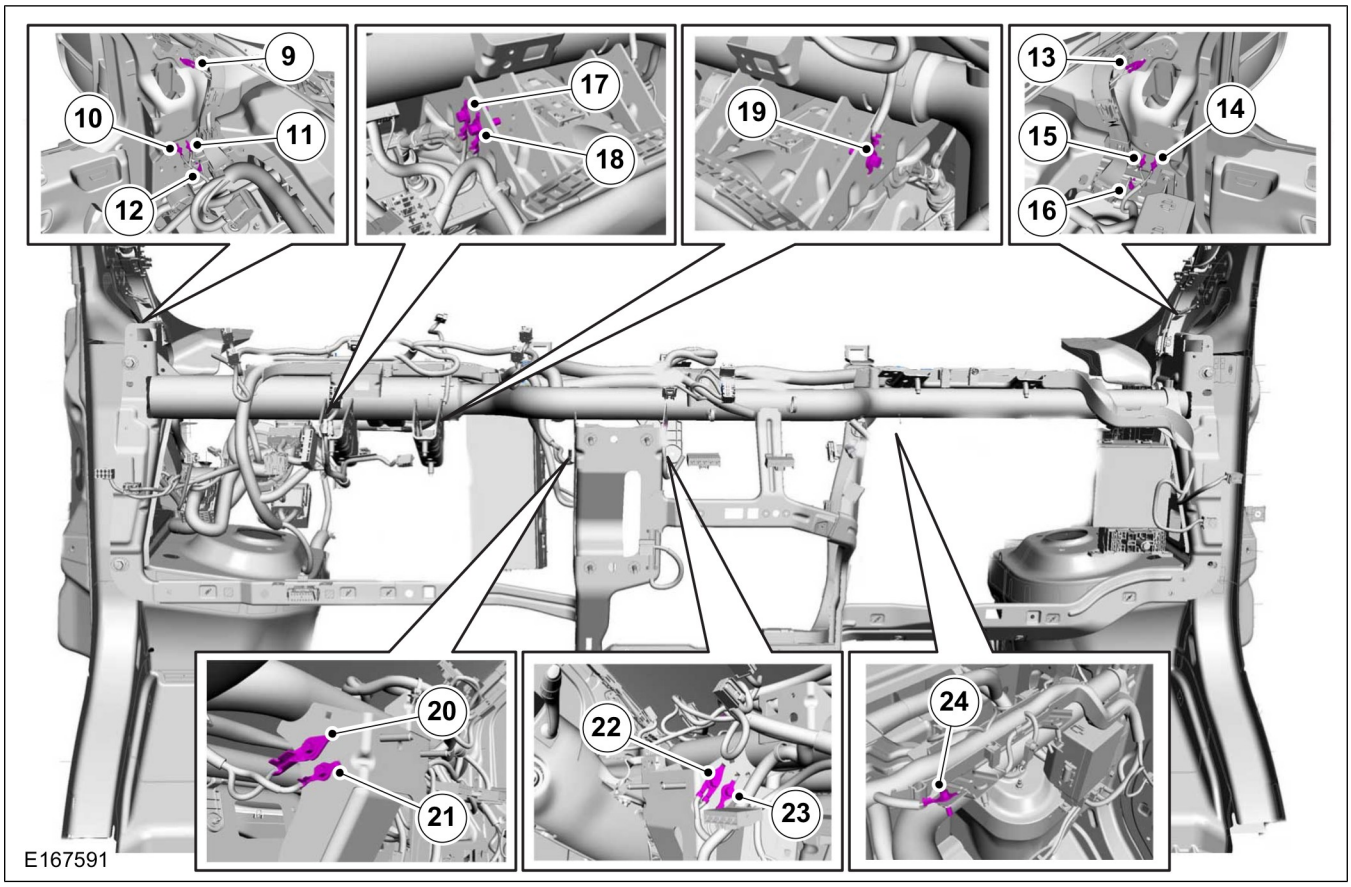
E167589



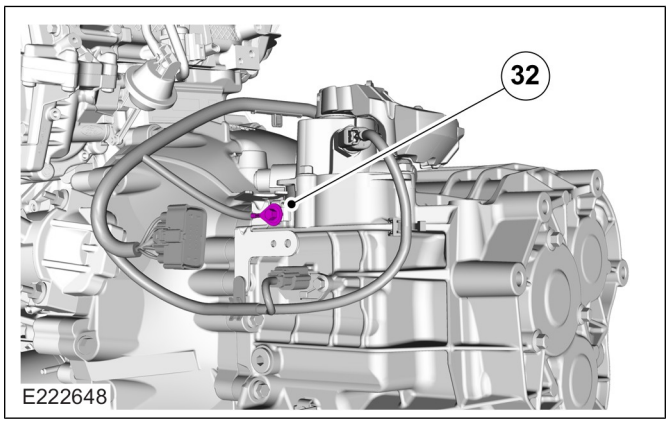
E222645


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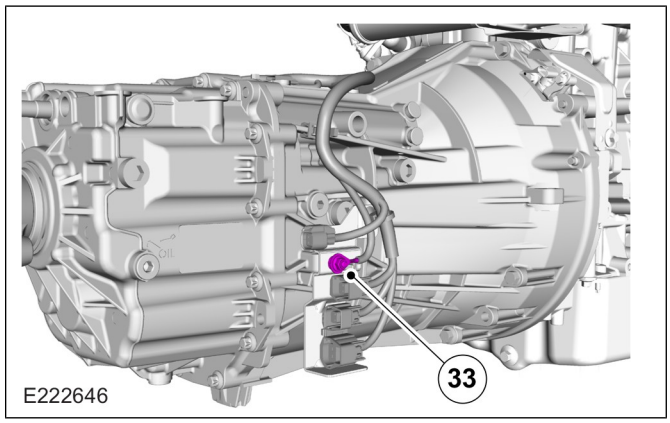

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E168874


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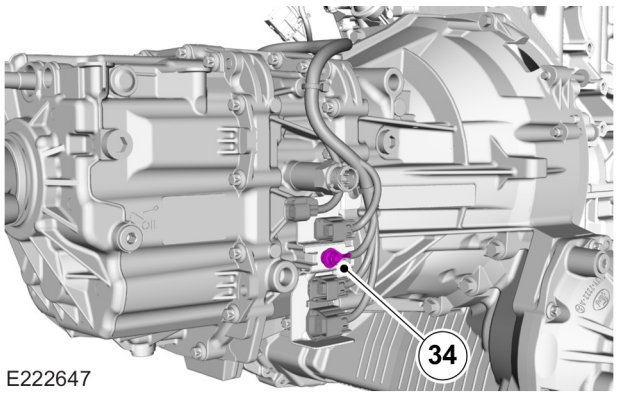
FWD


32
E222648

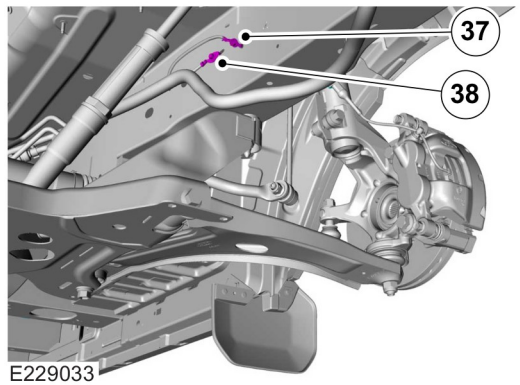
RWD


33
E222646

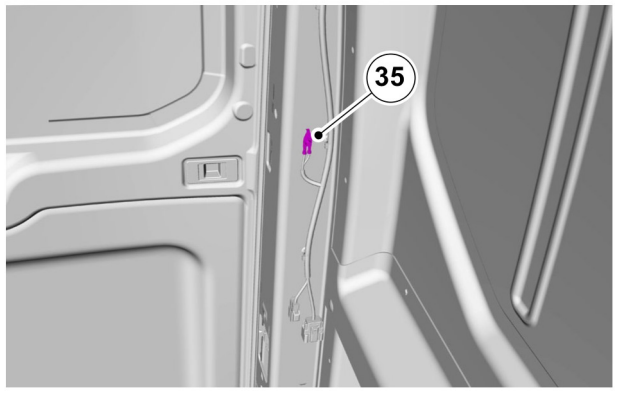
AWD

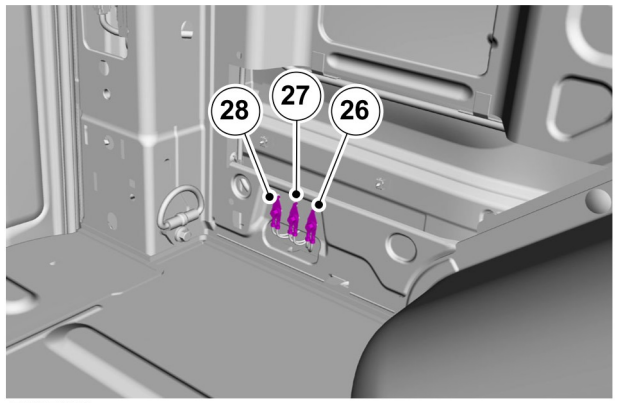


E222647

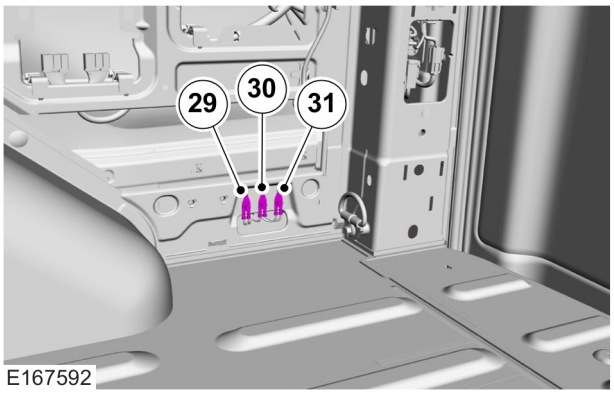


E229033



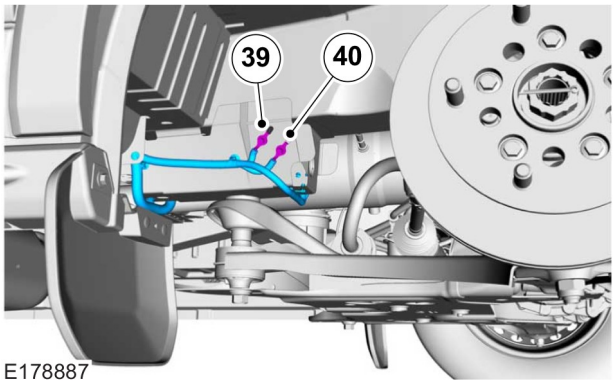


E167593

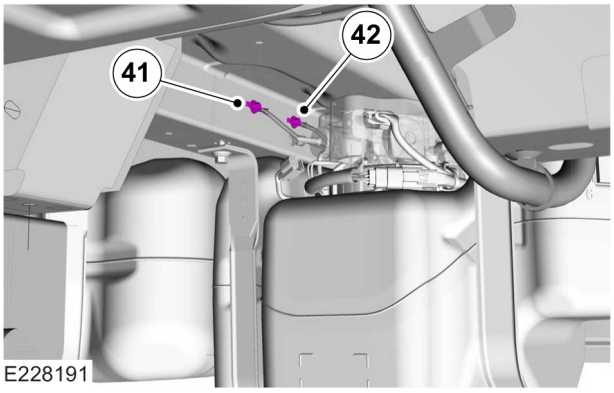


E167592

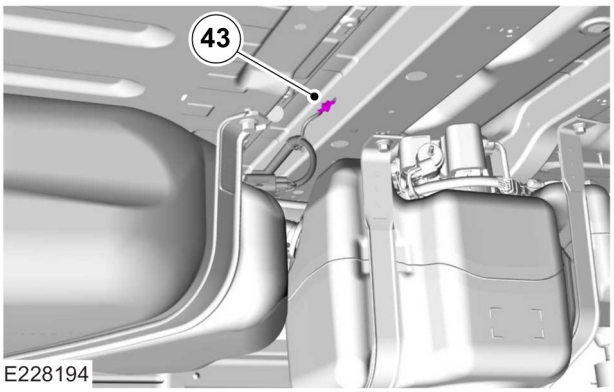
RHS Wheel Arch



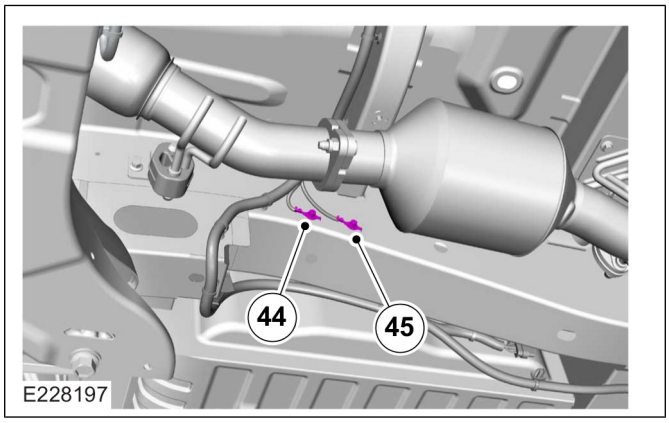
E178887



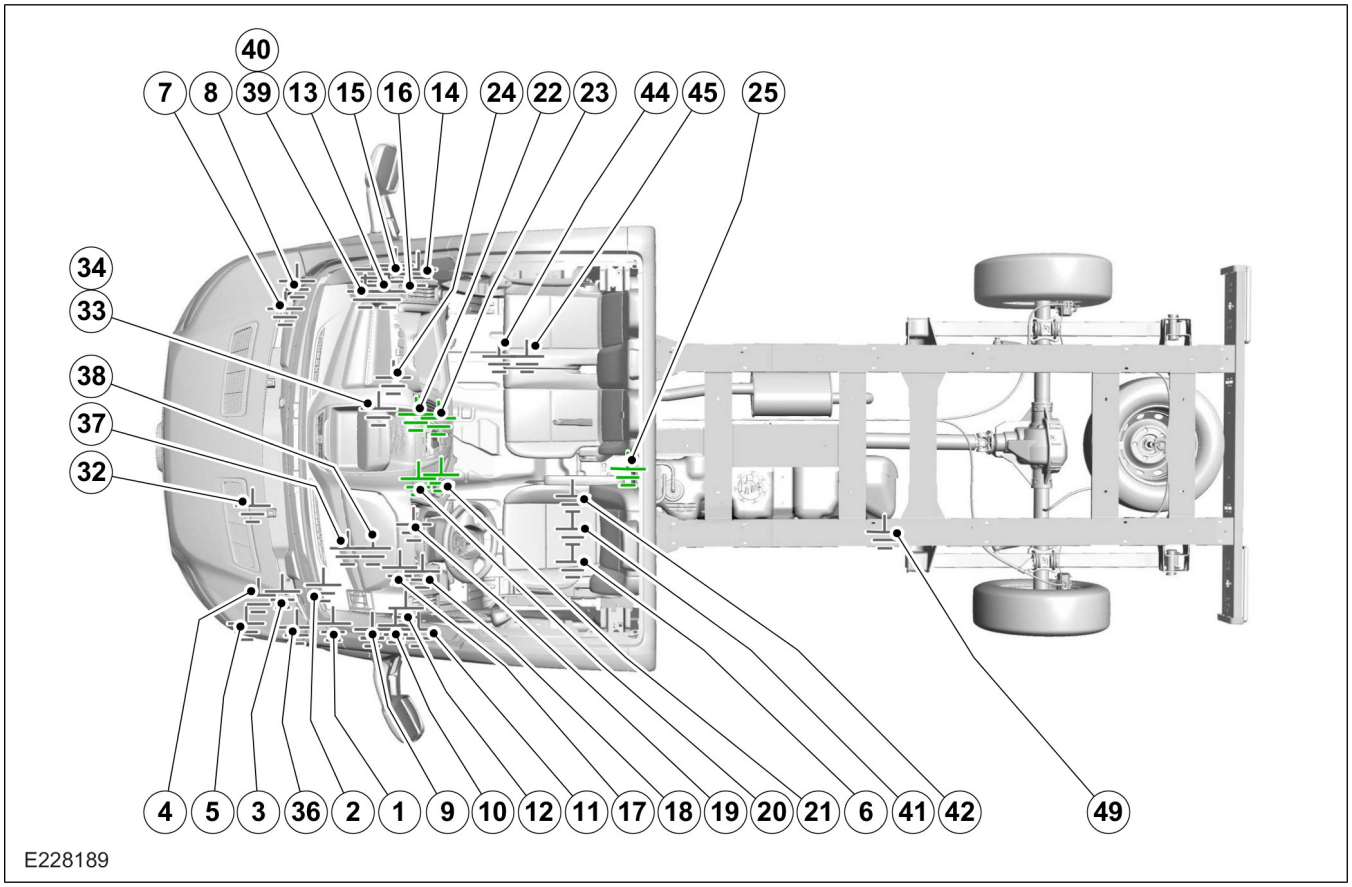
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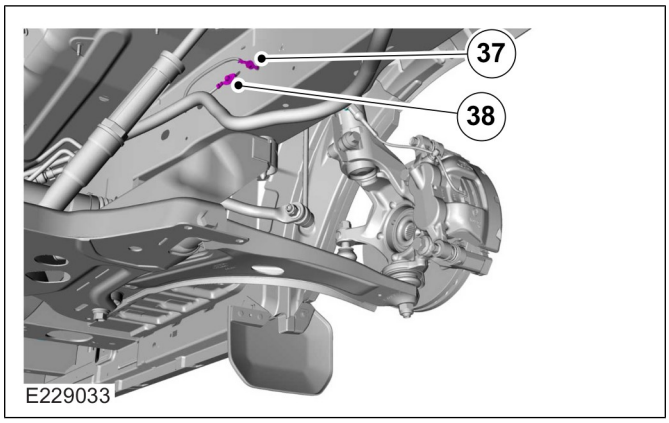


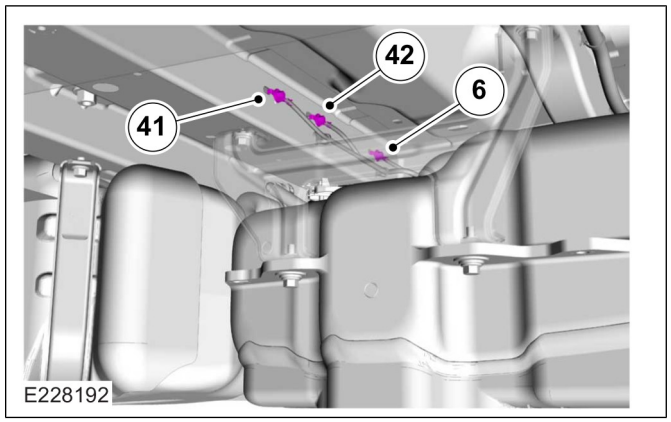
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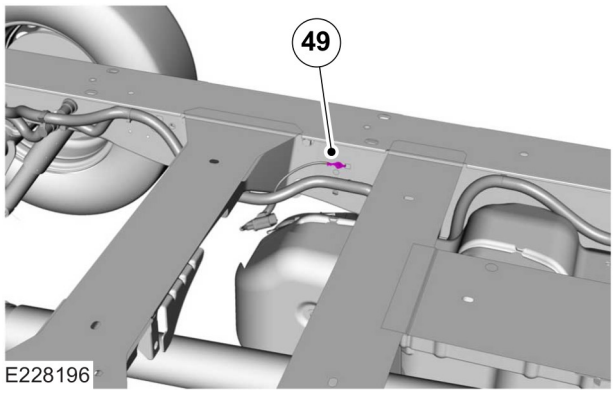


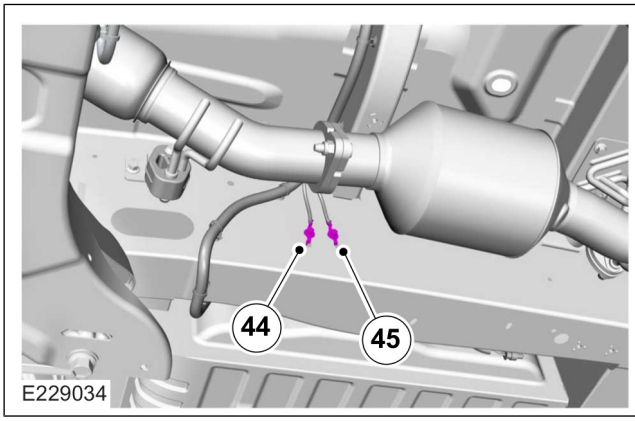
Chassis Cab Ground Points



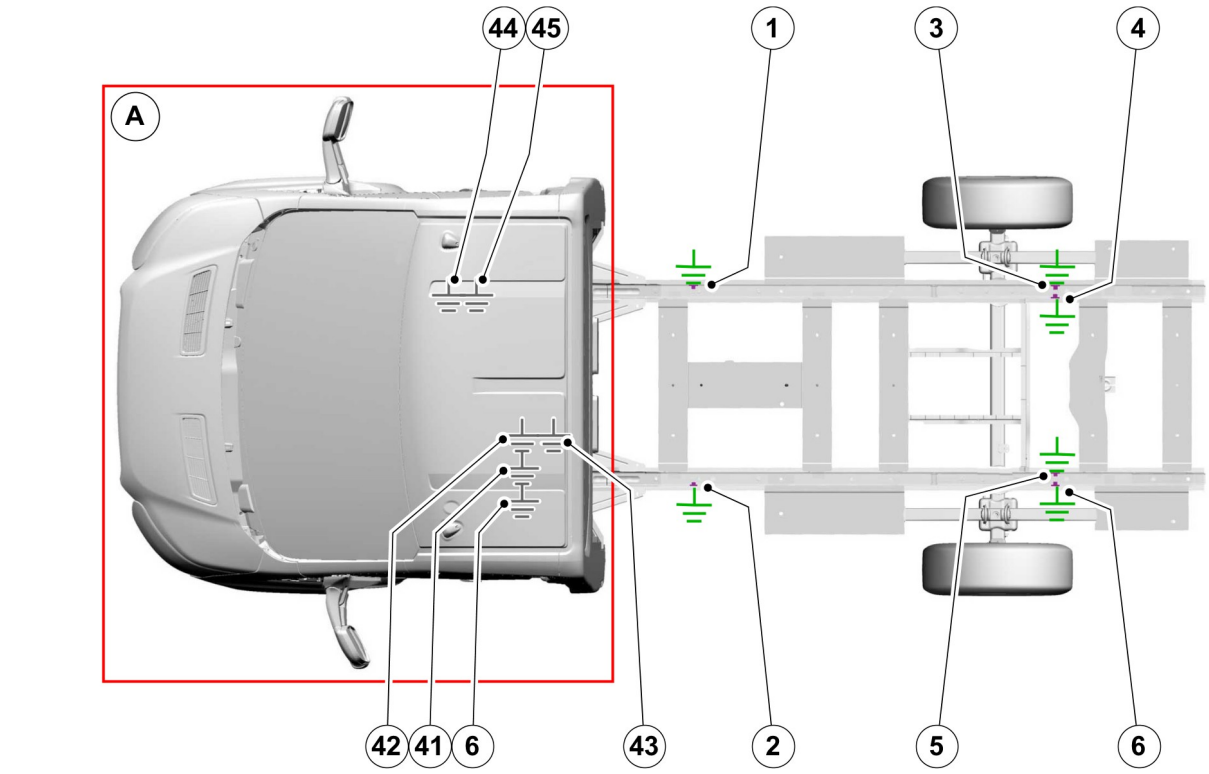




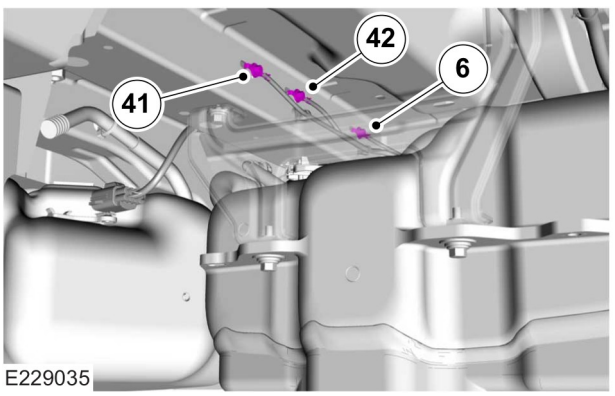


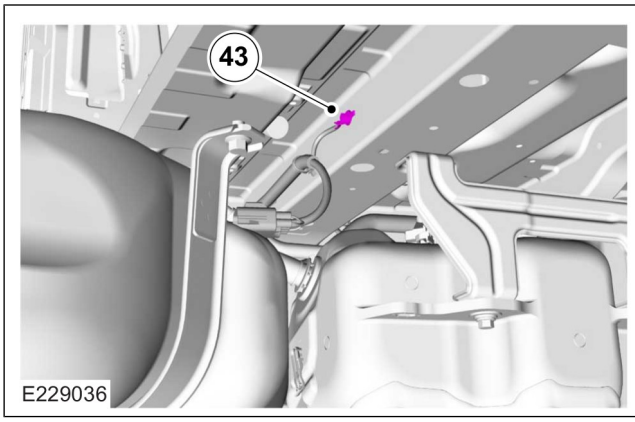


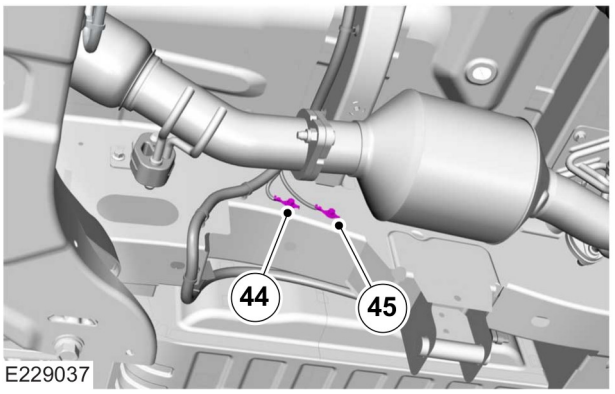
Motorhome Chassis

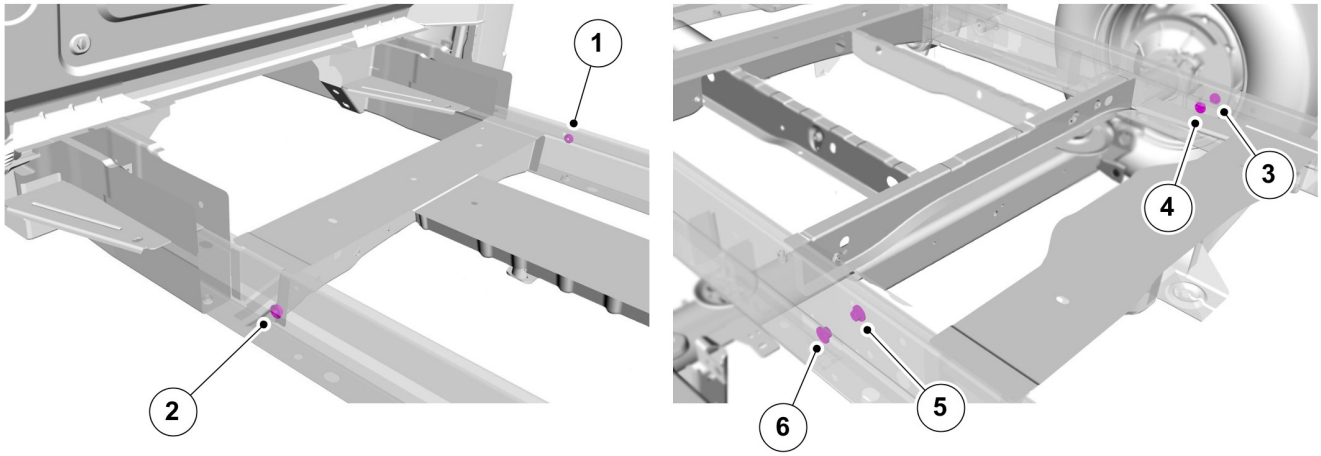


Item	Description
A	All ground points are the same as Van, Bus, Kombi, except GP6.
1 - 6	Additional ground points (Locations 1 and 2 use the outer rail positions only). M8 threadless weld nuts requiring M8 thread rolling screws.






44
45
E229037


1
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E175119

Ground Point	Location	Type	Harness
Ground Points - Chassis Cabs and Van, Bus, Kombi			
GP1	Engine Bay LHS	Misc Power Electric	14401
GP2	Engine Bay LHS	Misc Power Electric	14401
GP3	Engine Bay LHS Front	Exhaust Emissions Control	9K499
GP4	Engine Bay LHS Front	Exhaust Emissions Control	9K499
GP5	Engine Bay LHS Front	Exhaust Emissions Control	9K499
GP7	Engine Bay RHS Front	Misc Power Electric	14401
GP8	Engine Bay RHS Front	Misc Power Electric	14401
GP9	A Pillar LHS Upper	Rear Air Condition Control	13A409
GP10	A Pillar LHS Lower	Misc Power Electric	14401
GP11	A Pillar LHS Lower	Misc Power Electric	14401
GP12	A Pillar LHS Lower	Misc Power Electric	14401
GP13*	A Pillar RHS Upper	Misc Power Electric	14659
GP14	A Pillar RHS Lower	Misc Power Electric	14401
GP15	A Pillar RHS Lower	Misc Power Electric	14401
GP16	A Pillar RHS Lower	Misc Power Electric	14401
GP17	Cross Car Beam LHS	Misc Power Electric	14K024
GP18	Cross Car Beam LHS	Misc Power Electric	14K024
GP19	Cross Car Beam LHS	Misc Power Electric	14K024
GP20*	Cross Car Beam LHS	Misc Power Electric	14K024
GP21*	Cross Car Beam LHS	Misc Power Electric	14K024
GP22	Cross Car Beam LHS	Misc Power Electric	14K024/14C007
GP23*	Cross Car Beam LHS	Misc Power Electric	14K024
GP24*	Cross Car Beam RHS	Misc Power Electric	14K024
GP25*	Floor Pan	Misc Power Electric	14401
GP26	Bodyside Rear LHS	Misc Power Electric	13A409
GP31	Engine Bay LHS	Engine Control Sensor and Fuel Charge	12B637
GP32	Transmission FWD	Diesel Vaporizer Pump	14D502
GP33	Transmission RWD	Diesel Vaporizer Pump	14D502
GP34	Transmission AWD	Diesel Vaporizer Pump	14D502
GP36	Engine Bay LHS Front	Engine Control Sensor and Fuel Charge	12B637
GP39	RHS Wheel Arch	Exhaust Emissions Control	14D469
GP40	RHS Wheel Arch	Exhaust Emissions Control	14D469
GP41	Frame Middle Left	Trailer Tow	14406
GP42	Frame Middle Left	Fuel Fired Heater & Filter Heater	14406
GP44	Frame Middle Right	NOx Sensor	14406
GP45	Frame Middle Right	NOx Sensor	14406
Ground Points - Van, Bus, Kombi Only			
GP27	Bodyside Rear LHS	Misc Power Electric	13A409
GP28	Bodyside Rear LHS	Misc Power Electric	13A409
GP29	Bodyside Rear RHS	Misc Power Electric	13A409

Ground Point	Location	Type	Harness
GP30	Bodyside Rear RHS	Misc Power Electric	13A409
GP31	Bodyside Rear RHS	Misc Power Electric	13A409
GP35*	D Pillar LHS Middle	Misc Power Electric	14659
GP48	Frame Middle Right	PEM (Fuel Pump Control Module) RWD	14406
Ground Points - Chassis Cabs Only			
GP37	Engine Bay LHS	Fuel Tank Sender	14406
GP38	Engine Bay LHS	Fuel Tank Sender	14406
GP49	Frame Middle Left	PEM (Fuel Pump Control Module)	14406
Ground Points - Van, Bus, Kombi and Transit Motorhome Chassis			
GP43	Frame Middle Left	PEM (Fuel Pump Control Module)	14406
Ground Points - Chassis Cab and Transit Motorhome Chassis			
GP6	Frame Middle Left	Lighting	14406

* Recommended Ground Points that can be used.

Ford Part Number W505255-S450M, M6 screw type fixing - torque 12Nm +/- 1.8

Abbreviations used in table:

- LHS - Left Hand Side
- RHS - Right Hand Side
- Misc - Miscellaneous
- FWD - Front Wheel Drive
- RWD - Rear Wheel Drive
- AWD - All Wheel Drive

5.1 Body

5.1.1 Body Structures - General Information

When carrying out vehicle conversions/modifications the following points should be considered:

- Make sure that the vehicle structural integrity is maintained.
- Do not drill into closed frame body members.
- Make sure that the design for the body alterations or additional structure disperse the load evenly.

CAUTION: Uneven load distribution could result in unacceptable handling and braking characteristics.

- Re-paint metal edges after cutting or drilling. All metal edges must comply with exterior and interior protection legislation.
- All fixings through the floor, sides or roof must be sealed.

Ensure proper sealing against ingress of water, salt, dust, after cutting or drilling the body. Use Ford approved sealing and finishing material, and underbody corrosion protection.

Refer to: 5.14 Corrosion Prevention (page 268).

- Make sure that fixings in the 'B'-pillar area do not encroach on the seat belts or seat belt reels.

For unique floor fixings, see (Frame Drilling and Tube Reinforcing).

Refer to: 5.15 Frame and Body Mounting (page 269).

For Load Compartment Tie Downs (Load Lashing Points)

WARNINGS:

Before drilling see figure E167660 for Boron Steel parts, in this section of the manual.

Before drilling the floor, check the Precautionary Drill Zones, see Figure E167548 in this section of the manual.

For additional Precautionary Drill Zones

Refer to: 4.1 Wiring Installation and Routing Guides (page 76).
Refer to: 5.6 Body Closures (page 249).

5.1.2 Welding

WARNING: Before welding see figure E167660 for Boron Steel parts, in this section of the manual.

Before welding work is performed on a vehicle body, all safety measures for the protection of people, modules and electrical components must be observed.

Electronic Components

Increased use of comfort and safety electronics in modern motor vehicles also requires the greatest attention to be paid during body work. Over voltages produced during welding and in alignment work during body shell 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 personnel 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.

Before Welding

Interior surfaces of new bodywork components which will no longer be accessible after installation must be painted beforehand. The welding flanges are treated with a special welding primer. 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.

NOTE: Do not touch cleaned bare metal any more with the bare hands. The dampness of your hands will corrode the metal.

Procedure:

- Remove the primer or paint/zinc layer 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 allow to dry.

NOTE: The welding primer must only be applied thinly to the spot welding area, to minimize spattering when welding.

The following points must be noted when welding:

- 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.
- 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.

After Welding

During work, body panels are often heated at very high temperatures, which results in the destruction of the corrosion protection.

Working of the affected areas is therefore vital:

- Grind the welded seams flat and clean thoroughly with silicone remover. Dry with a lint-free cloth.
- If the join area is accessible from the inside, the transition area to the paint must be abraded for all types of join so that good adhesion of the primer is achieved later.
- If the join area is not accessible from the inside, the cleaning and sanding work is not done. For this reason, ensure that there is as little contamination as possible in the area of the repair. This allows the cavity wax applied later to penetrate the join area without hindrance.

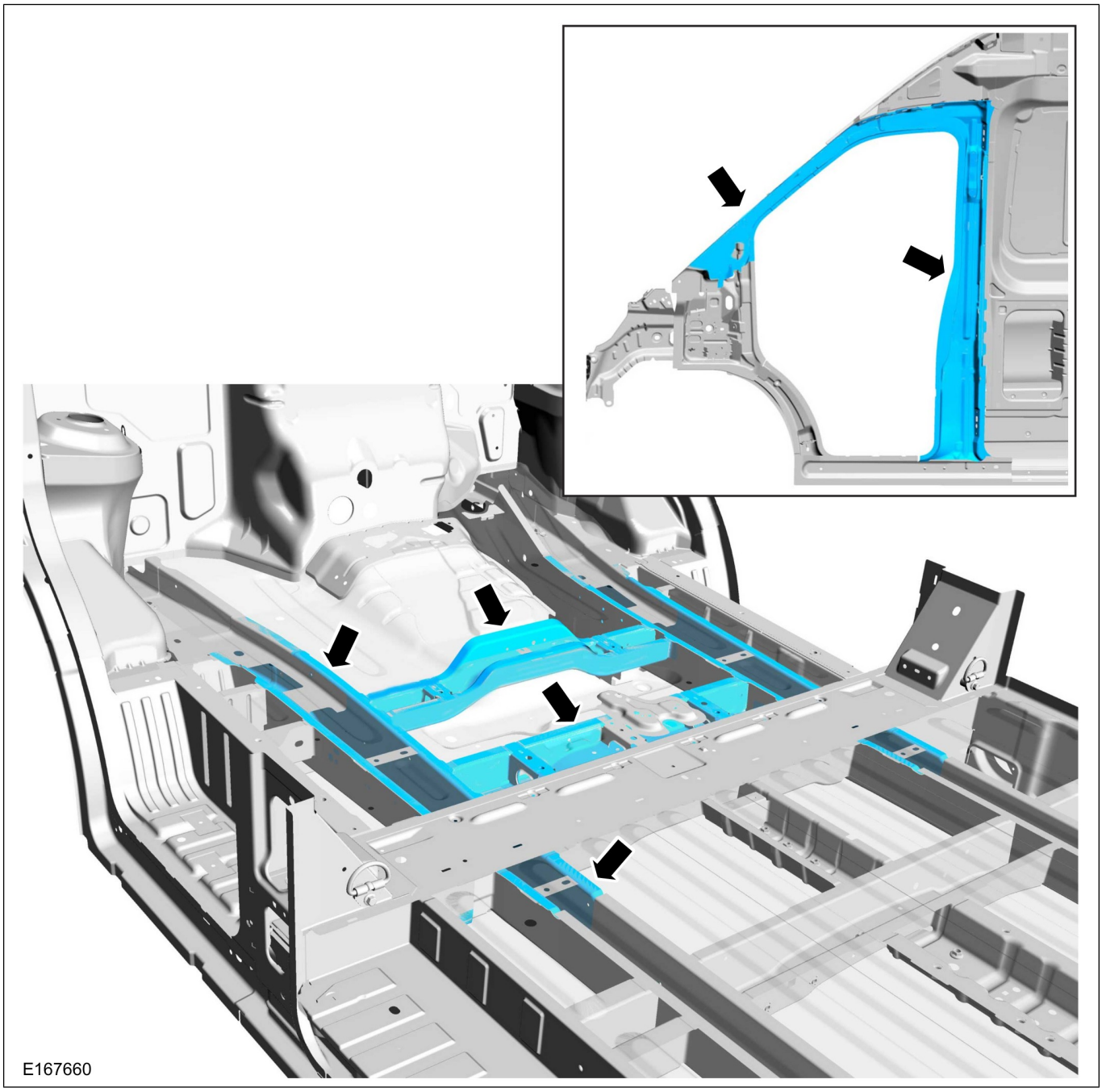
NOTE: Only apply a small amount of panel cleaner to the cleaning cloth when cleaning the area. Make sure that no cleaner reaches the connecting flange, so that the welding primer is not washed away again.

Priming after welding

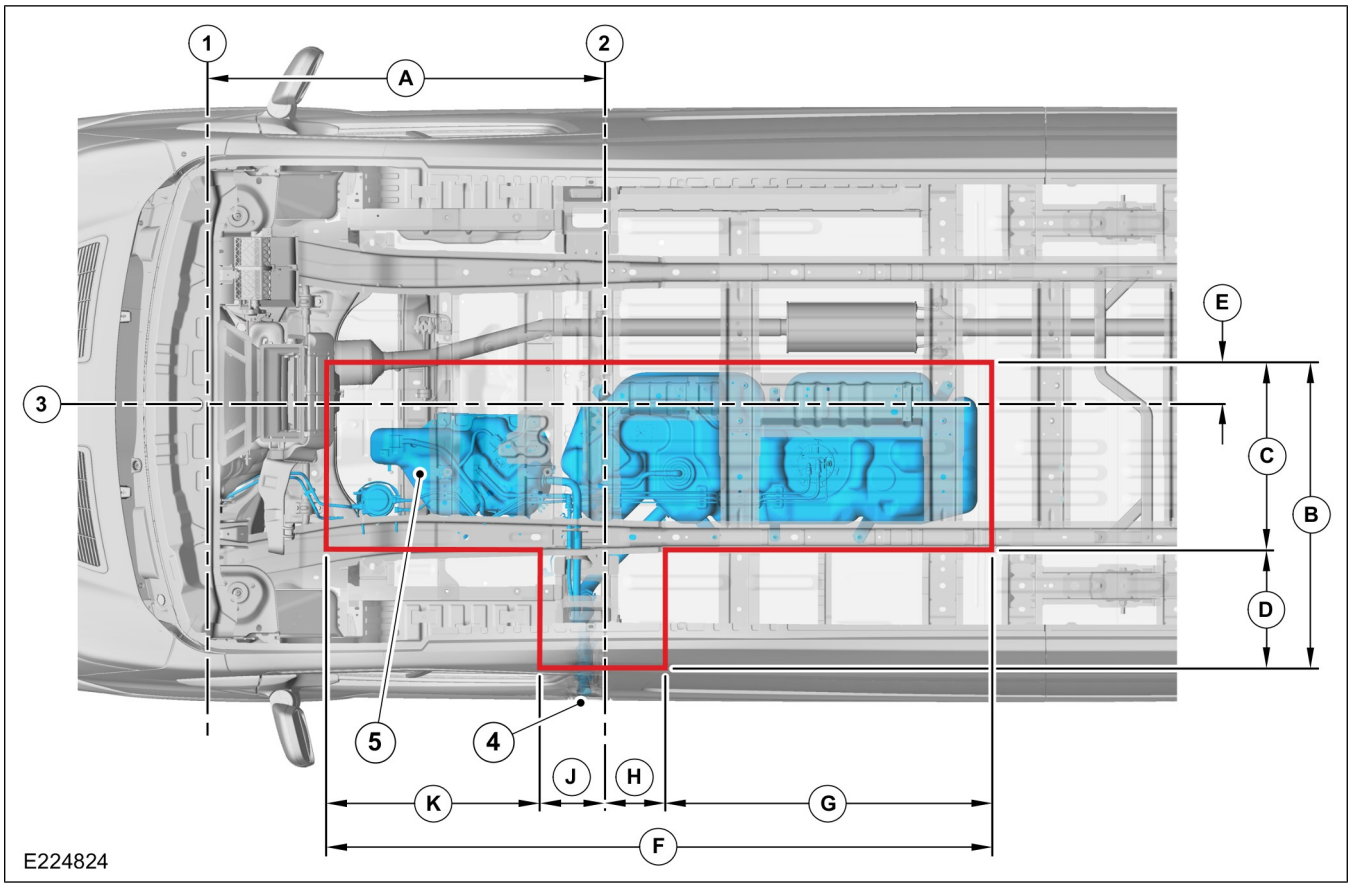
Primer is applied to the welded flanges after cleaning. A check must also be made that the production corrosion protection is present in the area of the flanges. Any damage must also be re-primed.

5.1.3 Boron Steel Parts

Boron Steel Parts - Precautionary Drill or Weld Zones

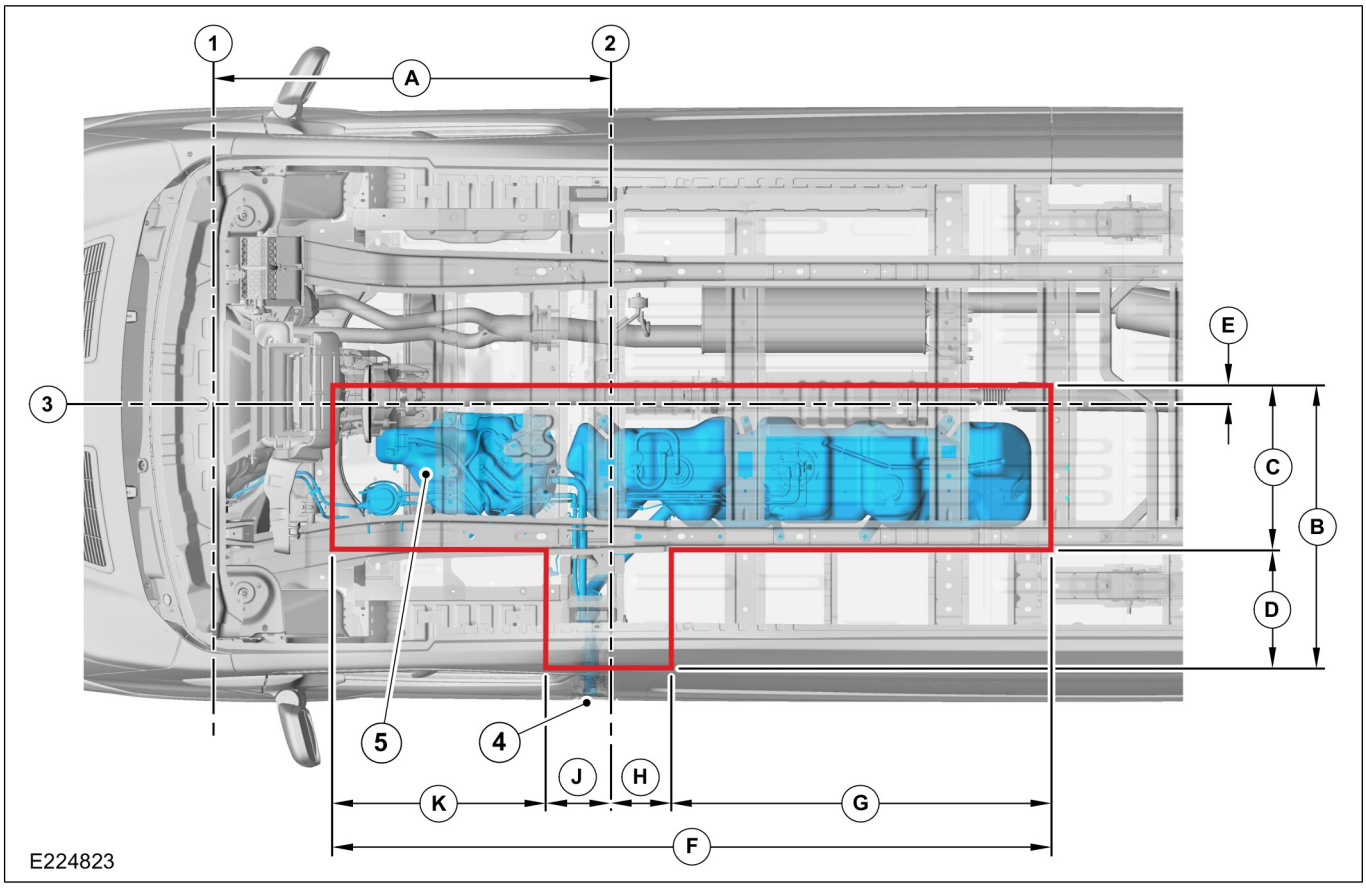


5.1.4 Floor Precautionary Drill Zones Front Wheel Drive Vehicles (FWD) - Fuel Tank



Floor Precautionary Drill Zone Dimensions (mm)	
1	Center line Front Wheel Axle
2	Center of 'B'-Pillar
3	Center line of vehicle
4	Fuel Filler - Driver's side B- Pillar
5	UREA Tank
A	1250
B	1055
C	665
D	390
E	155
F	2285
G	1100
H	260
J	195
k	730

5.1.5 Floor Precautionary Drill Zones Rear Wheel Drive Vehicles (RWD) - Fuel Tank



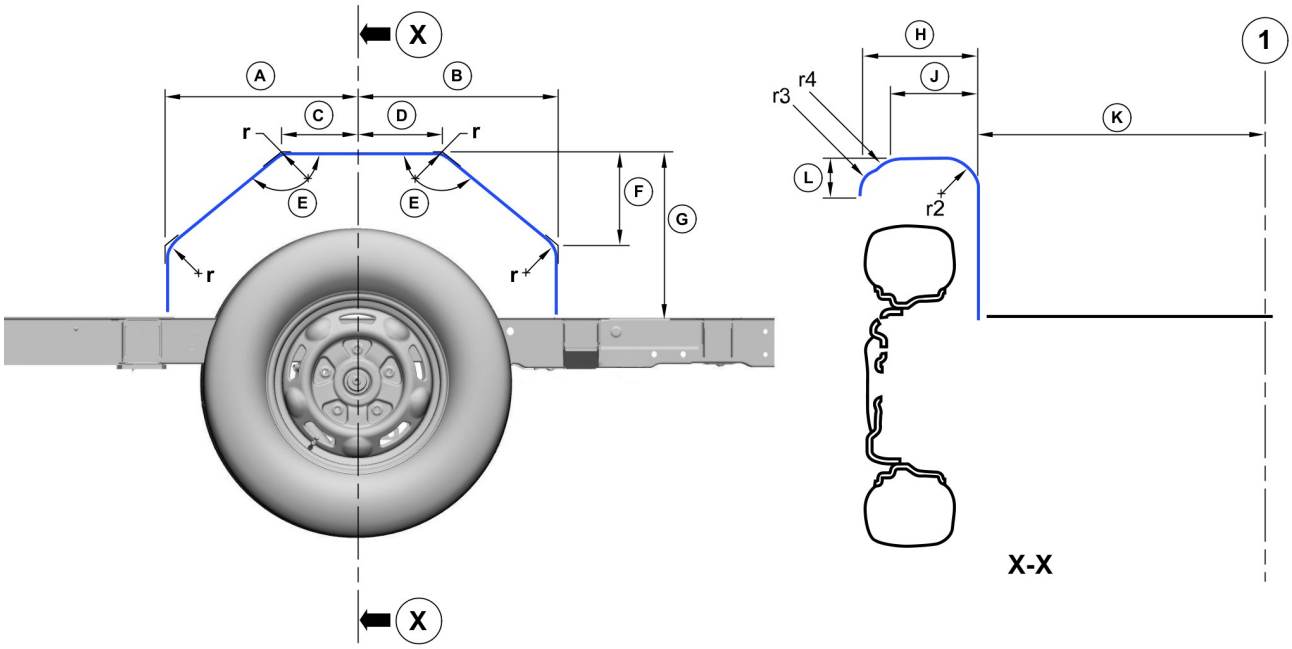
Floor Precautionary Drill Zone Dimensions (mm)	
1	Center line Front Wheel Axle
2	Center of 'B'-Pillar
3	Center line of vehicle
4	Fuel Filler - Driver's side B- Pillar
5	UREA Tank
A	1250
B	970
C	580
D	390
E	70
F	2455
G	1270
H	260
J	195
k	730

5.1.6 Integrated Bodies and Conversions

For integral structures such as ambulances or motor homes with increased rear overhang built onto the chassis the following applies:

- Reduced departure angles, e.g. rear entry step, should be discussed with the end user/customer. Consider removable components to avoid damage on ferries or low-loaders.
- Unique spare wheel stowage may be required if obscured by rear step, check for accessibility.
- The recommended dimensions for wheelhouses on conversions are outlined in Figures E74529, E74530 and E167664. However in case a specific conversion requires wheelhouse dimensions smaller than described, please consult the Vehicle Converters Advisory Service (VCAS@ford.com) for an individual solution.

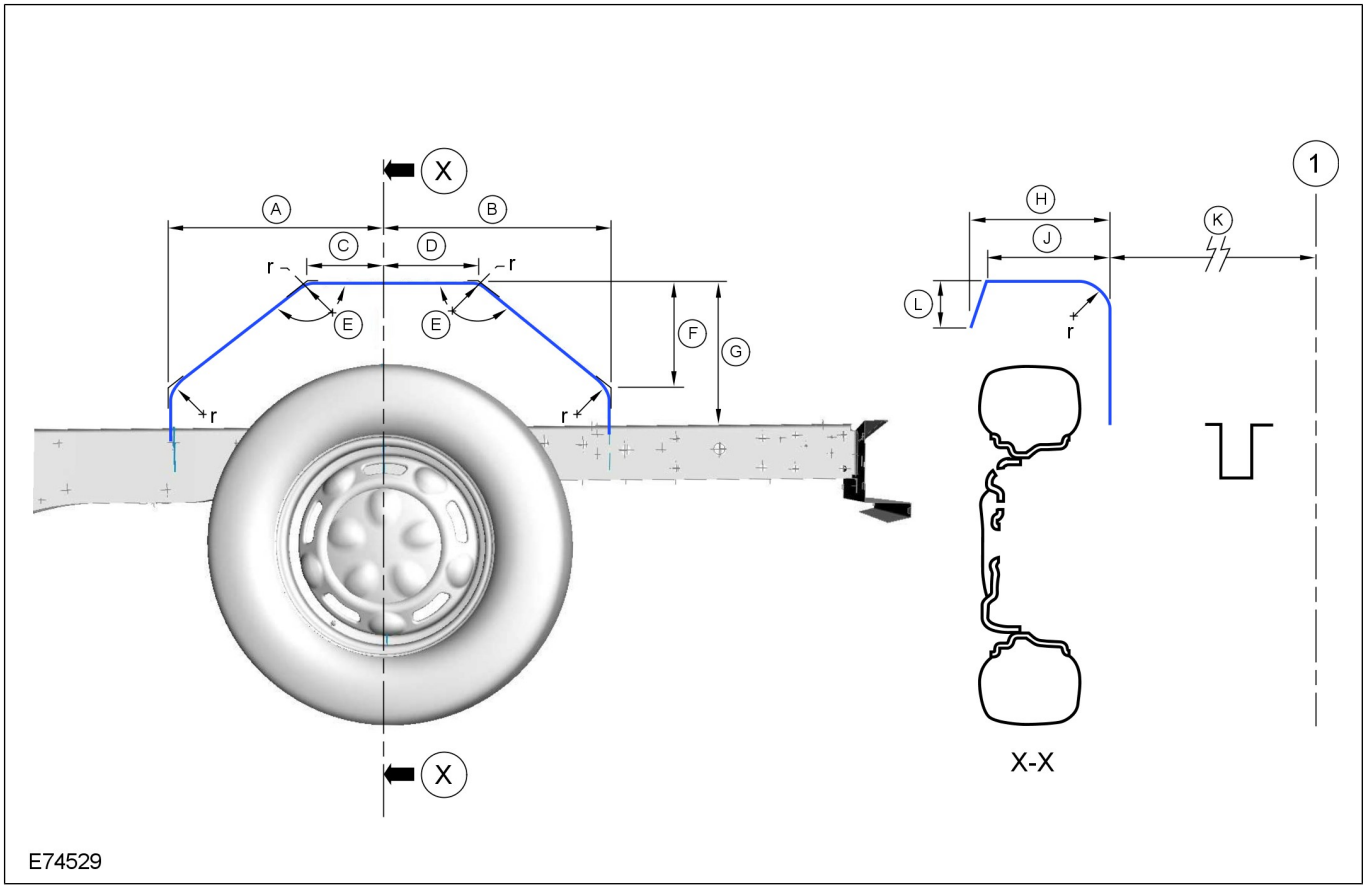
Transit Motorhome Chassis



E167664

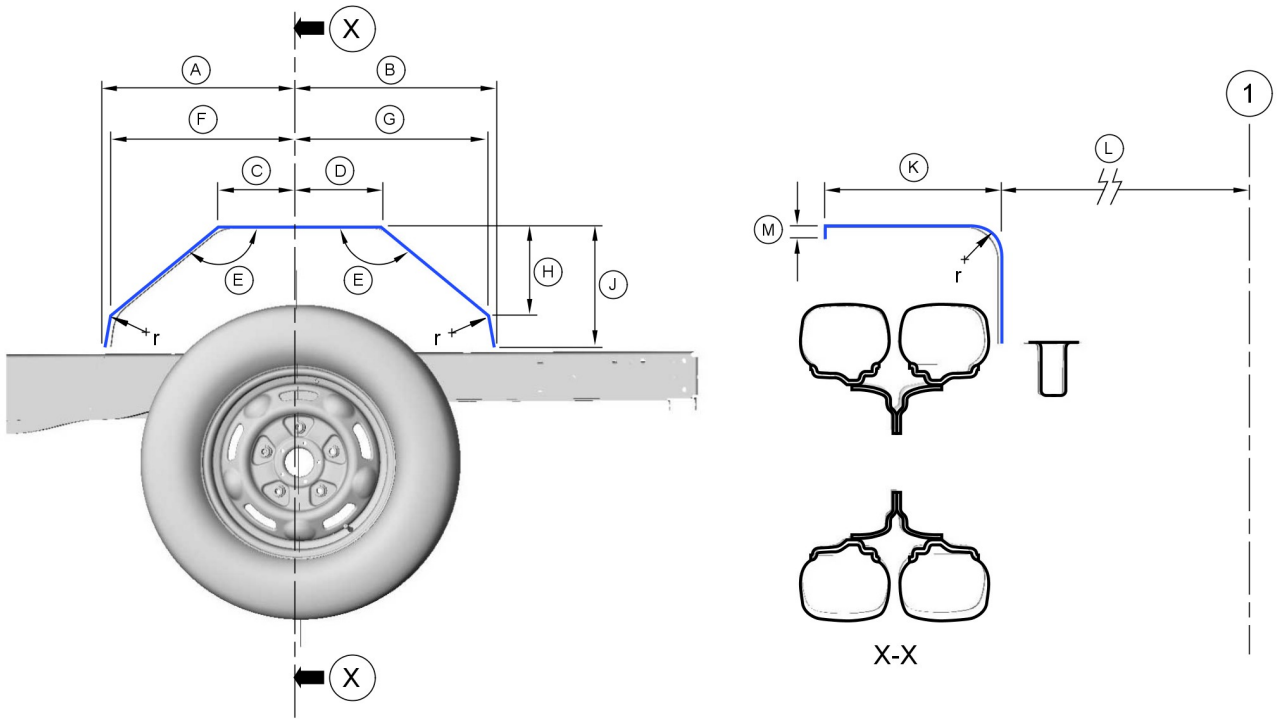
Wheelhouse Dimensions for Transit Motorhome Chassis		
Rear Track Width	**1743 mm Standard**	**1980 mm Wide**
A	420mm	420mm
B	449mm	449mm
C	176mm	176mm
D	205mm	205mm
E	141°	141°
F	197mm	197mm
G	362mm	364mm
H	302mm	302mm
J	236mm	236mm
K	696mm	803mm
L	72mm	72mm
r1	75mm radius	75mm radius
r2	75mm radius	75mm radius
r3	50mm radius	50mm radius
r4	42mm radius	42mm radius
1	Center line of Vehicle	
X	Section through Center of Wheelhouse	

Chassis Cab with Single Rear Wheel Axle for FWD and RWD Vehicles



Wheelhouse Dimensions for Chassis Cab with Single Rear Wheel Axle for FWD and RWD Vehicles			
A	418mm	G	265mm
B	448mm	H	268mm
C	165mm	J	242mm
D	194mm	K	696mm
E	141°	L	80mm
F	197mm	r	75mm
1	Center line of Vehicle		
X	Section through Center of Wheelhouse		

Chassis Cab with Dual Rear Wheel Drive Axle



E74530

Wheelhouse Dimensions for Chassis Cab with Dual Rear Wheel Drive Axle			
A	418mm	G	436mm
B	448mm	H	197mm
C	164mm	J	265mm
D	194mm	K	403mm
E	141°	L	577mm
F	406mm	M	27mm
1	Center line of Vehicle	r	75mm
X	Section through Center of Wheelhouse		

5.1.7 Chassis Cab

WARNING: Excessive heat can build up from the exhaust system, in particular from the catalytic converter. Ensure adequate heat shields are maintained.

CAUTION: Uneven load distribution could result in unacceptable handling and braking characteristics.

When carrying out vehicle conversions/modifications the following points should be considered:

- Make sure that all of the reinforced holes provided in the chassis frame top surface are used for full length bodies or sub-frames, see Figures E167667, E167668, E167669 and E167670.
- Make sure that the vehicle structural integrity is maintained
- Do not drill into closed frame body members.
- Make sure that the design for the body alterations or additional structure disperse the load evenly.
- Re-paint metal edges after cutting or drilling. All metal edges must comply with exterior and interior protection legislation.
- All fixings through the floor, sides or roof must be sealed.

Refer to: 5.14 Corrosion Prevention (page 268).

- Ensure that any additional equipment in the vicinity of the fuel tank will not damage the tank in a crash condition.

NOTE: The reinforcement plate in cab back panel to chassis member area must be maintained. Do not drill or cut into this area, see figure E167672.

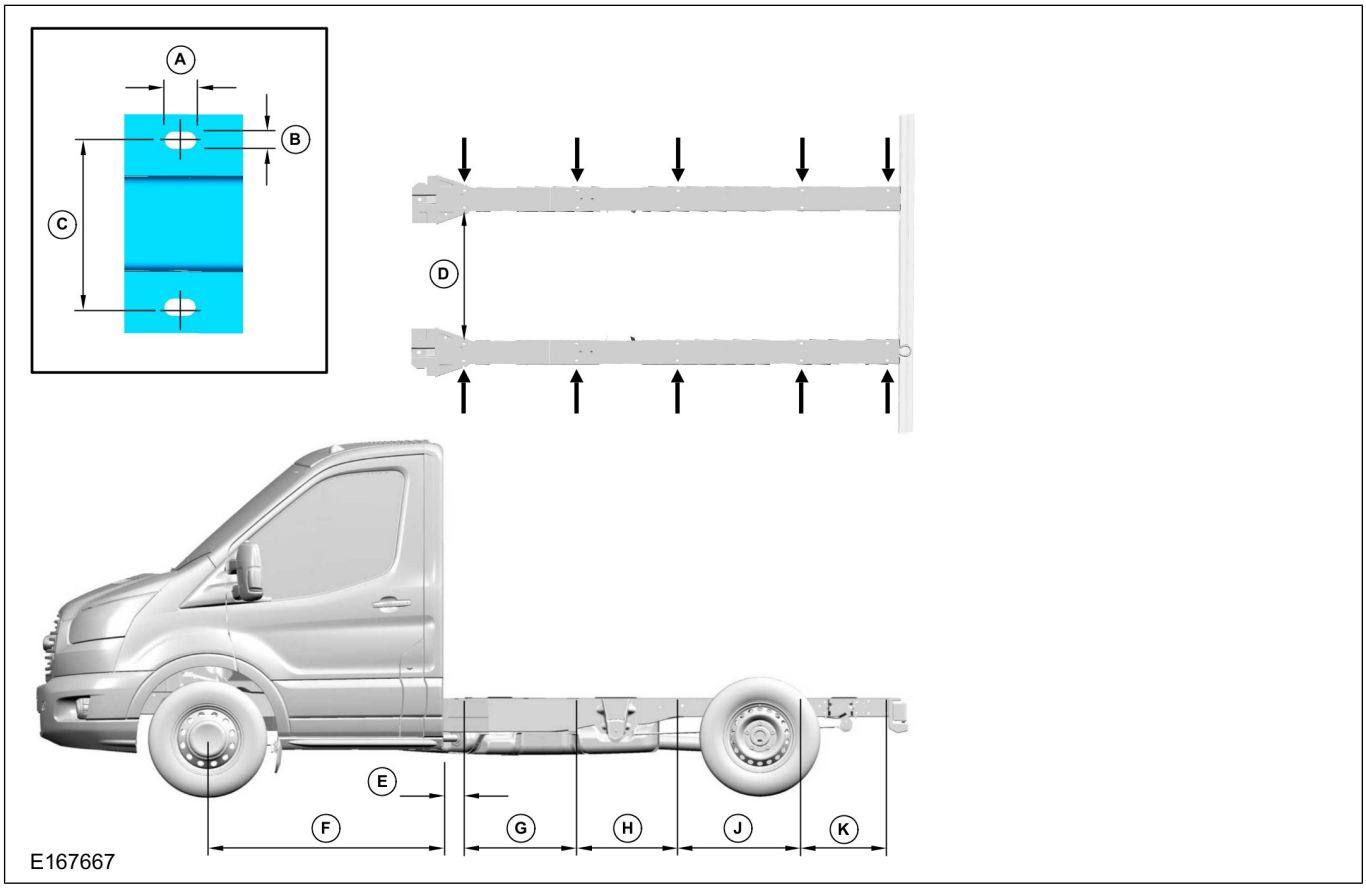
For additional information:

- Refer to: 5.15 Frame and Body Mounting (page 269).
- Refer to: 5.13 Roof (page 265).

For any conversion structure attached to or mounted onto the base vehicle cab structure the following applies:

- Ensure that neither the conversion structure nor the existing vehicle structure get pre-loaded by the assembly process.
- Adhesive jointing is recommended but should be supplemented with mechanical fasteners to prevent initial peel and long term failure.
- Spread bolt loads to minimize local stress.

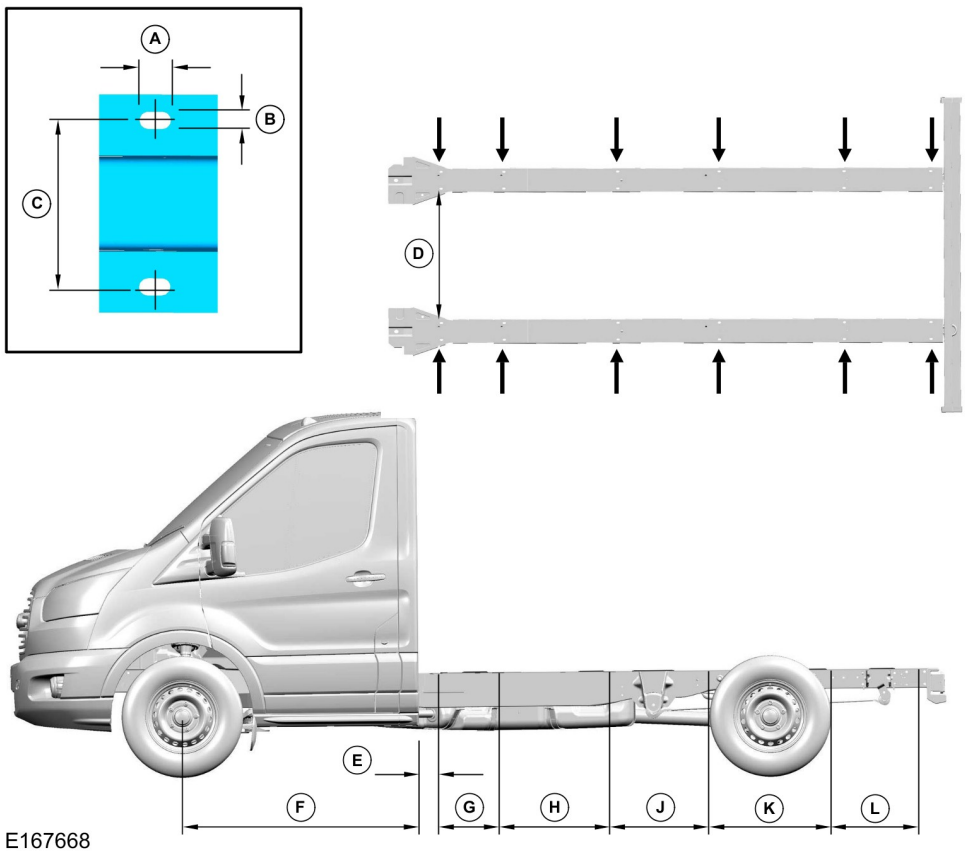
Body Attachment Holes - Chassis Frame Top Flange L1 Wheelbase



Body Attachment Holes -Chassis Frame Top Flange L1 Wheelbase			
A	19	F	1407
B	11	G	665
C	100	H	592
D	800	J	730
E	108	K	506

Dimensions in mm. For wheelbase dimensions see 'Vehicle Dimension Key' table in Package and Ergonomic section of this manual.

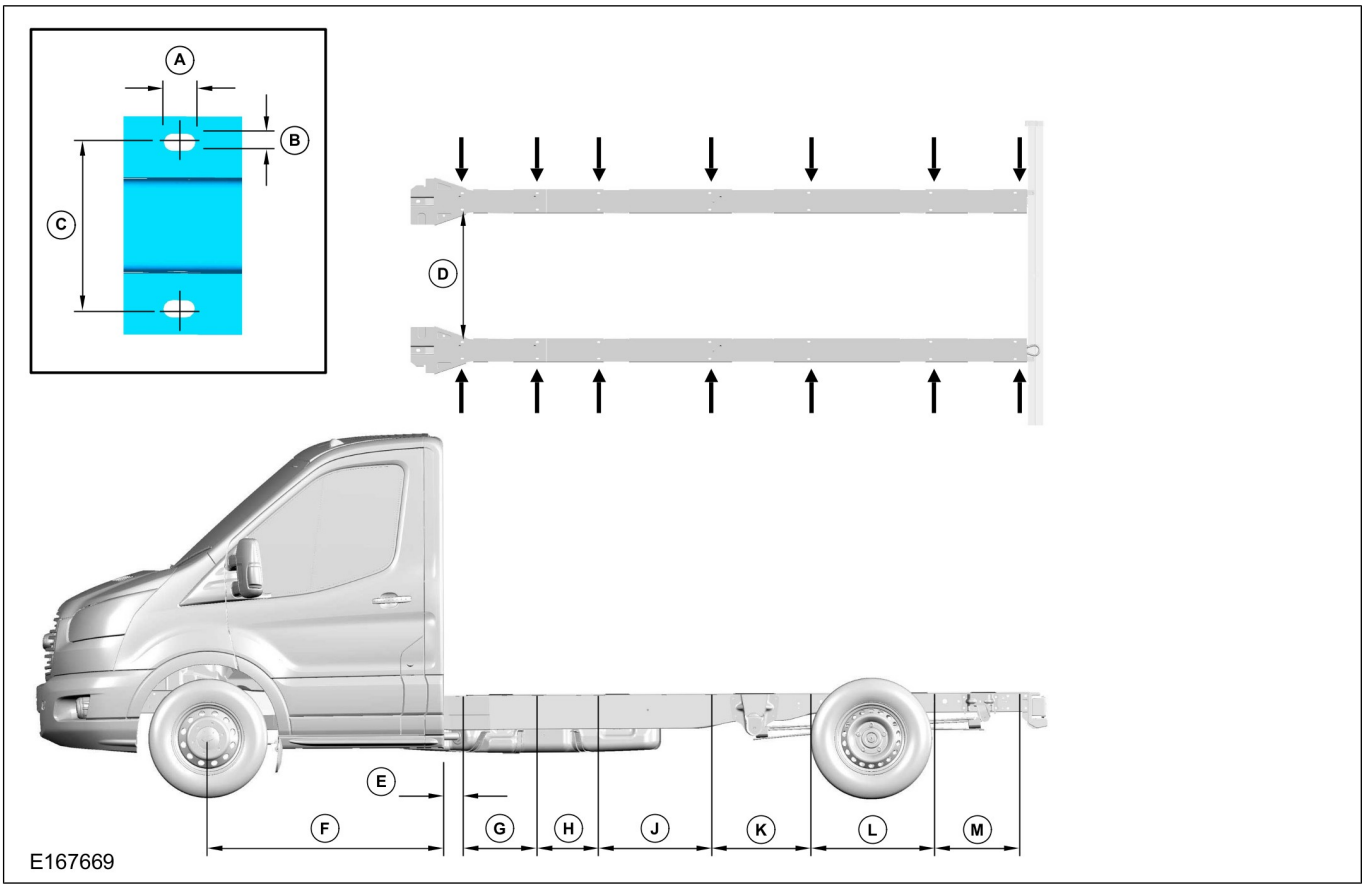
Body Attachment Holes - Chassis Frame Top Flange L2 Wheelbase



Body Attachment Holes -Chassis Frame Top Flange L2 Wheelbase			
A	19	G	367
B	11	H	665
C	100	J	592
D	800	K	730
E	108	L	506
F	1407	-	-

Dimensions in mm. For wheelbase dimensions see 'Vehicle Dimension Key' table in Package and Ergonomic section of this manual.

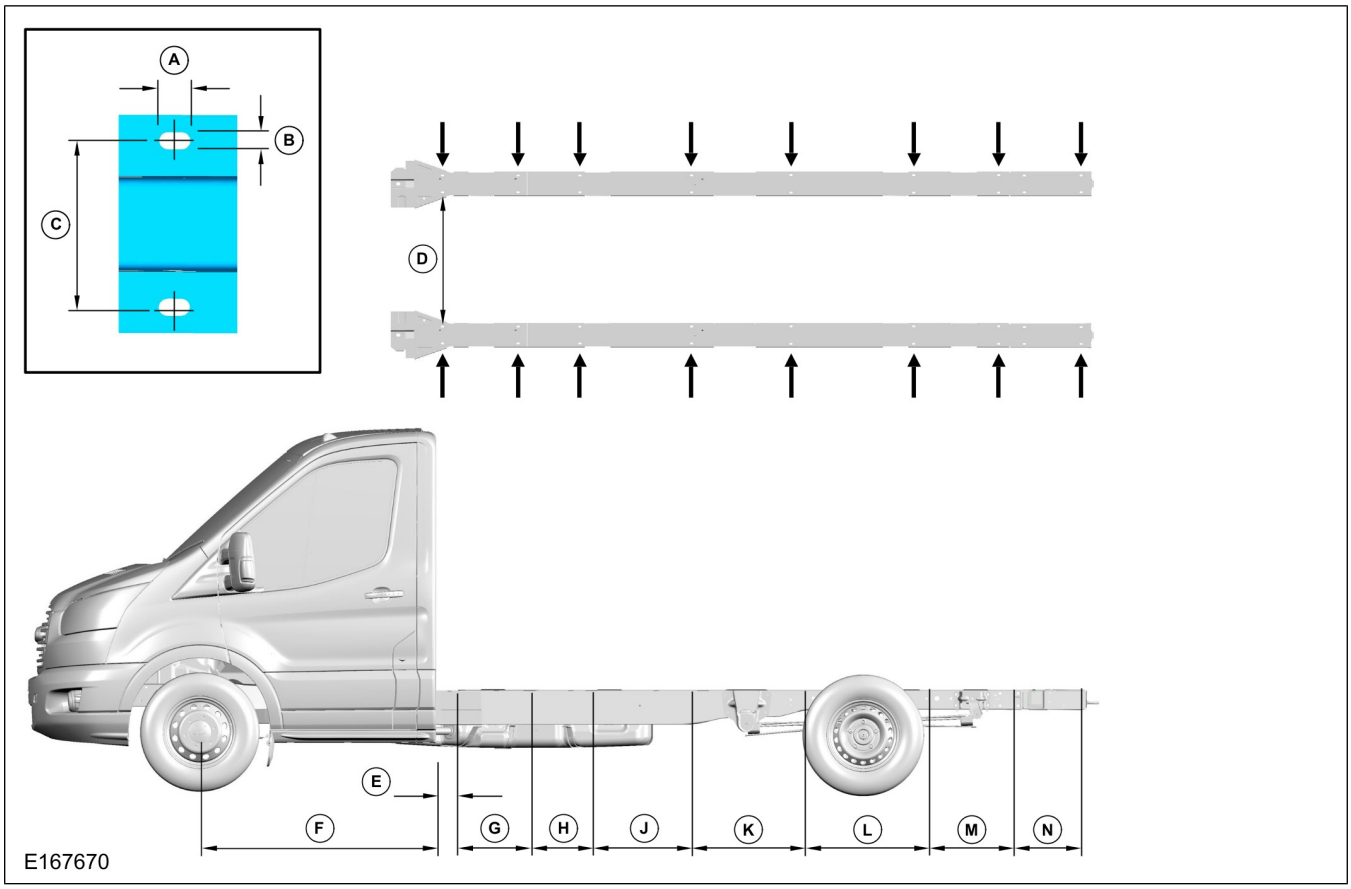
Body Attachment Holes - Chassis Frame Top Flange L3 Wheelbase



Body Attachment Holes - Chassis Frame Top Flange L3 Wheelbase			
A	19	G	450
B	11	H	367
C	100	J	665
D	800	K	592
E	108	L	730
F	1407	M	506

Dimensions in mm. For wheelbase dimensions see 'Vehicle Dimension Key' table in Package and Ergonomic section of this manual.

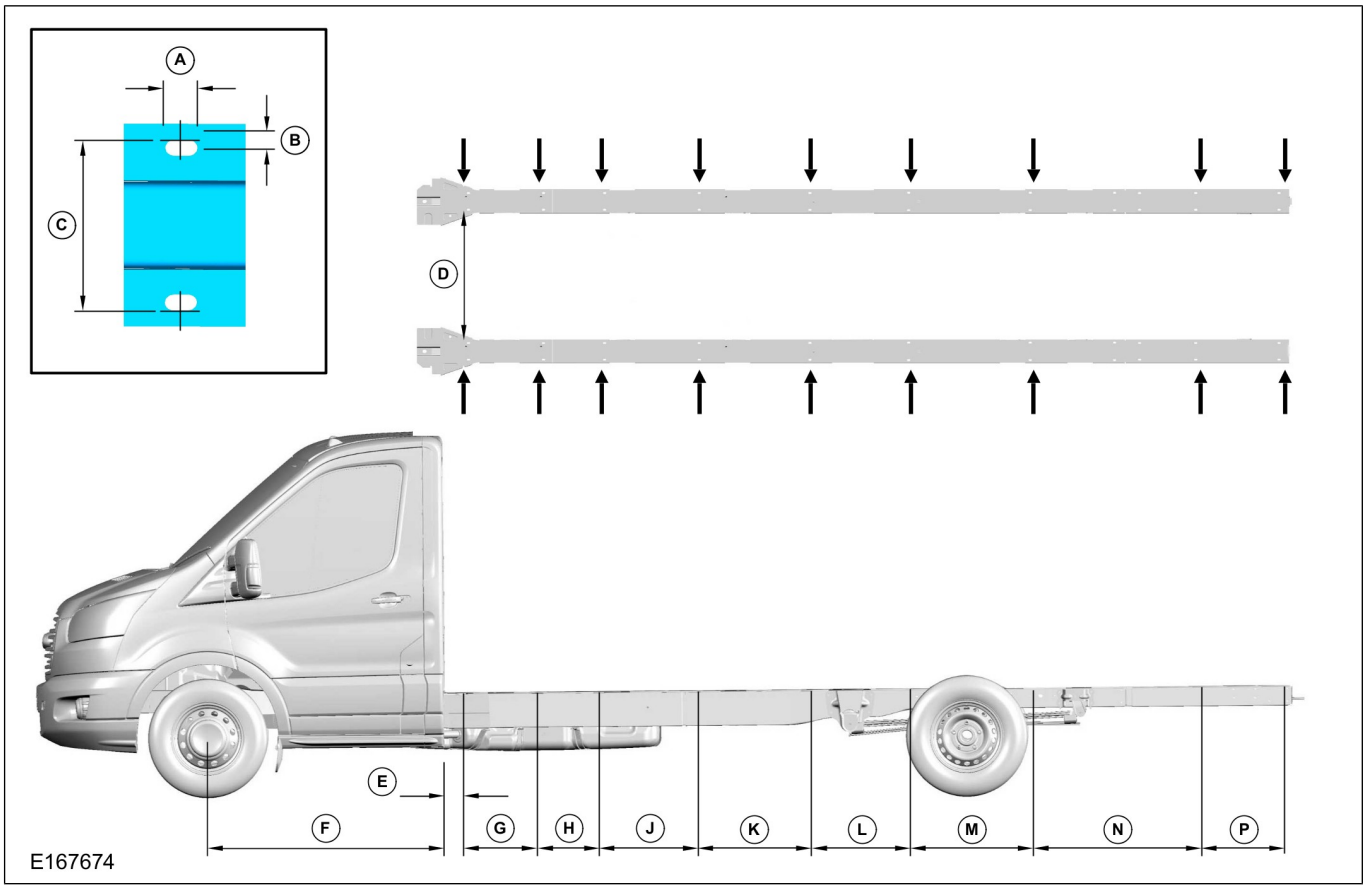
Body Attachment Holes - Chassis Frame Top Flange L4 Wheelbase



Body Attachment Holes Chassis Frame Top Flange L4 Wheelbase			
A	19	H	367
B	11	J	665
C	100	K	592
D	800	L	730
E	108	M	506
F	1407	N	561
G	450	-	-

Dimensions in mm. For wheelbase dimensions see 'Vehicle Dimension Key' table in Package and Ergonomic section of this manual.

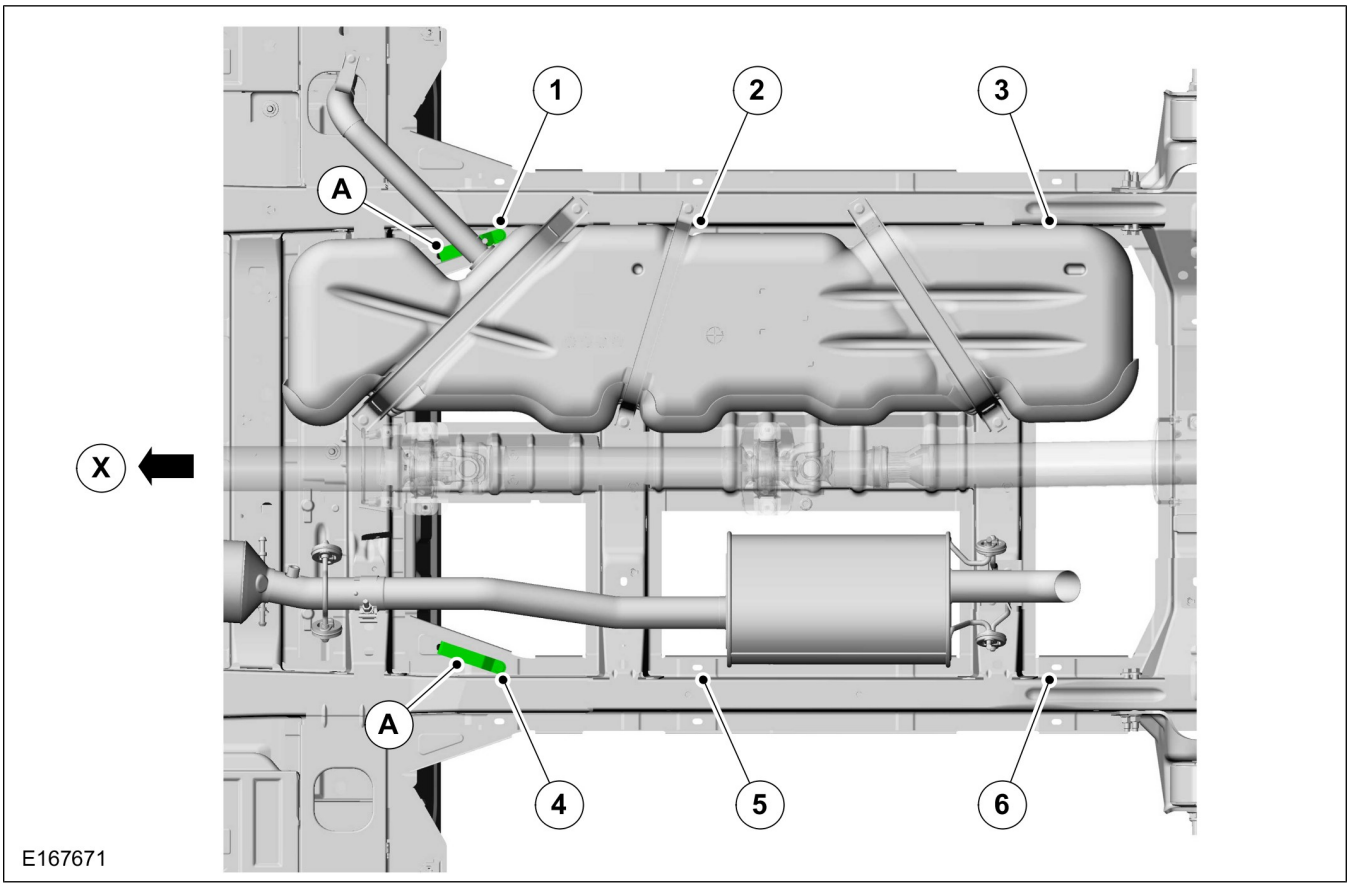
Body Attachment Holes - Chassis Frame Top Flange L5 Wheelbase



Body Attachment Holes Chassis Frame Top Flange L5 Wheelbase			
A	19	H	367
B	11	J	568
C	100	K	665
D	800	L	592
E	108	M	730
F	1407	N	993
G	450	P	500

Dimensions in mm. For wheelbase dimensions see 'Vehicle Dimension Key' table in Package and Ergonomic section of this manual.

Recommended Second Unit Body Fixing Strategy - Single Chassis Cabs



Item	Description
A	Anti Rotation Bolt - EK31-101D80-A_
1	Restricted access to inner attachment hole due to fuel tank. Must use Anti Rotation Bolt 'A'
2 and 3	Inner attachment holes can be omitted.
4	Restricted access to inner attachment hole due to heat shield. Recommended to use Anti Rotation Bolt 'A'
5 and 6	Inner attachment holes can be omitted.

When mounting a Second Unit Body all of the attachment holes shown in figures E167667, E167668, E167669, E167670 or E167674 should be used unless specified they can be omitted.

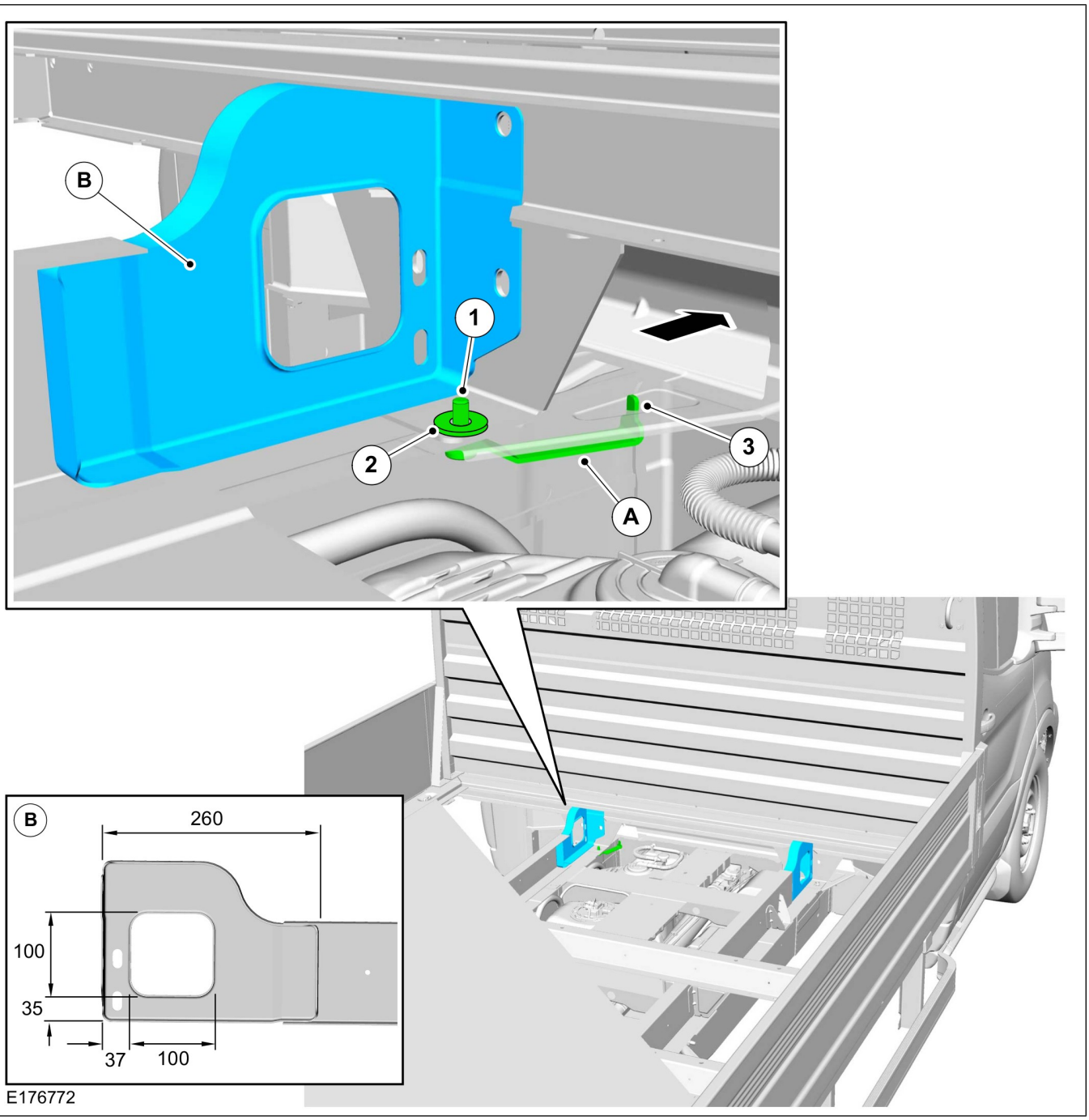
NOTE: Some of the attachment holes are difficult to reach or obscured by the fuel tank and can be omitted, EXCEPT attachment hole 1 which must be used, a special anti-rotation bolt is available - EK31-101D80-A_. It is recommended to use this special bolt in both the inner first positions 1 and 4, see figure E176671 'Recommended Second Unit Body Fixing Strategy'.

NOTE: So that the bolt can be tightened from outside the vehicle, a cut out in the lower rail of the second unit body may be necessary for tool access.

Fitting the Anti-rotation Bolt

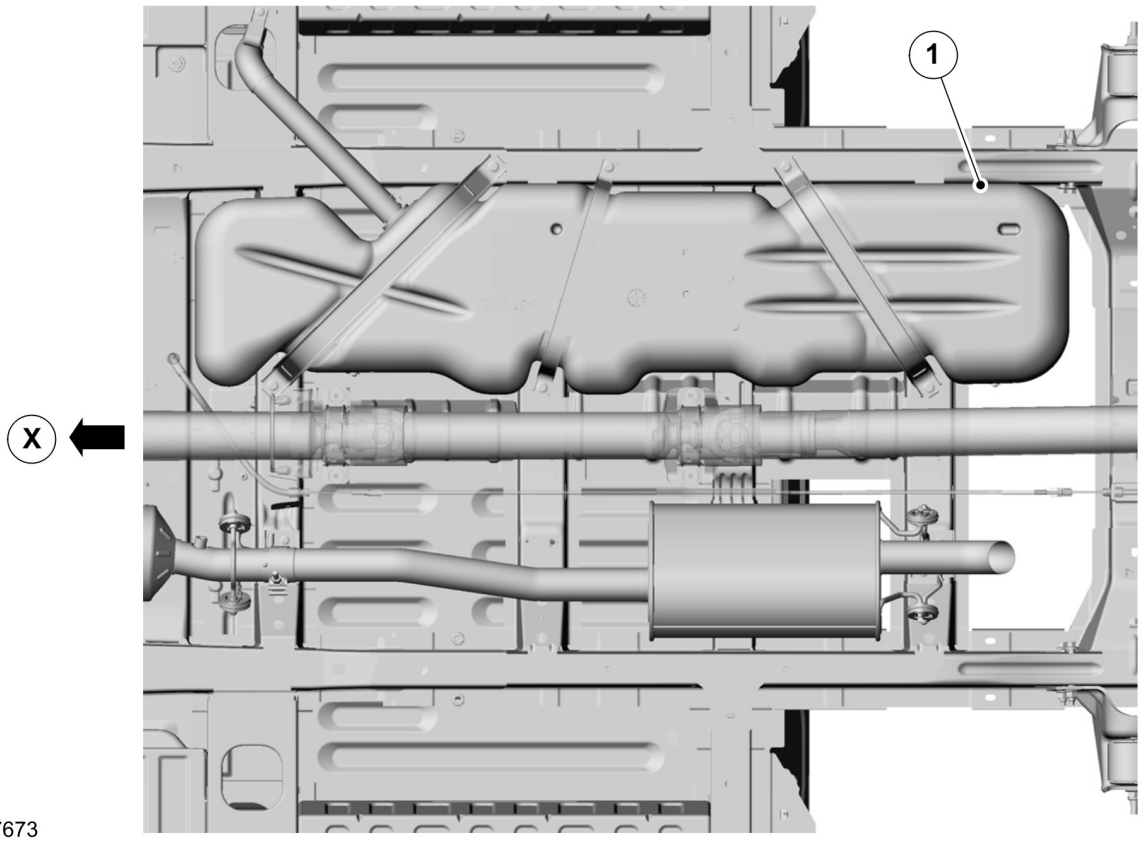
- Insert anti-rotation bolt from underneath into hole 1 and insert the anti-rotation pin into hole 3, see figure E1766712, repeat for other side.
- Temporarily secure the bolt using the locking/grip washer on the upper side of the chassis rail, see item 2 in figure E176672.
- Mount the float, box body ensuring the bolt aligns with the hole in the second unit body.
- Complete the joint by tightening the bolt, torque 55Nm.

Recommended Fixing Strategy - Second Unit Body to Chassis Frame



Item	Description
A	Anti-rotation bolt -EK31-101D80-A_
B	Cut out in lower rail of second unit body to allow tool access to tighten bolt
1	Anti-rotation bolt
2	Locking/Grip Washer
3	Anti-rotation pin

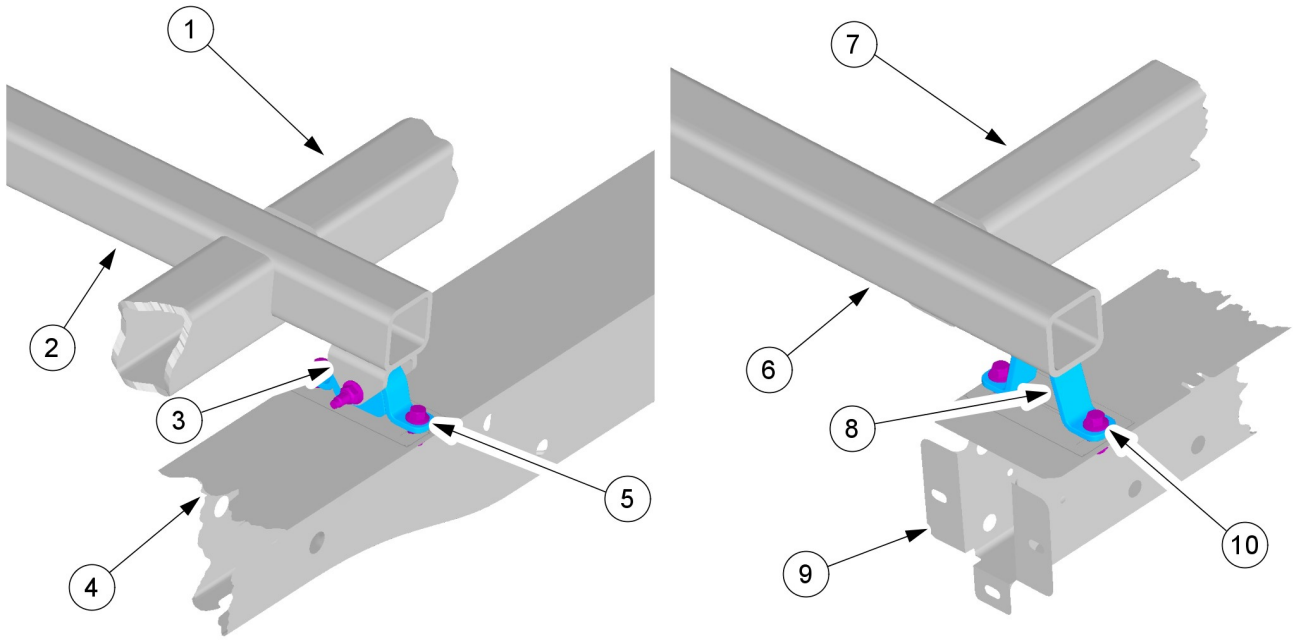
Recommended Second Unit Body Fixing Strategy - Double Chassis Cabs MWB only



E167673

When fitting a second unit body to a Medium Wheelbase (MWB) Double Chassis Cab not all the attachment points are accessible, position 1, shown in figure E167673 is obscured by the fuel tank and can be omitted. All other fixing points should be used.

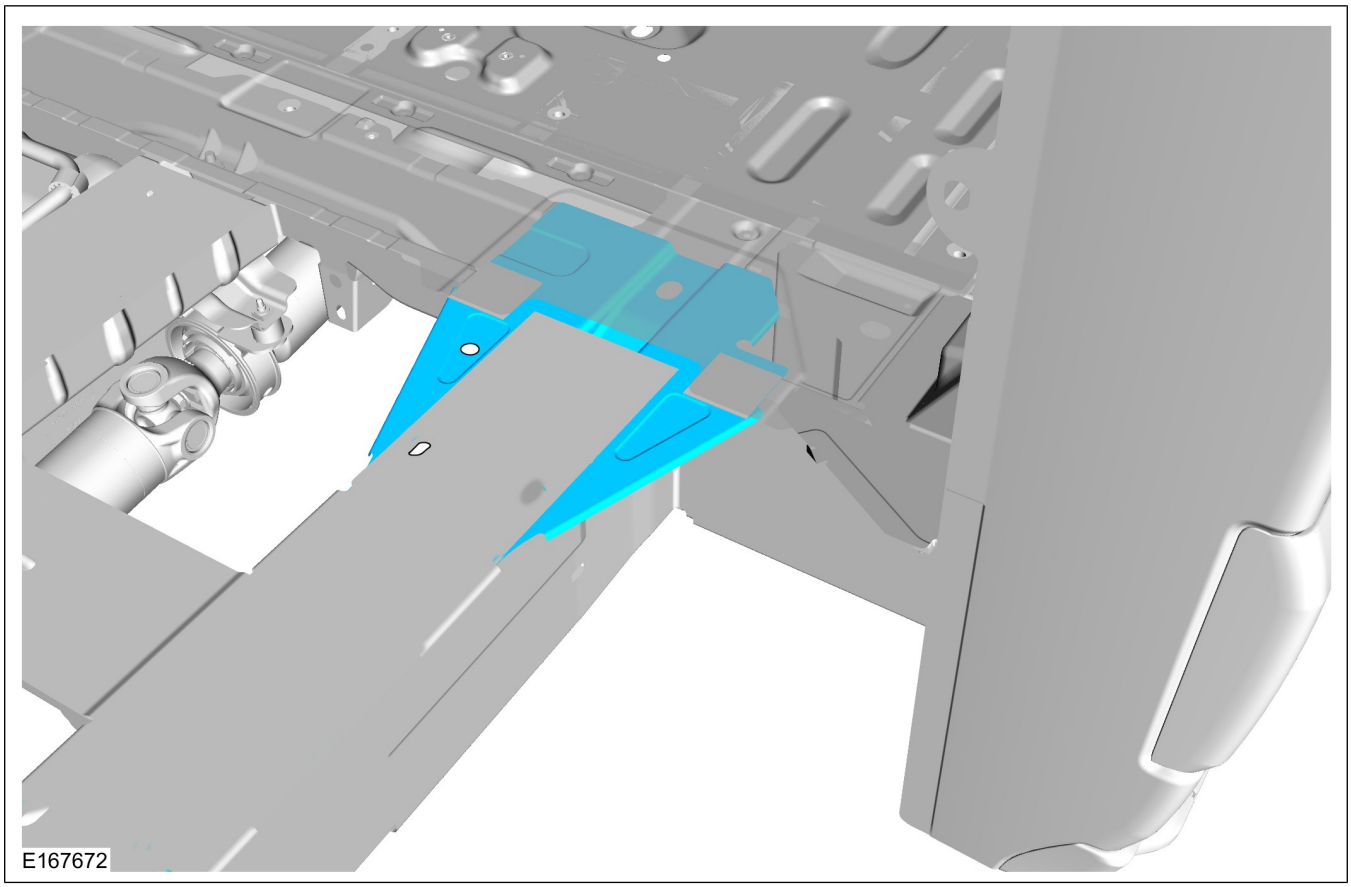
Sub Frame Attachment to Chassis Frame



E74696

Item	Description
1	Sub-frame Longitudinal
2	Sub-frame Outriggers
3	Compliant Mount
4	Chassis Frame
5	M10 Bolts and Self Locking Nuts
6	Sub-frame Outriggers
7	Sub-frame Longitudinal
8	Solid or Fixed Mount
9	Chassis Frame
10	M10 Bolts and Self Locking Nuts

Reinforcement Plate on Single Chassis Cab Vehicles



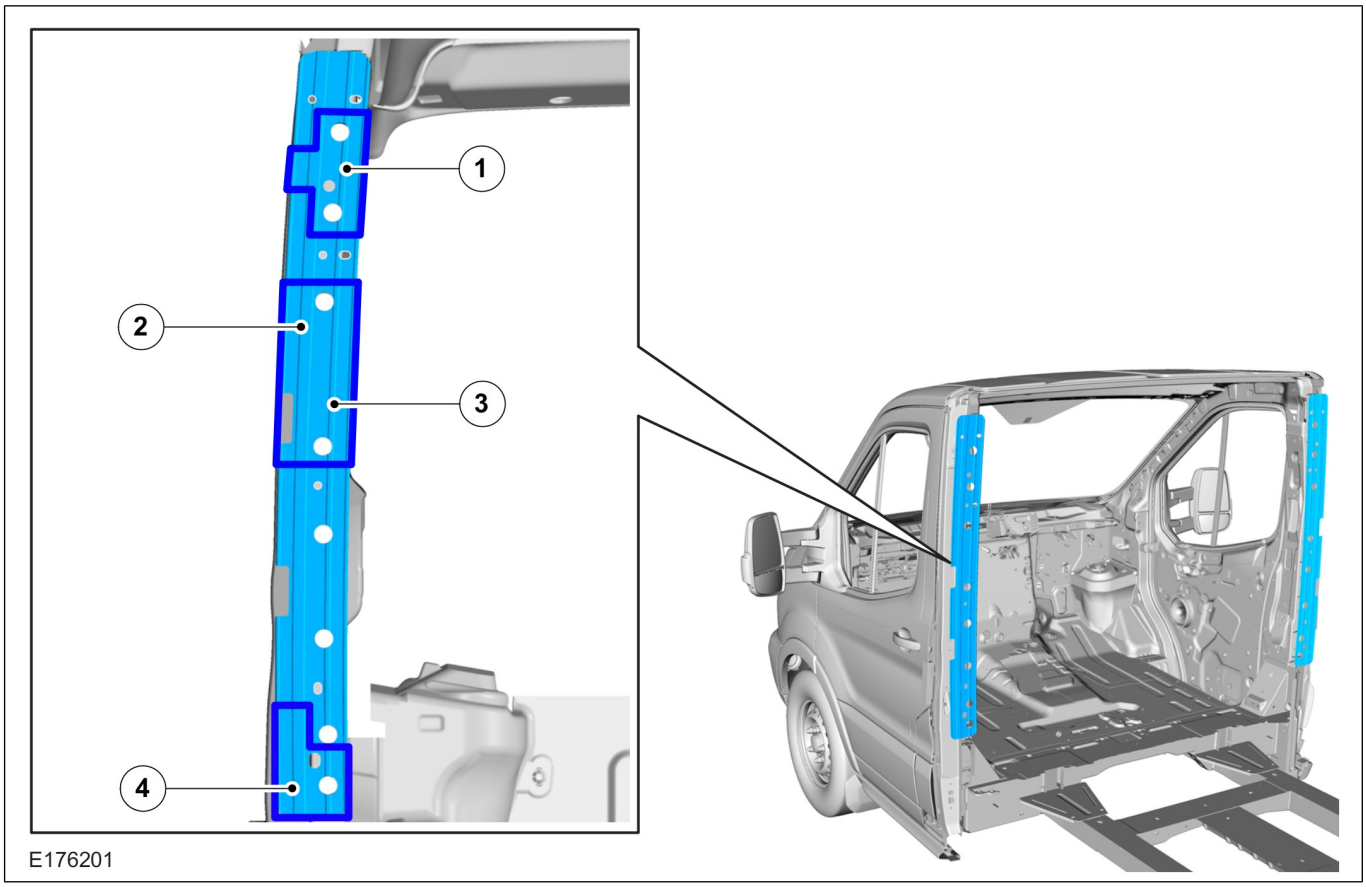
5.1.8 Transit Motorhome Chassis

NOTE: Transit Motorhome Chassis models are currently only available for use in Motorhome applications. For use in other applications contact your local National Sales Company representative or the Vehicle Converters Advisory Service VCAS@ford.com

Please refer to general advice and warnings for Chassis Cab. For Transit Motorhome Chassis vehicles, the following additional guidelines apply:

- The Transit Motorhome Chassis as an incomplete vehicle does not offer a self supporting body structure. A box body **Must** be added.
- Design a sufficient connection to the B-pillar bracket (sidewall to cab connection), by using at least 4x M8 screws per side, see figure E176201 for the areas that can be used for bolting the body to the B-pillar bracket.
- Do not drill into B-pillar flange behind bracket. Leave sufficient space between drilled hole and outer border of bracket.

Body to B-Pillar Bracket - Recommended Attachment Area



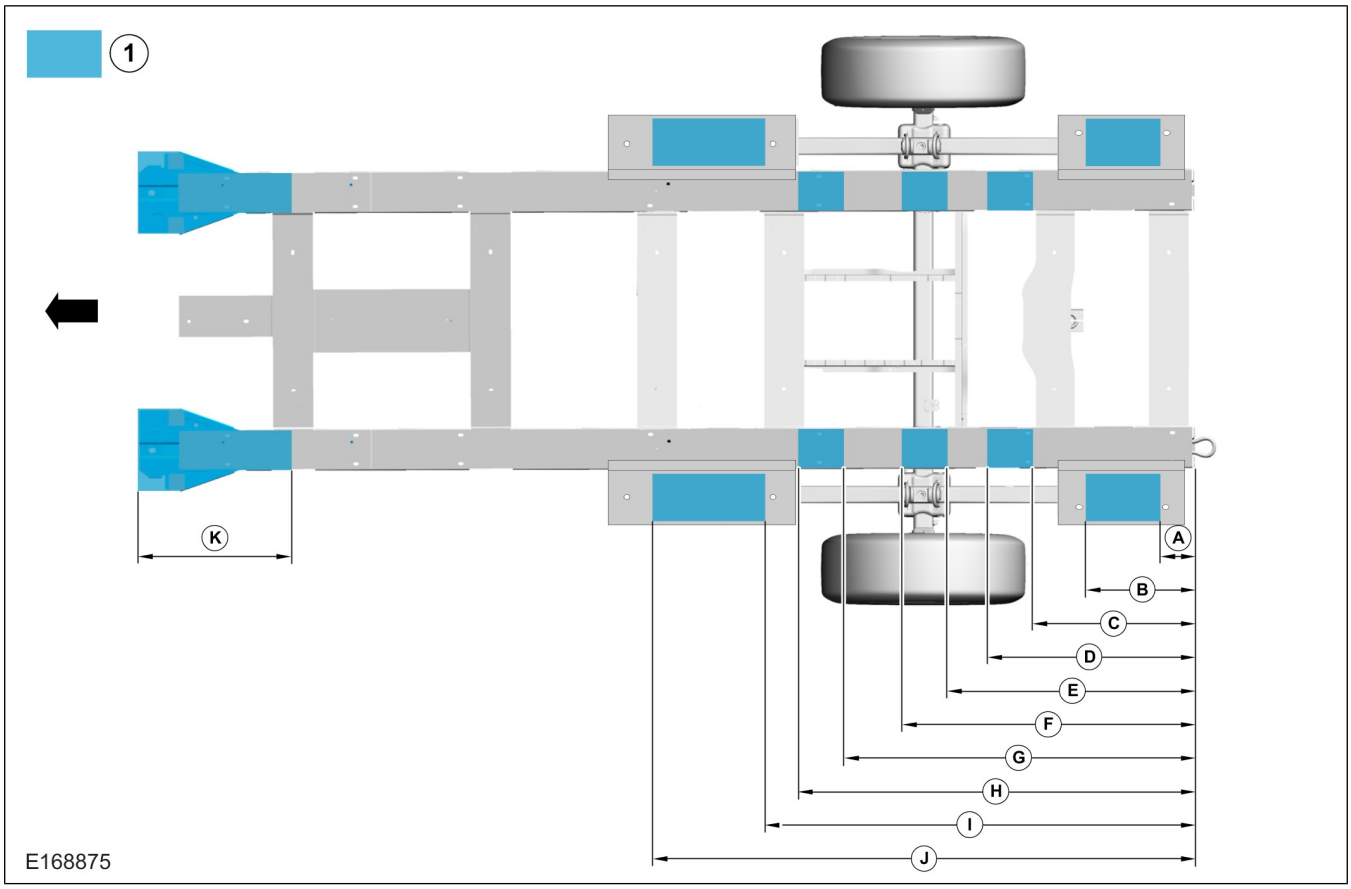
E176201

- If implementing a fully sealed body air extraction is required, the recommendation is the use of one Ford service part 6G91_A280B62_A* on each side of the vehicle. If this is not possible the alternative extractor should provide 150cm^2 of cross sectional area on each side of the vehicle. An ideal position for the extractors would be in the back panel of the cab. If this is not feasible, then the extractors should be situated rearwards of B-pillar such that there is a free airflow path equating to the extractor effective CSA maintained both upstream and downstream of each extractor to maintain windshield defogging performance and door closing efforts. Extraction should not be installed near exhaust components, or areas exposed to potential fuel spillage.
- It is recommended to fix the converters floor by using additional U-type fixings around the main rails and cross members or by using screws running vertically through floor and rails, cross members and outriggers. To eliminate deformation of the rails during screwing process, we recommend to use tubing

  Refer to: 5.15 Frame and Body Mounting (page 269).
- The Transit Motorhome Chassis offers most design flexibility for adding a sidestep.
- Due to the wide side overhang it is recommended to support the vehicle converters floor.

  Refer to: 5.15 Frame and Body Mounting (page 269).
- Do not cut or drill into areas as shown in figure E168875.
- Drill only through the center line of rails and ensure no spot weld is drilled out.
- The vehicle structure must not get preloaded by the conversion structure or the assembly process.

Transit Motorhome Chassis Rails - Precautionary Drill Zones (1)



Item	Wheel Base		
	L2 - 3300	L3 - 3750	L4 - 3954
A	166	166	166
B	396	396	396
C	596	596	596
D	754	754	754
E	926	926	926
F	1066	1066	1066
G	1356	1356	1356
H	1442	1442	1442
I	1580	1580	1580
J	2020	2020	2020
K	430	430	430

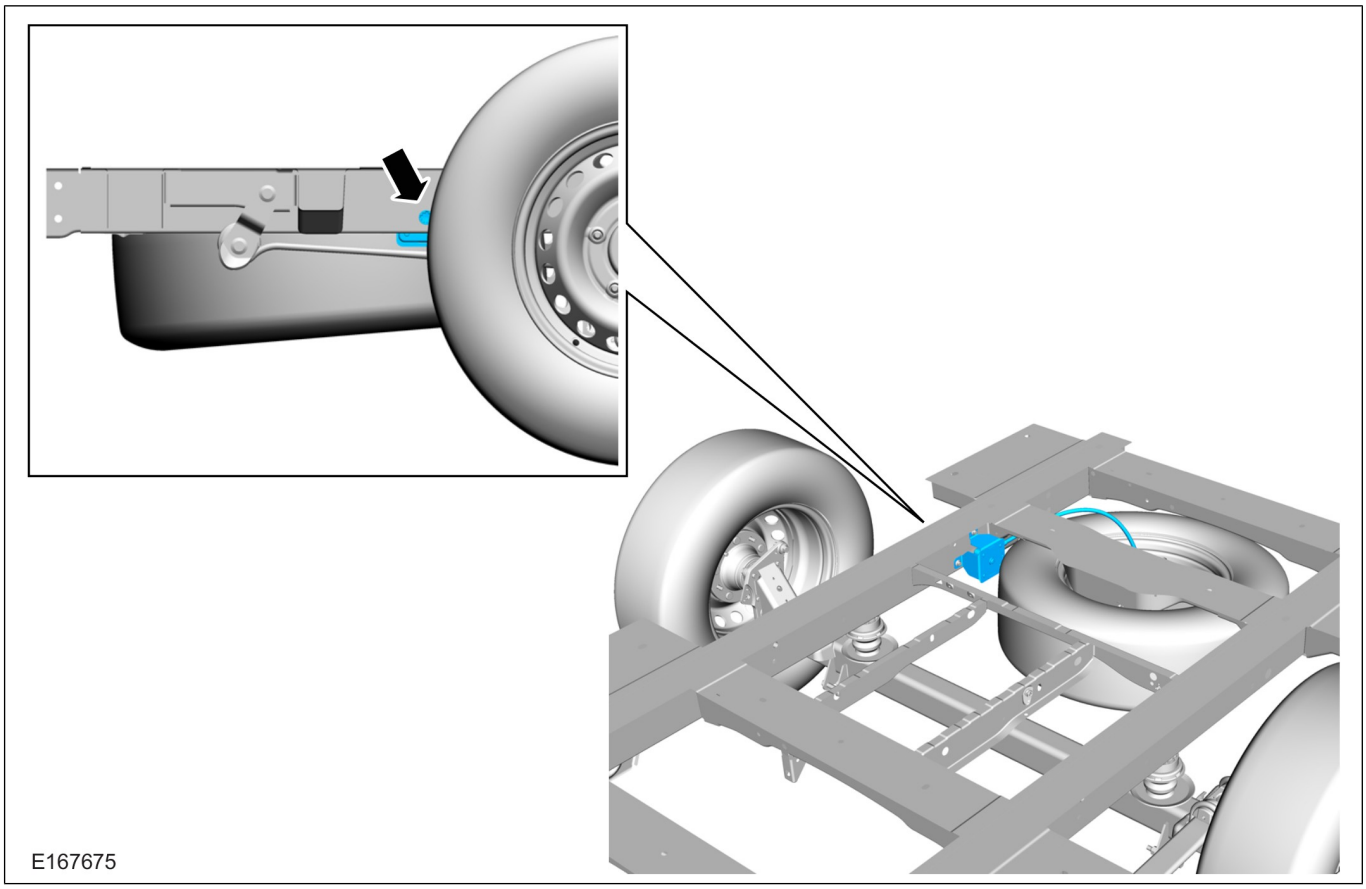
Dimensions in mm.

- The Transit Motorhome Chassis offers a fixing strategy for rear extensions with or without towbar. The extension can be inserted into the motorhome chassis rails, all 4 fixing locations must be used.

  Refer to: 5.15 Frame and Body Mounting (page 269).
  figure E167540.
- For attachment to the base vehicle

  Refer to: 1.16 Towing (page 43).
- For basic dimensions and weights see figure E176200 and table.
- For standard track and wide track width rear axle see figure E131488.

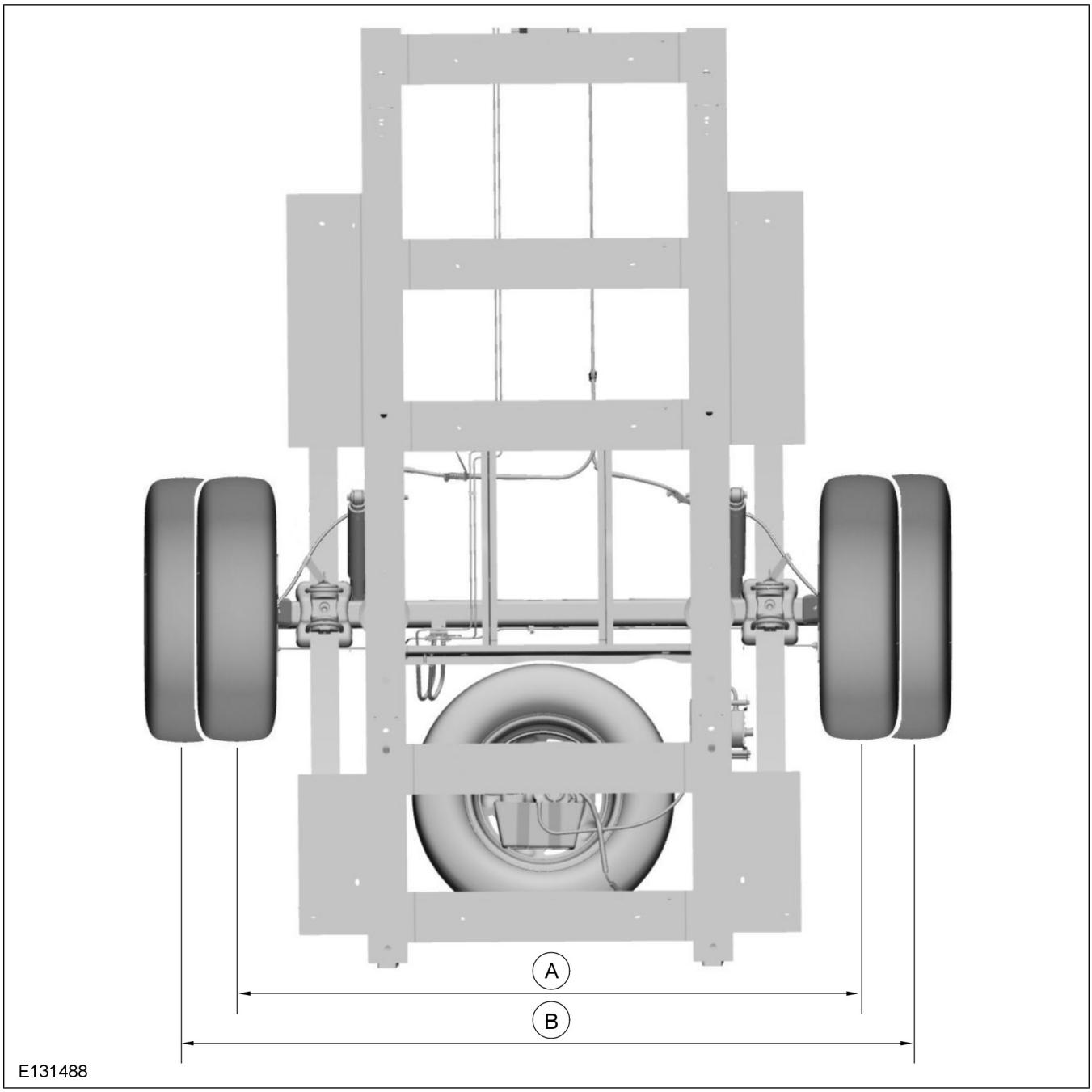
Transit Motorhome Chassis - Spare Wheel Winch Location (Left hand side shown)



Ensure sufficient access to the winch for additional information

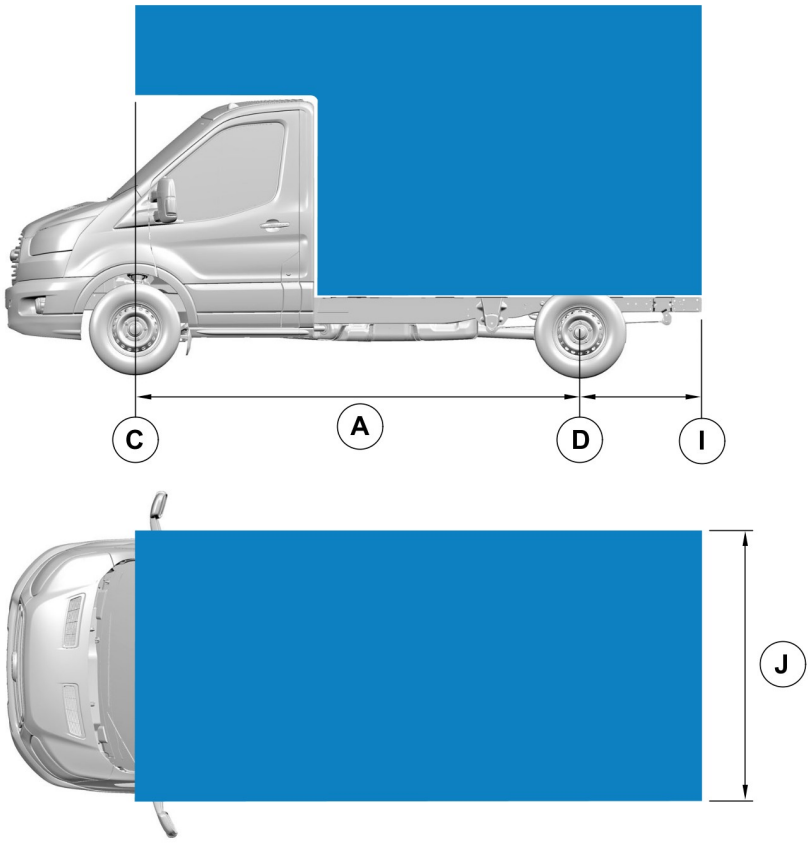
Refer to: 2.4 Wheels and Tires (page 53).

Transit Motorhome Track Widths



Item	Description
A	Standard Track Width - 1759mm
B	Wide Track Width - 1980mm

Transit Motorhome Chassis - Basic Dimensions and Weights



E176200

Description		L2	L3	L4
A	Wheelbase	3300	3750	3954
B	Gross Vehicle Mass GVM (kg)	3500	3500/4100	3500/4100
C	Max. Axle load front (kg)	1750/1850	1750/1850	1750/1850
D	Max. Axle load rear (kg)	2150	2250/2500	2250/2500
E	Max. Trailer load (kg)	1400/2000	1400/2000	1400/2000
F	Max. Towing nose mass (kg)	112	112	112
G	Standard track width (mm)	1759	1759	-
H	Wide track width (mm)	1980	1980	1980
I	Max. Rear Overhang/Extension (mm)	60% of the wheelbase or the donor vehicle		
J	Max Body Width (mm)	2400*		

NOTE: The frontal area (Width x Height) should NOT exceed 6.4m2.

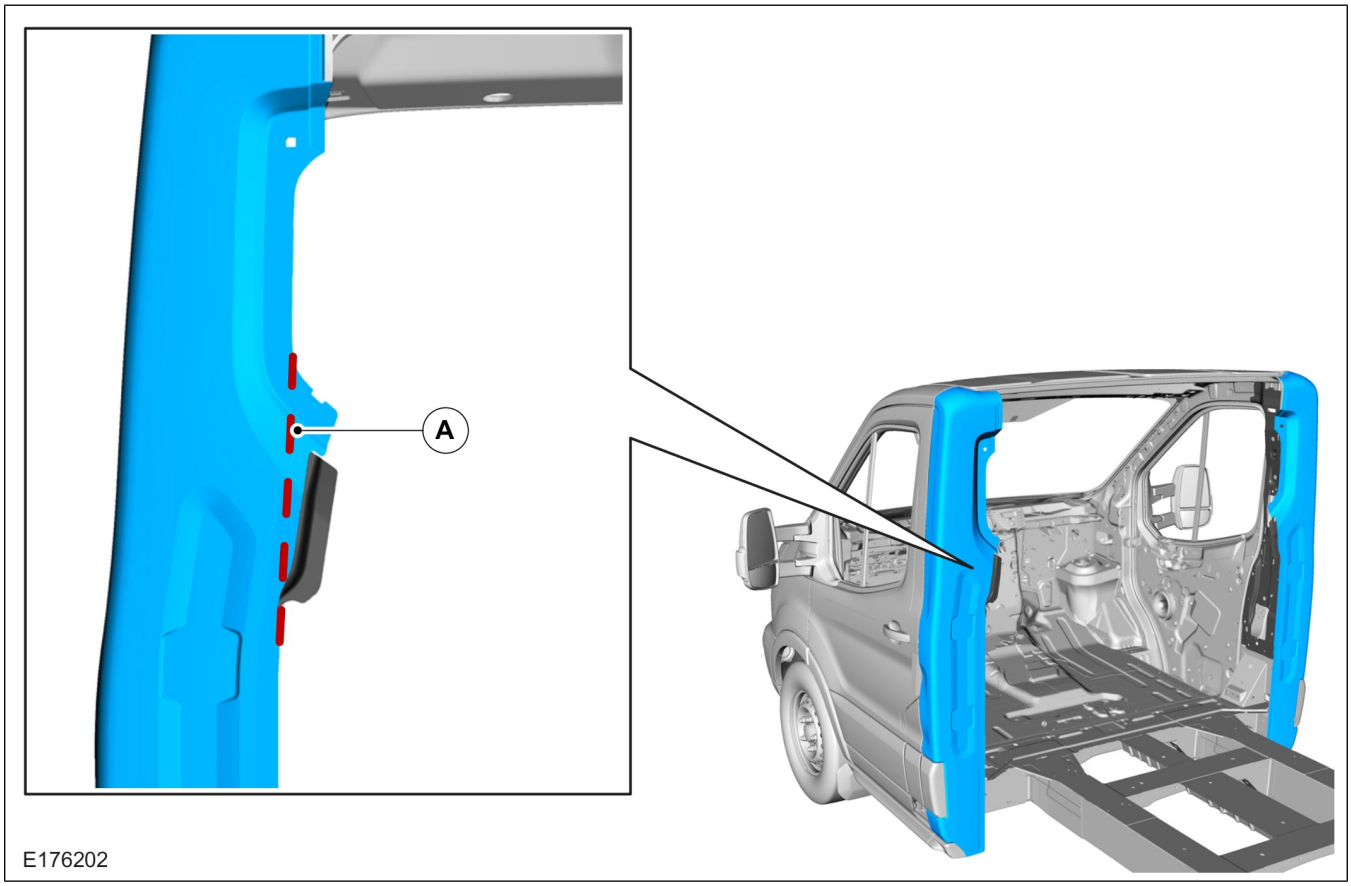
* The maximum width of a vehicle conversion may be restricted below 2400mm in order to comply with installation of Lighting Regulation ECE R48 which specifies widths restrictions for mandatory light components. Fitting optional Front Fog Lamps restricts the vehicle width to 2375mm.

For non-European Union territories, please refer to local legislation.

For Australia and New Zealand, please refer to ADR13 Vehicle regulations.

For availability please contact your National Sales Company representative or Local Ford Dealer.

5.1.9 Camper Single Chassis Cab



E176202

NOTE: When trimming the edge, do not cut further outboard that the trim line 'A' as shown in figure E176202. Do not cut outboard of the last spotweld joining the 2 panels together on each flange. The cut must be more than 5mm away from the last weld.

Left hand side shown, right hand side symmetrically opposite.

If implementing a fully sealed body air extraction is required, the recommendation is the use of one Ford service part 6G91_A280B62_A* on each side of the vehicle. If this is not possible the alternative extractor should provide 150cm^2 of cross sectional area on each side of the vehicle. An ideal position for the extractors would be in the back panel of the cab. If this is not feasible, then the extractors should be situated rearwards of B-pillar such that there is a free airflow path equating to the extractor effective CSA maintained both upstream and downstream of each extractor to maintain windshield defogging performance and door closing efforts. Extraction should not be installed near exhaust components, or areas exposed to potential fuel spillage.

For further information contact your National Company Sales representative or your Local Ford Dealer.

5.1.10 Front End Integrity for Cooling, Crash, Aerodynamics and Lighting

Cooling Continuous air flow through the front end and engine compartment is not to be hindered by adding any additional equipment. If uncertain please consult the Vehicle Converter Advisory Service VCAS@ford.com

Lighting Do not alter the lighting system.

Crash Do not cut, drill or weld any parts that are load path relevant in case of crash. Do not add material in the crash zone. This could affect the crash sensor calibration.

The side airbag system is not permitted if:

- A swiveling device is fitted on the front seats.
- Any additional material or structure is attached to the B-pillar inner and/or outer area.

5.1.11 Tipper Bodies

For tipper conversions single and double Chassis Cab versions except extended rear chassis frame can be used. All variants allow single and three way tipping.

It is recommended to have the tipping system operative only when the engine is running. It is also recommended to have the master control switch in the security of the cab. According routing of wires and hydraulic lines please refer to section hydraulic lift.

Ensure that axle plated weights including the front axle minimum are not exceeded.

For tipper sub-frames please refer to the following guidelines:

- Design for full length continuous frame with mountings for motor, pump unit, reservoir, pivot points and ram.
- Use all mounting points on the chassis frame to mount sub-frame, see Chassis Cab - Body Attachment figures E167671 and E176772 for fixing strategy.
- The rear two sets of chassis frame mounting brackets should have a full torque with 100% grip. The attachment to the remaining forward chassis frame brackets must be precisely located and retained, but allow some relative flexing between the sub-frame and chassis frame. That is clamp control devices such as conical washer stacks or machine springs with self locking fastenings.
- Very stiff sub-frames may damage the chassis frame by preventing its natural flexing, therefore appropriate and captive fail safe compliant mounts should be used. See figures E74696 sub-frame attachment to chassis frame and figure E175999 rigid or torsion stiff sub-frame for chassis cab.
- Use two M10 grade 8.8 minimum bolts, washers and self locking nuts at each solid and compliant chassis frame location.
- Sub-frame must extend to the back of the cab and attach to all mounting locations, with the forward end designed to minimize local frame stress, see figures E167671 and E176772 for fixing strategy and figure E74575 sub-frame for low floor or other equipment. However it is preferable to mount the sub-frame onto the mounting brackets with a clearance to the chassis frame top surface.
- Side tipping loads/forces must be resolved by the sub-frame. It is not recommended to strain the chassis frame.

5.1.12 Tank and Dry Bulk Carriers

Due to the high rigidity of tanks it is necessary to isolate the tank and its sub-frame from the chassis frame allowing the chassis frame to naturally flex. Please refer to the following guidelines:

- Mount tank to full length of sub-frame.
- Use all mounting points on the chassis frame to mount sub-frame, see Chassis Cab - Body Attachment figures E167671 and E176772 for fixing strategy.
- Brackets should have solid full bolts torque with 100% grip.
- The remaining forward location mounts must be compliant to allow relative chassis frame to sub-frame deflections
- Sub-frame must extend to the back of the cab and not contact chassis frame at forward end under worst case deflection.
- Use appropriate and captive fail safe compliant mounts, please refer to figures E74696 Sub-frame attachment to Chassis frame and figure E175999 Rigid or Torsion Stiff sub-frame for Chassis Cab.
- Use two M10 grade 8.8 minimum bolts, washers and self lock nuts per chassis frame mount bracket at each solid and compliant location.

5.2 Hydraulic Lifting Equipment

5.2.1 General Information

WARNINGS:

Do not cut away any structural member.

Equipped vehicles must be designed to be stable under "worst case" operating conditions with support legs extended, if fitted.

Do not lift vehicle off the ground by using supporting legs.

CAUTIONS:

Safety devices must ensure the legs are deployed when operating the lifting equipment.

Safety devices must ensure the legs are stowed and locked away prior to engaging vehicle drive.

NOTE: It is the converters responsibility to fix with adequate reinforcements from below.

For additional information:

Refer to: 5.15 Frame and Body Mounting (page 269).

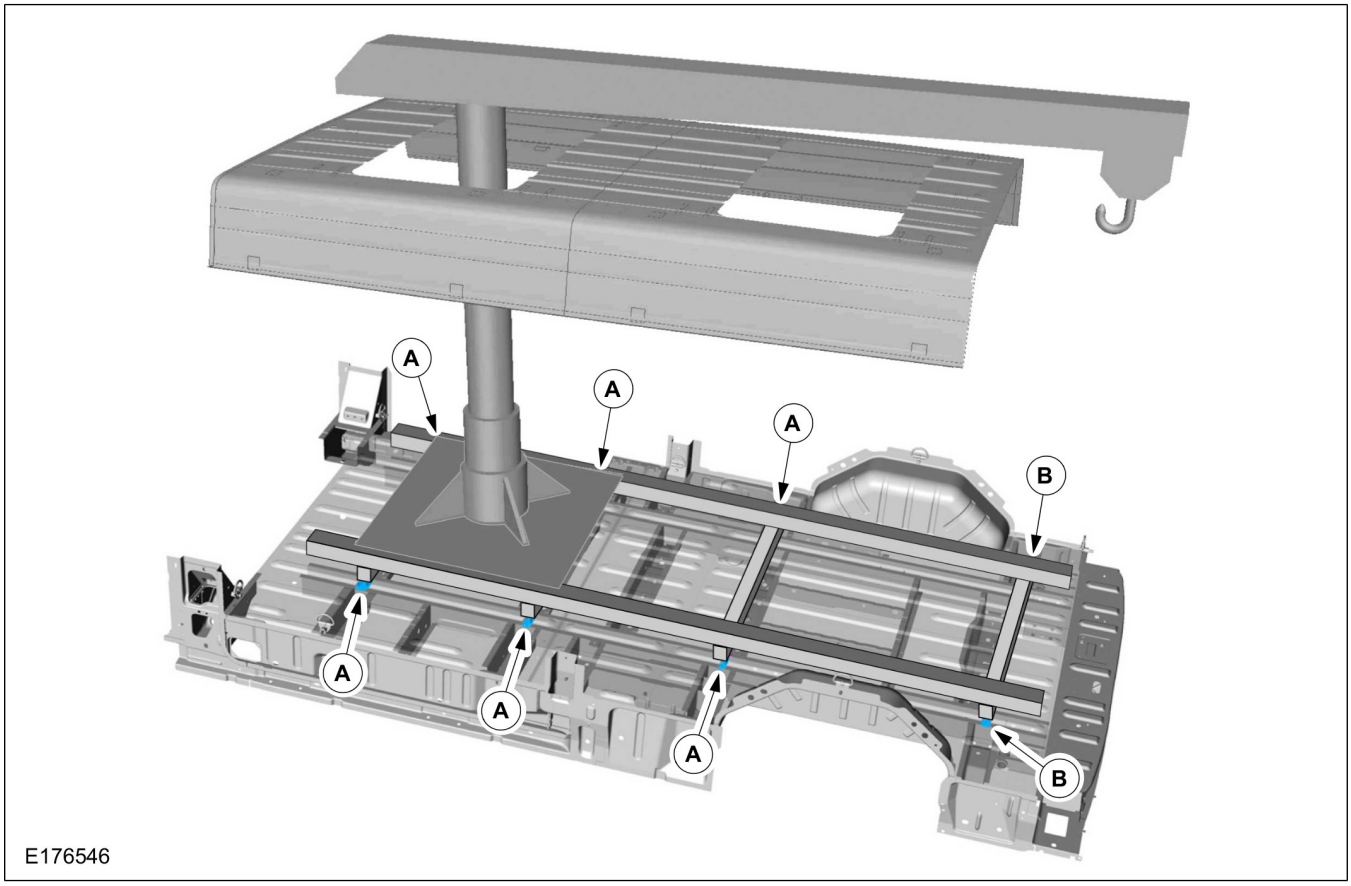
The vehicle converter is responsible for:

- Fitting decals, advising on the safe use of the equipment.
- Route electrical and hydraulics separately and away from original Ford equipment.
- Use suitable clip to fix on vehicle body and sub frame.
- Offer master switch in the cab to isolate the whole system.

Cranes and Platforms

It is recommended to mount Cranes and Aerial Platforms on a full length sub-frame for Van vehicles as shown in figure E176546 and for all reinforced holes on longitudinal rails for Chassis Cabs as shown in figure E175999.

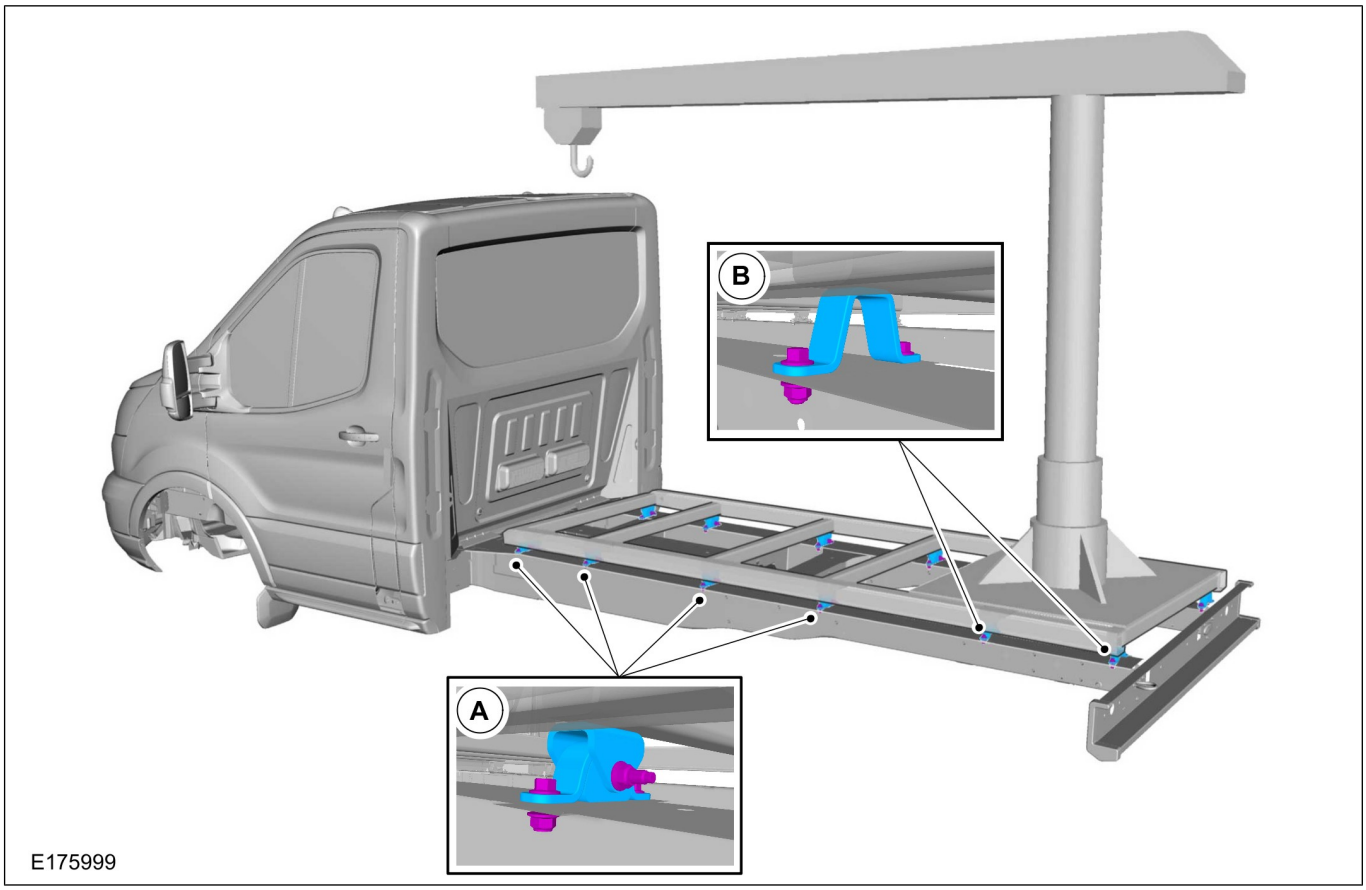
Design Principle - Rigid or Torsion Stiff Sub-frame for Van



E176546

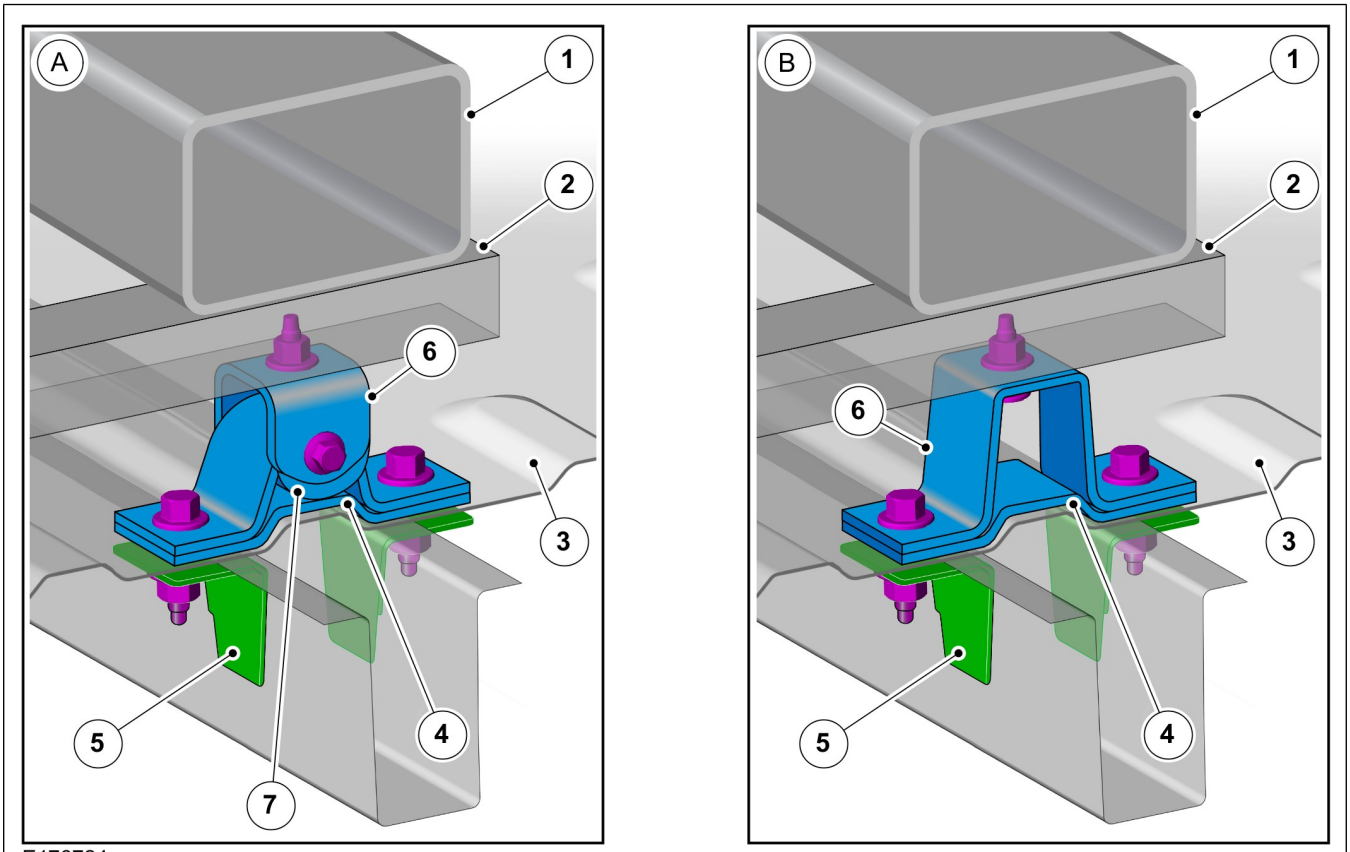
Item	Description
A	Compliant Mount - see 'A' in figure E176724
B	Fixed Mount - see 'B' in figure E176724

Design Principle - Ridgid or Torsion Stiff Sub-frame for Chassis Cab



Item	Description
A	Compliant Mount
B	Fixed Mount

Sub-frame Mounted on Floor



E176724

Item	Description
A	Compliant Mount
B	Fixed Mount
1	Sub-frame Logitudinal
2	Sub-frame Outriggers
3	Floor of Vehicle
4	Fix to floor using adequate reinforcements
5	Reinforcement Bracket - Use 2x per attachment location, one each side of the rail
6	Reinforcement Bracket to Sub-frame
7	Captive Compliant Bush

It is recommended to design sub-frames in the way that there is no adverse strain on the vehicle structure. Use compliant and fixed mounts to attach to the vehicle body. For design principle refer to E176546.

For Van, Bus and Kombi:

- It is recommended to fix every mount with M8 bolt grade 8.8 minimum.
- It is not recommended to engineer through the floor fixings to clamp around side members.

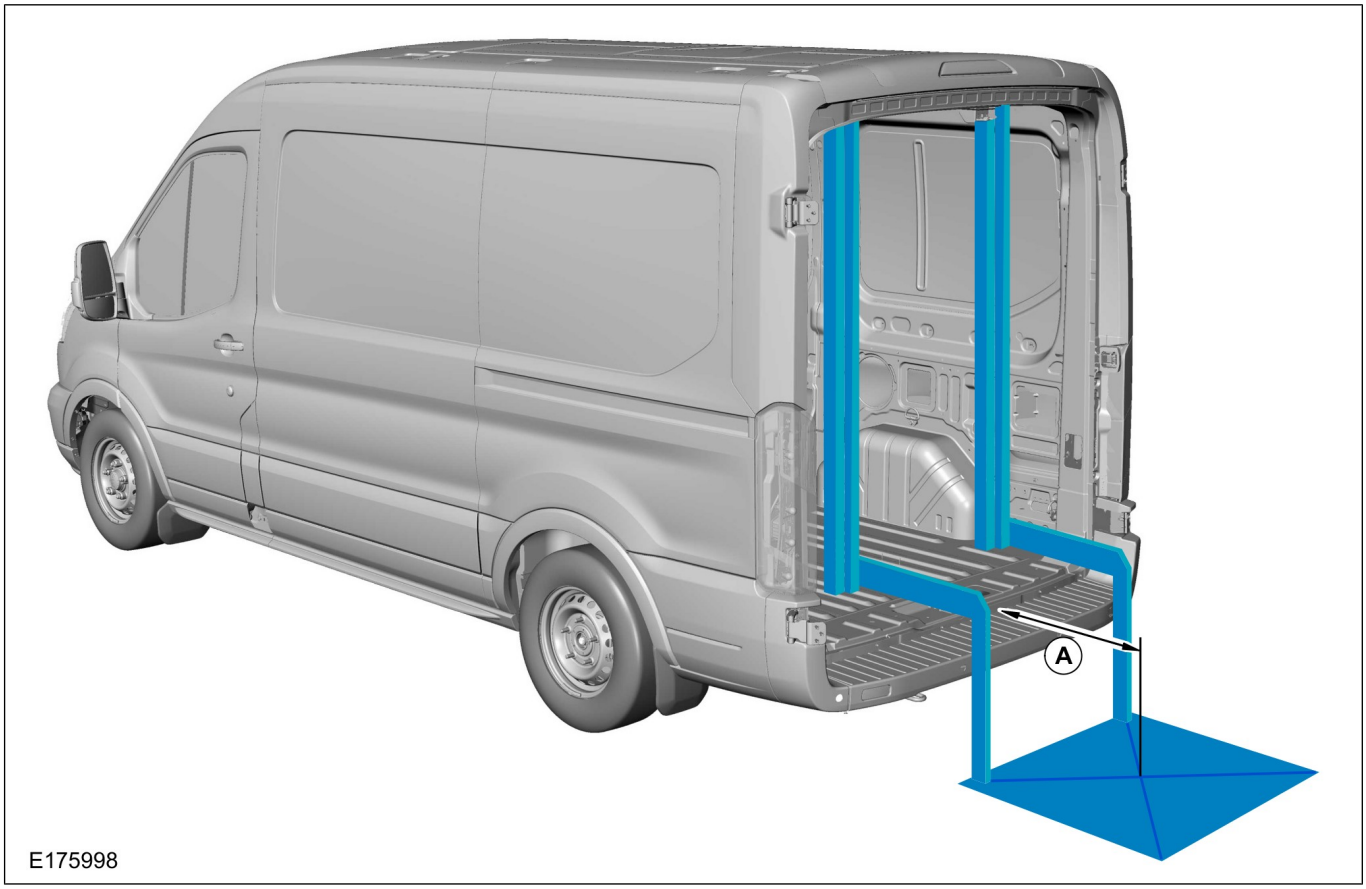
  Refer to: 5.15 Frame and Body Mounting (page 269).
- Please see figure E176546 which show the principle of adequate fixings.
- Very stiff sub-frames should not be rigidly mounted to the floor, please refer to figure E176724 for examples of a compliant mount. Compliant bushes should allow up to +/-12mm movement at a rate of 100kg per 1.0mm deflection with only the rear pair of mounts being fixed.
- Support legs, if required, must be fitted directly to the sub-frame.
- Support legs must be designed to prevent any adverse strain on the vehicle structure when operating equipment.

For Chassis Cabs:

- Sub-frame ends must be relieved at forward end to miminise local contact stress concentrations, see figure E176724.

  Refer to: 5.15 Frame and Body Mounting (page 269).
  (it is recommended to mount the longitudinal brackets with a clearance to the chassis frame top surface.)
- Stiff sub-frames, for example closed section longitudinal rigidly connected with similar section cross members, may damage the chassis frame by preventing its natural flexing. Therefore appropriate compliant mounts should be used. Please refer to figure E176546.
- Each set of brackets must use 2x 10 bolt grade 8.8 minimum.
- For safety device on outriggers/legs please refer to Van, Bus and Kombi.

Hydraulic Tail Lift



E175998

Item	Description
A	1000mm

It is recommended to fix lift framework on bottom and on top side by using reinforcing plates and through bolts. It is also recommended to design and/or locate the reinforcing plates in a way that load can be routed into adjacent reinforced body structure.

Hydraulic under-slung tail lifts are not recommended for Transit Van, Bus and Kombi.

For Chassis Cab with tail lift design it is recommended to use unique body sub-frame for fixing to Chassis Cab structure. For connection between sub-frame and Chassis Cab body structure, see figure E176724.

Greater off-sets and/or loads require additional stabilizing equipment such as outriggers or ground jacks. If uncertain please consult your local National Sales Company representative or the Vehicle Converter Advisory Service VCAS@ford.com

It is the Vehicle converters responsibility to fit a decal to the converted vehicle stating that the equipment must not be used without outriggers/ground jacks in operating position. It is also the vehicle converters responsibility to guarantee safe functioning of the equipment.

For hydraulic tail lifts as used for general loading or more specialised for wheel-chair lifts refer to E176546.

5.3 Racking Systems

5.3.1 Racking Systems

For attaching a racking system it is recommended to use the marked areas shown in figure E176000.

NOTE: Upper fixing locations are not structural and take a 30kg maximum load only.

- Frames should be rigid, self-supporting and bolted through the floor, use reinforcements on the underfloor.
- It is not recommended to drill through the floor in combination with plastic load floor liners.
- For alternatively fixing through the floor to the side members refer to Frame and Body Mounting section of this manual, Figure E176203 Frame Drilling and Tube Reinforcing.

  Refer to: 5.15 Frame and Body Mounting (page 269).
- Load compartment tie downs can also be used for additional fixing locations.

  Refer to: 5.4 (page 246).
- Ensure proper sealing against ingress of water, salt, dust, after cutting or drilling the body. Use Ford approved sealing and finishing material, and underbody corrosion protection.
- To minimize stress in body side upper area additional cross brace roof bows are to be used.
- If linings are planned for the inside of the load area. All racking through bolts must be designed to be accessible through the lining to the body structure with spreader plate.
- No load bearing fixing to the lining only.
- For increased crash performance the racking system should be designed with diagonal reinforcements.
- Vehicle should be equipped with Ford standard option bulkhead to give best protection to driver and front passengers.
- Preferably, there should be a rack each side to balance the vehicle load.

For designing glass carrying rack on body side outer, construct internal structure and bolt through the body side to the internal structure, using the recommended fixing locations, see figures E176000 and E176512, or load compartment tie downs.

Refer to: 5.4 (page 246).

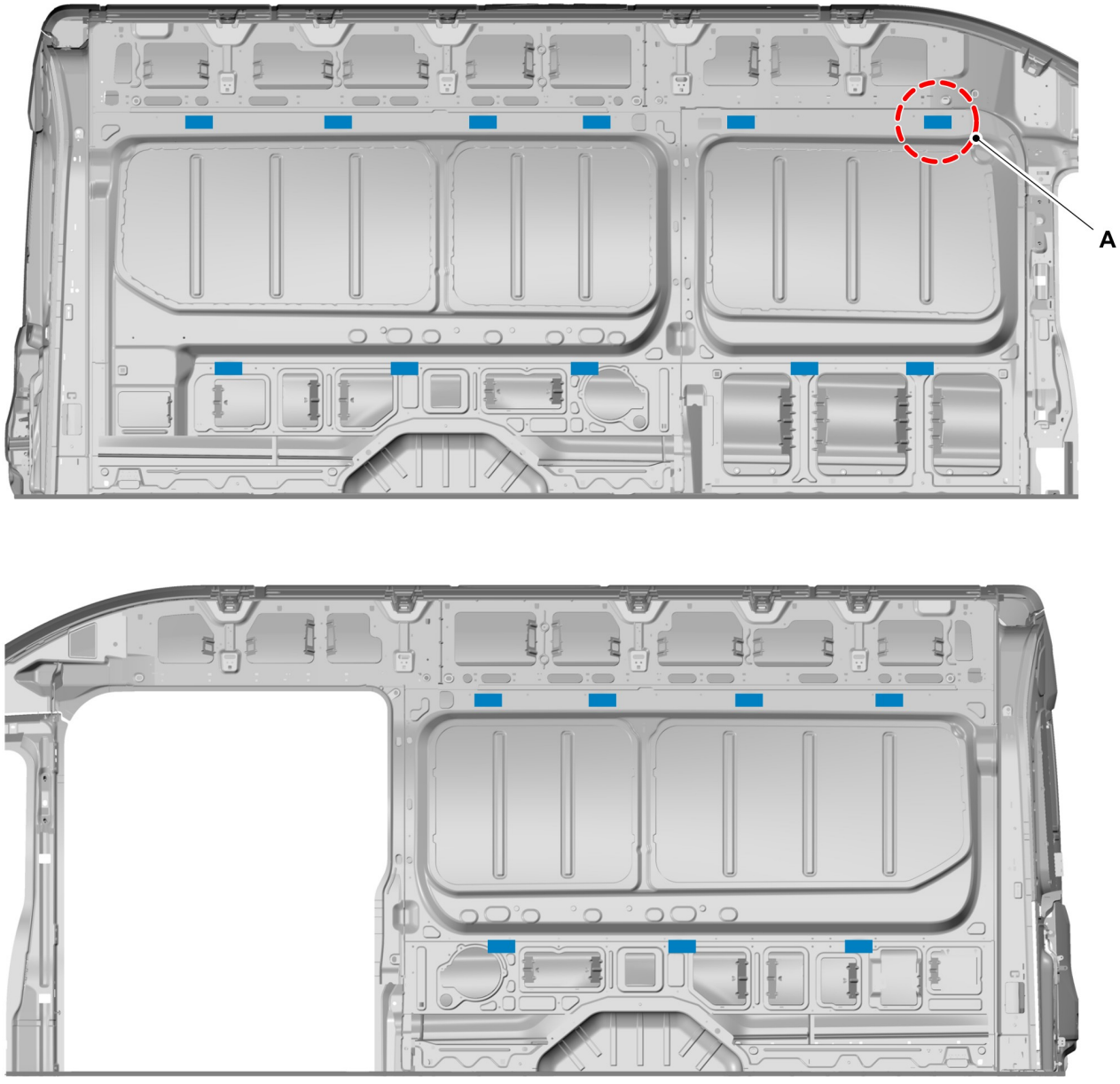
For additional information

Refer to: 5.14 Corrosion Prevention (page 268).

For additional information on Precautionary/No Drill Zones

Refer to: 4.1 Wiring Installation and Routing Guides (page 76).
Refer to: 5.1 Body (page 214).
Refer to: 5.6 Body Closures (page 249).

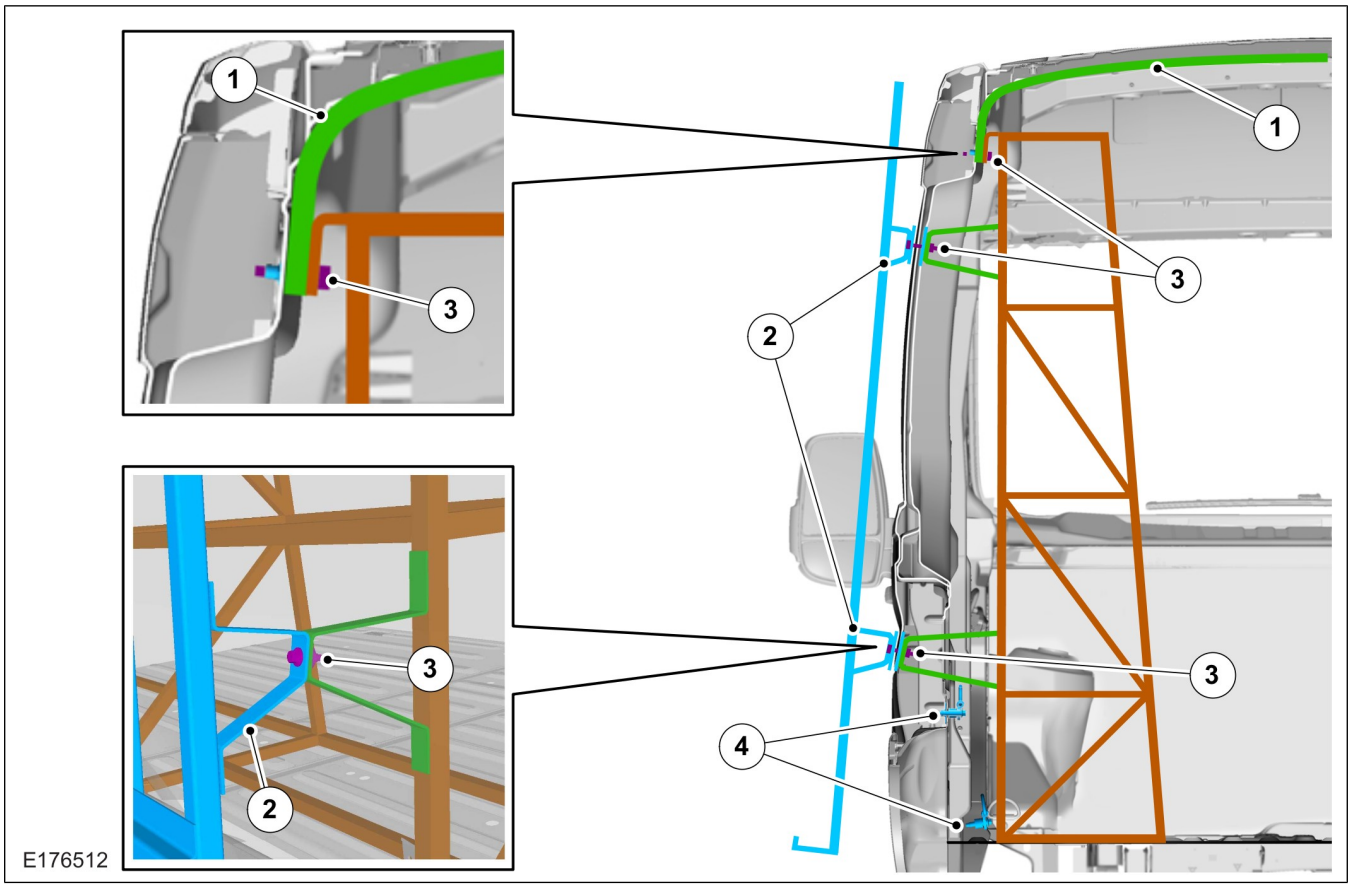
Recommended Fixing Locations



E176000

Item	Description
A	Low roof vehicles do not have this fixing location.

Glass Racking on Outside of Van



Glass Racking on Outside of Van - Through Fixed to Internal Strong Structure (Recommended Minimum)

Item	Description
1	Full width cross bow brace.
2	Load bearing attachments, through body side to internal structure (2x minimum top and bottom).
3	Through bolts.
4	Load compartment tie down loops.

For designing glass carrying rack on bodyside outer, the following unique requirements are recommended:

- Construct the internal structure and bolt through the body side to the external structure, see figure E176512.
- Internal structures should be rigid, self-supporting and bolted through the floor. Use reinforcements on the underfloor.
- Avoid the no-drill zones when selecting fixing locations.

  Refer to: 4.1 Wiring Installation and Routing Guides (page 76).
- It is recommended to balance the vehicle load.

  Refer to: 1.15 Load Distribution (page 38).
- Distribute the force equal to the fixed structure.

5.4 Body System - General Information—Specifications

5.4.1 Load Compartment Tie Downs

All vehicles are fitted with load compartment tie downs, these are all 'D' rings as shown in E146219. Not all vehicles will have all locations shown, it will depend on the base vehicle. For additional information refer to the Owner's Manual and for additional fixing locations

Refer to: 5.3 Racking Systems (page 243).



E146219

5.5.1 Partitions (Bulkhead) - Driver and Front Passenger(s) Protection on Van, Bus

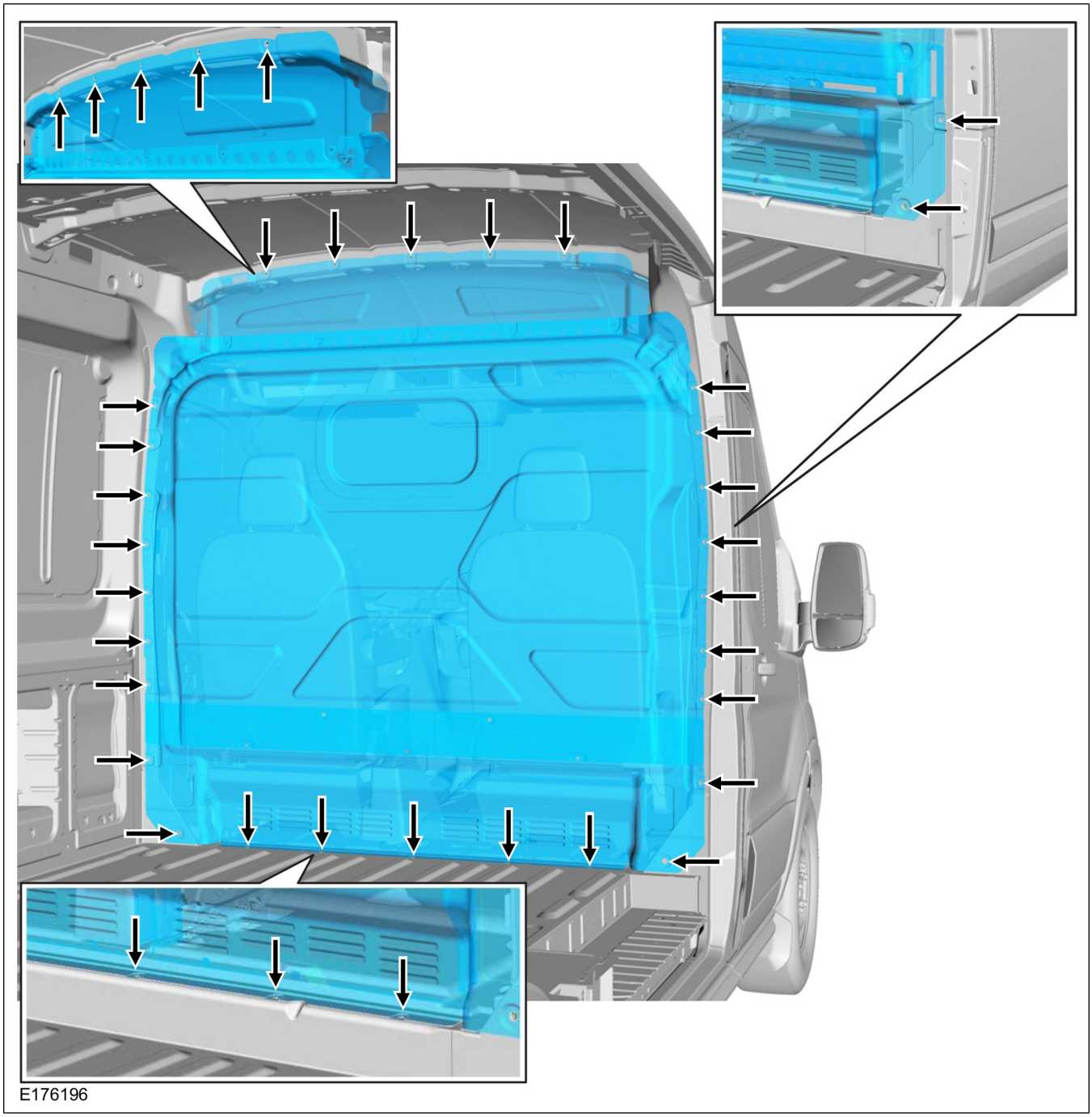
The following figure show the standard bulkhead fixing locations on B-pillar. These are standard weld nuts. The standard range of Ford bulkheads can be retro-fitted at these points.

Standard Ford bulkheads do have a clearance between bulkhead and body structure to allow natural body flexing and an air circulation from the cab to the rear load space for ventilation control.

Air circulation and body flexing must be also given consideration when engineering an alternative bulkhead. It is not recommended to restrict driver's or passengers's seat adjustment travel.

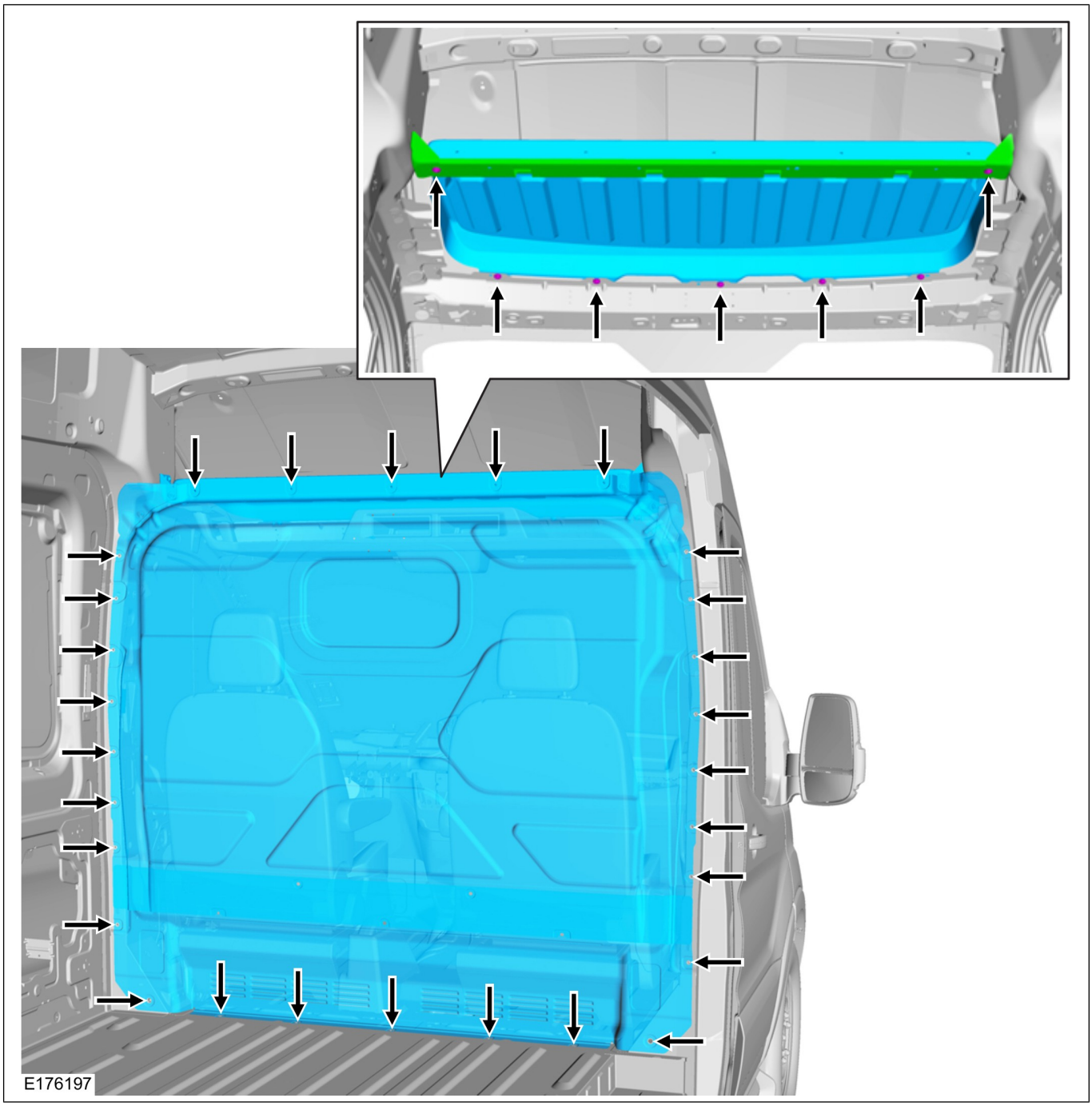
It is the vehicle converter's responsibility to ensure local current legislation, governing bulkheads and protective window grilles, is met. It is also the converter's responsibility to ensure legal load constraint requirements if using a non Ford standard bulkhead.

Medium Roof Bulkhead Fixing Holes



E176196

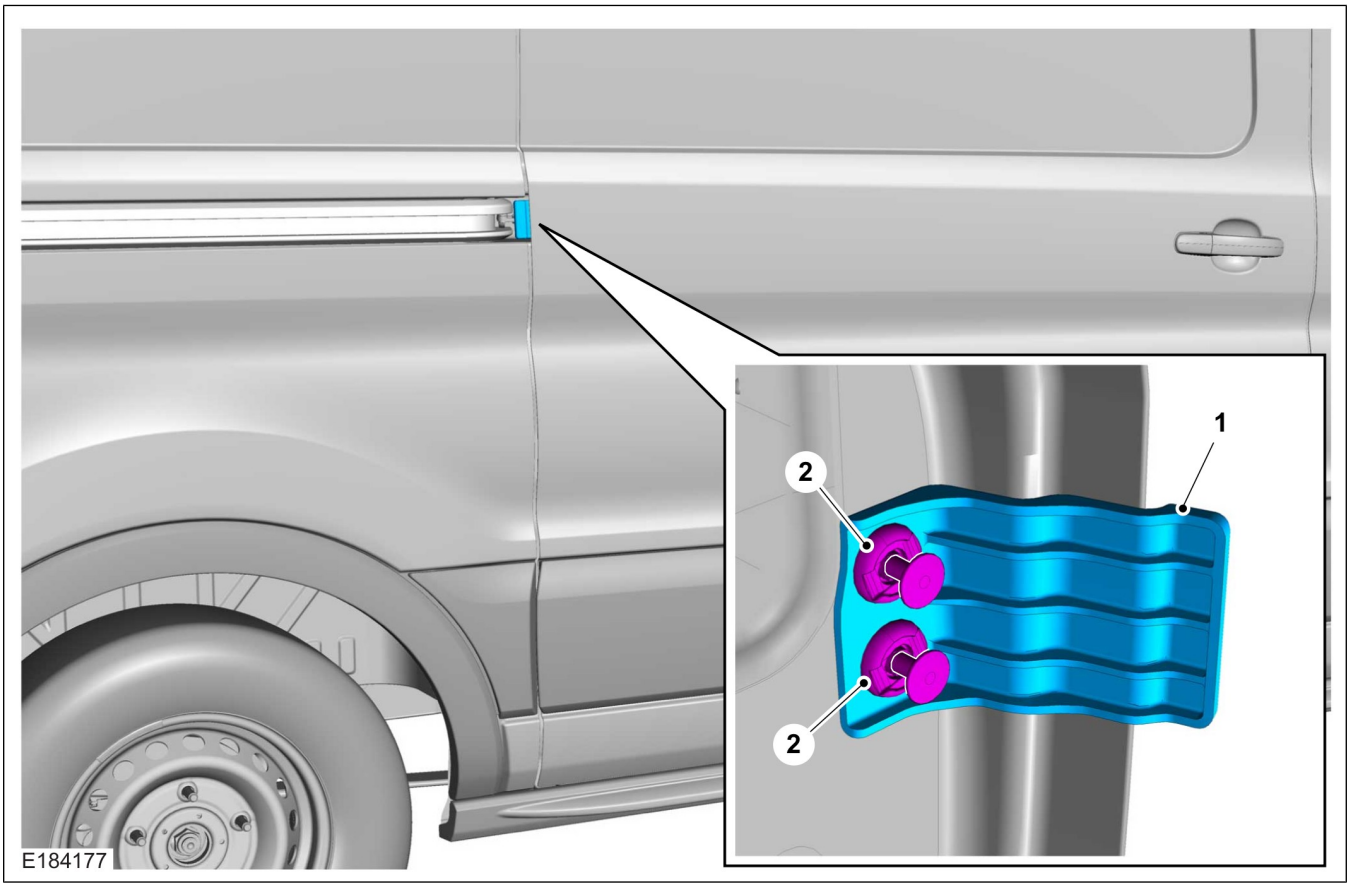
High Roof Bulkhead Fixing Holes



5.6.1 Sliding Door Gap Reduction on M1 Vehicles

CAUTION: When converting an N1/N2 or M2 vehicle into an M1 vehicle, left and right hand spacer brackets or an equivalent designed part must be retrofitted to the sliding side load doors.

For further information please contact your local National Sales Company representative or Local Ford Dealer.



Item	Description
1	Spacer Bracket - Right Hand Side BK31-A214A46-A_ / Left Hand Side BK31-A214A47-A_
2	2 X Clip and Fastener W711712

5.6.2 Security, Anti Theft and Locking System

NOTE: It is not recommended to alter the locking system or damage the security shielding around the lock and latch.

However, in case a modification is required for the conversions, please consult the Vehicle Converter Advisory Service VCAS@ford.com.

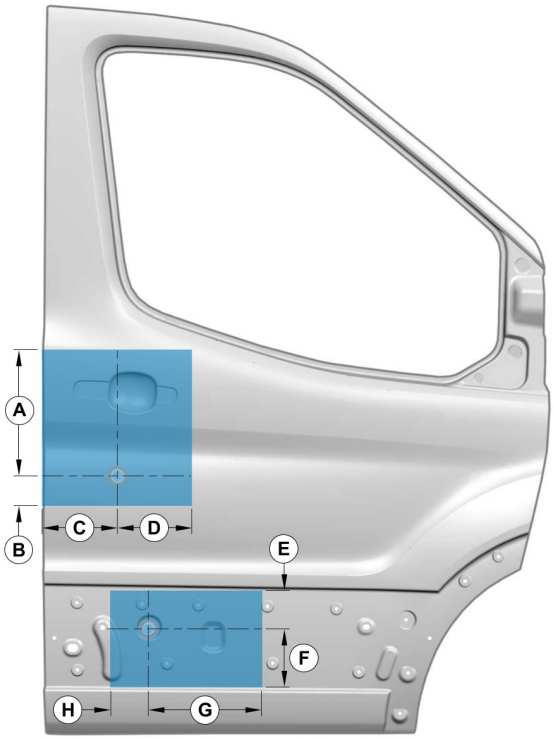
To avoid locking system security complications, it is recommended to discuss with the local Ford dealer prior to modifications taking place.

When removing and reapplying door seals take care to fit correctly, using the same seals as this is critical to door closing efforts. Any modification to the sealing flanges or surfaces will require consultation with your local Ford dealer or Vehicle Converter Advisory Service (VCAS@ford.com). This may also include air extraction/venting adjustments to assist door close efforts if significant changes to closures are required.

The Body Control Module is designed to work specifically with the Ford Transit lock and latch mechanisms and therefore drives latches to lock and unlock for specific time periods. Additional power locking functionality should be based around the use of additional Ford Transit latch mechanisms. Additional latches can be driven via relays connected in parallel with existing latches.

The following figures outline the areas in which it is not advisable to drill.

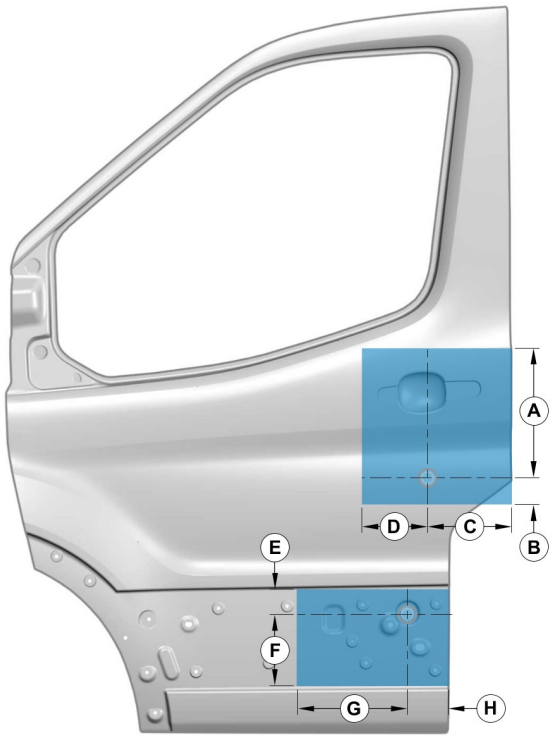
No Drill Zone - Right Hand Side Door



E171391

Item	Description
A	300mm
B	55mm on Right Hand Drive vehicles / 35mm on Left Hand Drive vehicles
C	190mm
D	150mm
E	100mm
F	140mm
G	200mm
H	70mm

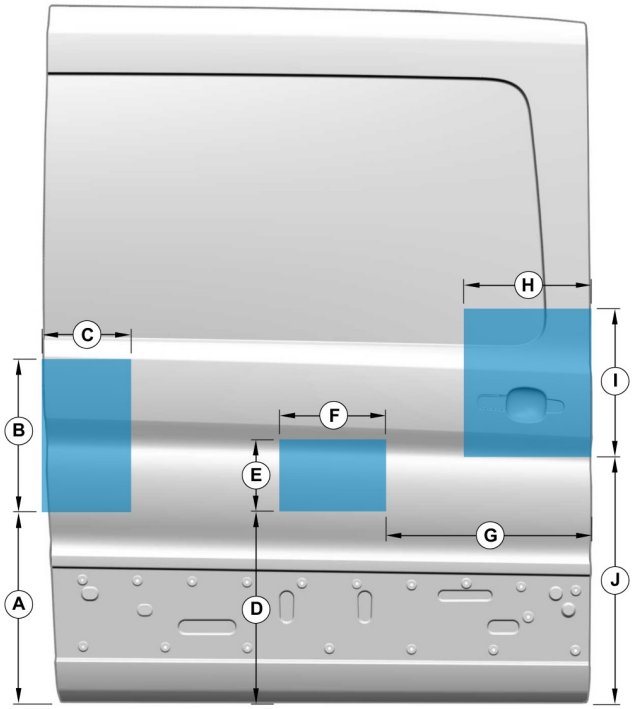
No Drill Zone - Left Hand Side Door



E171392

Item	Description
A	300mm
B	35mm on Right Hand Drive vehicles / 55mm on Left Hand Drive vehicles
C	190mm
D	150mm
E	60mm
F	140mm
G	200mm
H	90mm

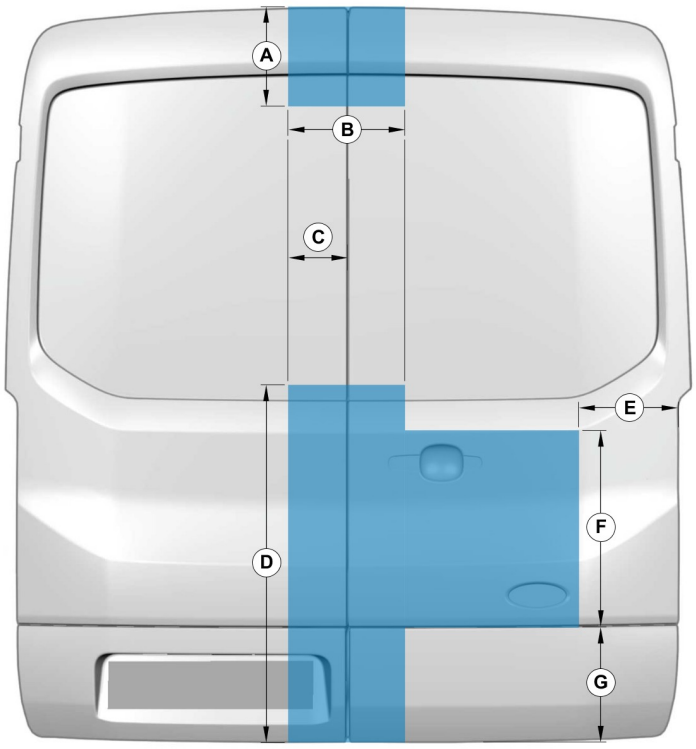
No Drill Zone - Side Sliding Doors (right side door shown, left hand door symmetrically opposite)



E171393

Item	Description
A	550mm
B	350mm
C	150mm
D	550mm
E	150mm
F	200mm
G	650mm
H	450mm
I	350mm
J	750mm

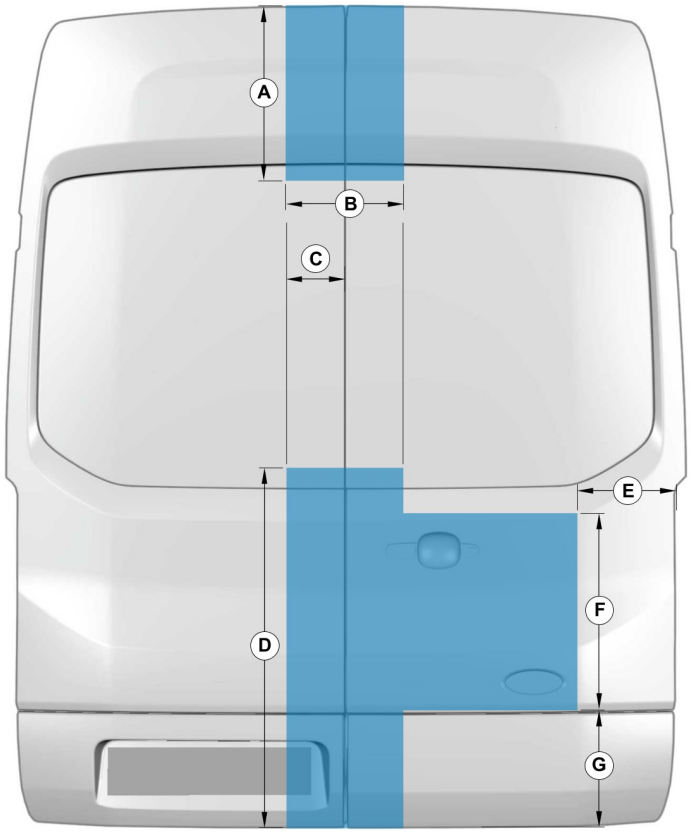
No Drill Zone - Rear Cargo Doors, H2



E171394

Item	Description
A	320mm
B	340mm
C	170mm
D	920mm
E	200mm
F	520mm
G	300mm

No Drill Zone - Rear Cargo Doors, H3



E171395

Item	Description
A	550mm
B	340mm
C	170mm
D	920mm
E	200mm
F	520mm
G	300mm

5.7 Interior Trim

5.7.1 Load Compartment Interior Lining

Do not damage the lock, hinge, latch or check arm system (electrical cables, release system) when applying interior lining.

Be careful not to damage the weather shield (water shield covering inner door access hole) when removing or applying interior door trim.

WARNINGS:

Plan fixing points for other fitments such as racking to ensure through bolting can be achieved. Fixing to the lining material may be inadequate for normal safe operation of the vehicle.

Varnish or paint wooden interior cargo area panels if exposed to high humidity conditions.

The additional weight of the linings on doors may require additional reinforcements to the door and pillar at the hinge and check mechanism.

5.7.2 Plywood Lining/Cladding

CAUTION: Do not drill into the vehicle before checking the Precautionary/No Drill Zones and electrical wire routing.

Refer to: 4.1 Wiring Installation and Routing Guides (page 76).
Refer to: 5.6 Body Closures (page 249).
Refer to: 5.1 Body (page 214).

- Panels should be precision cut by machine, not by hand jigsaw, to reduce rough edges and splinters.
- Panels should be pre drilled.
- Do not drill through floor panels, use existing load lashing points when securing the panels.
- It is recommended that when fitting a plywood floor that it is joint free.
- Use aluminum floor trims.
- Plywood should be water resistant (WBP, water and boil proof).
- It is recommended to use 9mm thickness for floors and 6mm thickness for side and door lining.

For further information please contact your local National Sales Company representative or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converters Advisory Service at VCAS@ford.com

5.8 Rear View Mirrors

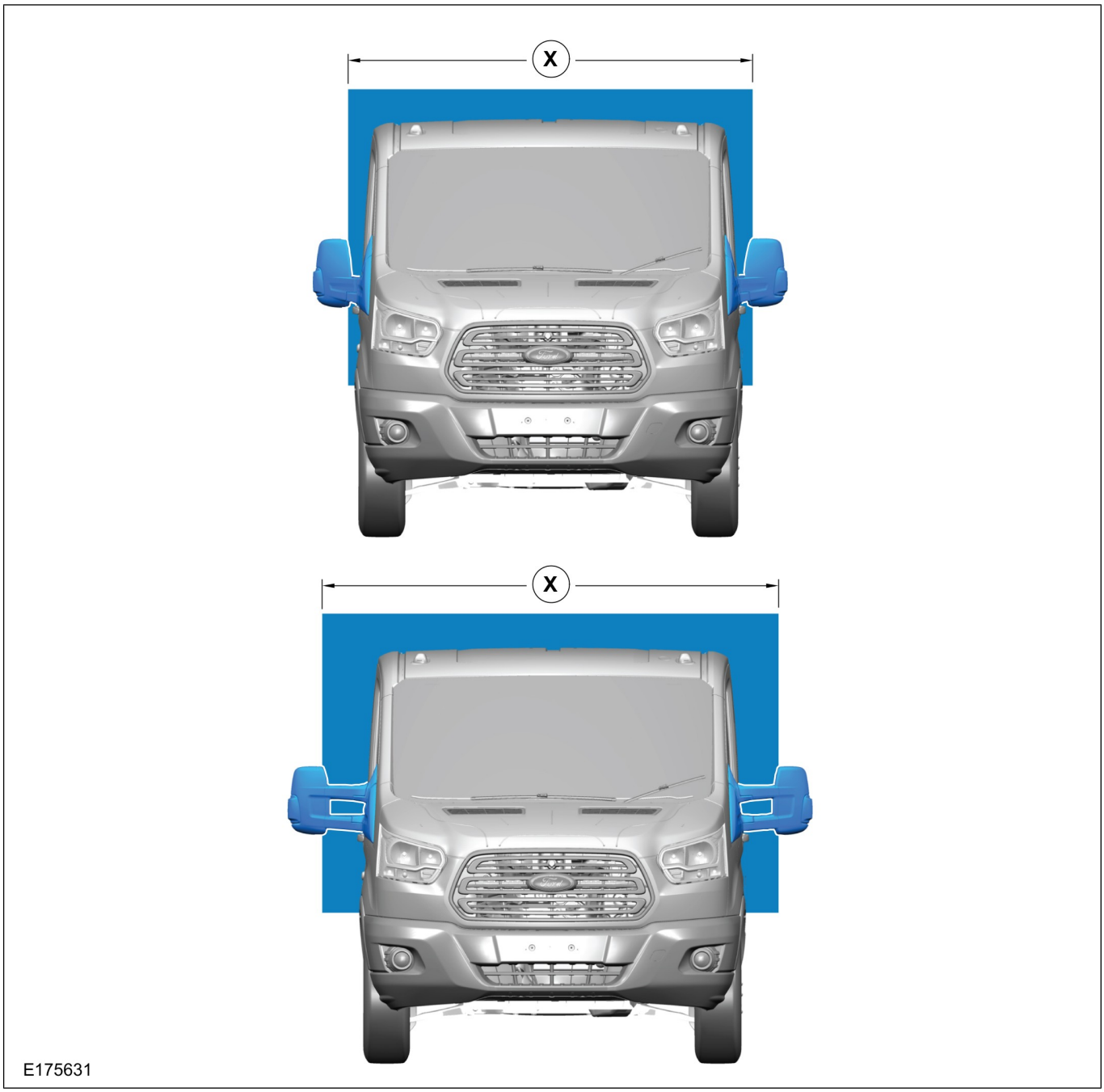
5.8.1 Door Mirrors

NOTE: The maximum width of a vehicle conversion may be restricted below 2400mm in order to comply with installation of Lighting Regulation ECE R48 which specifies widths restrictions for mandatory light components . Fitting optional Front Fog Lamps restricts the vehicle width to 2375mm.

- For non-European Union territories, please refer to local legislation.
- For Australia and New Zealand, please refer to ADR13 Vehicle regulations.

Short Arm Mirrors are specified on all versions and allow vehicle or trailer maximum widths of up to 2.2m.

Long Arm Mirrors are available as an option on Chassis Cab and Motorhome Chassis variants and covers vehicles or trailer maximum widths of up to 2.4m.



5.9 Seats

NOTE: When reassembling the seat and the seat belt use specified bolts and ensure to apply the specified torque. For torque specifications contact your local Ford dealer or the Vehicle Converter Advisory Service at VCAS@ford.com

5.9.1 Van

CAUTION: Do not install seats in the rear cargo area of a van.

5.9.2 Windowed Van

The body and floor of a windowed van are not equipped with the appropriate reinforcements required for Original Equipment Manufacturers (OEM) rear seats and seat belt systems. Do not install original rear seats or rear seat belts.

For installation of non OEM rear seats, the rear seats and seat belt systems need to comply with the relevant legal requirements and ECE directives or ADR13 or applicable local legislation.

Refer to: 3.6 Exhaust System (page 71).
Vehicle Exhaust Systems - Vans with Bulkheads.

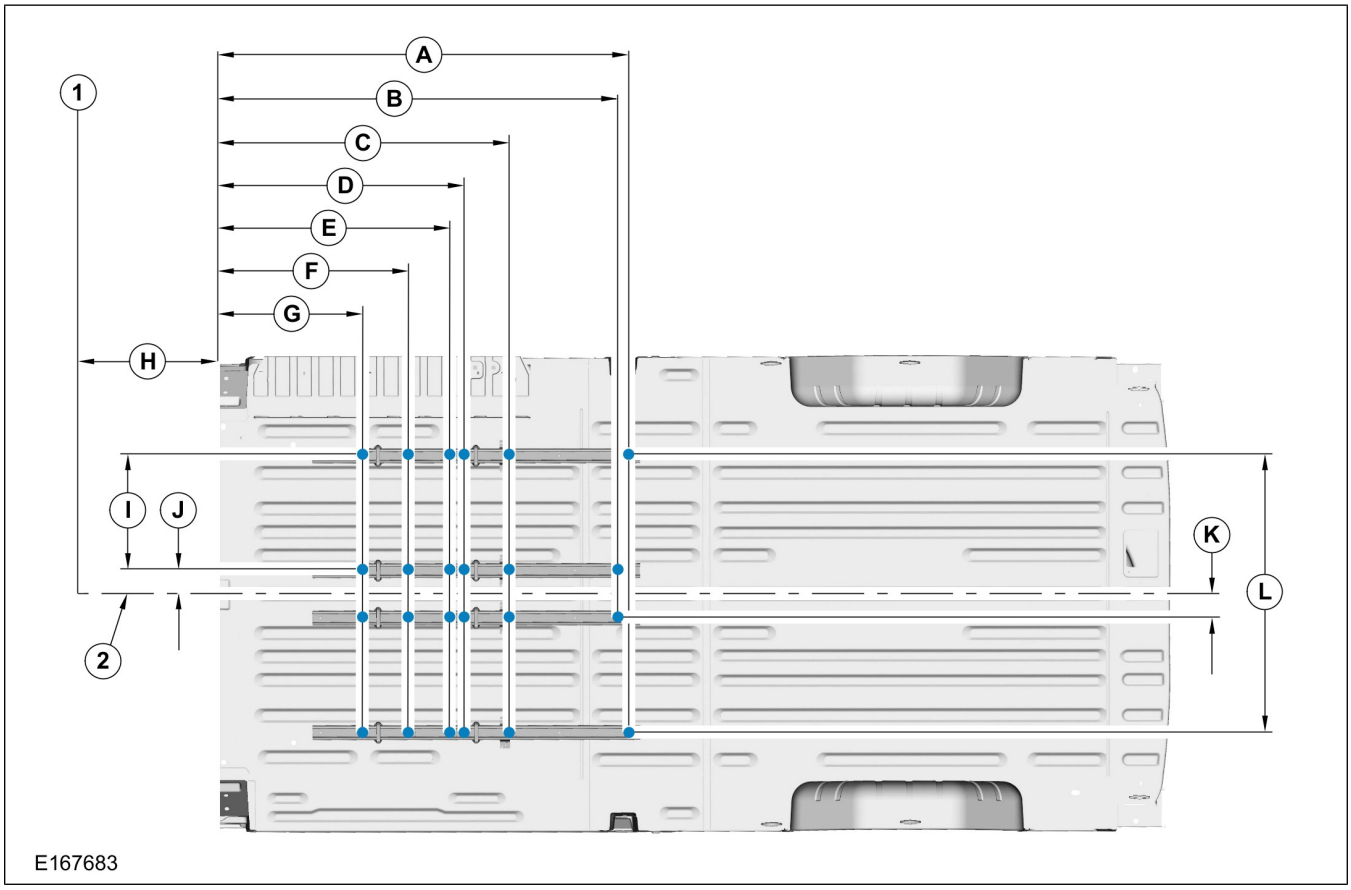
5.9.3 Heated Seats

WARNING: The electrical feed for the original heated Ford seat must not be used for other purposes, e.g. other electrical consumers.

It is not advisable to retrofit heated seats due to potential airbag operation or malfunction (incorrect configuration).

5.9.4 Rear Seat Fixing Positions

The following figures shows the second and third row seat fixing positions in the floor. These positions are independent of the wheelbase.



Item	Rear Seat Fixing Location (mm)
1	Front Axle
2	Center line of vehicle
A	1630
B	1504
C	1060
D	895
E	845
F	670
G	520
H	1225
I	425
J	88
K	88
L	1027

5.10 Glass, Frames and Mechanisms

5.10.1 Heated Windshield and Heated Rear Window

WARNING: The base system should not be tampered with (controlled by body control module and multiplex architecture) and no feeds taken from the associated wiring or controller.

These options are not suitable for aftermarket or Vehicle Converter fit.

NOTE: For further information please contact your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

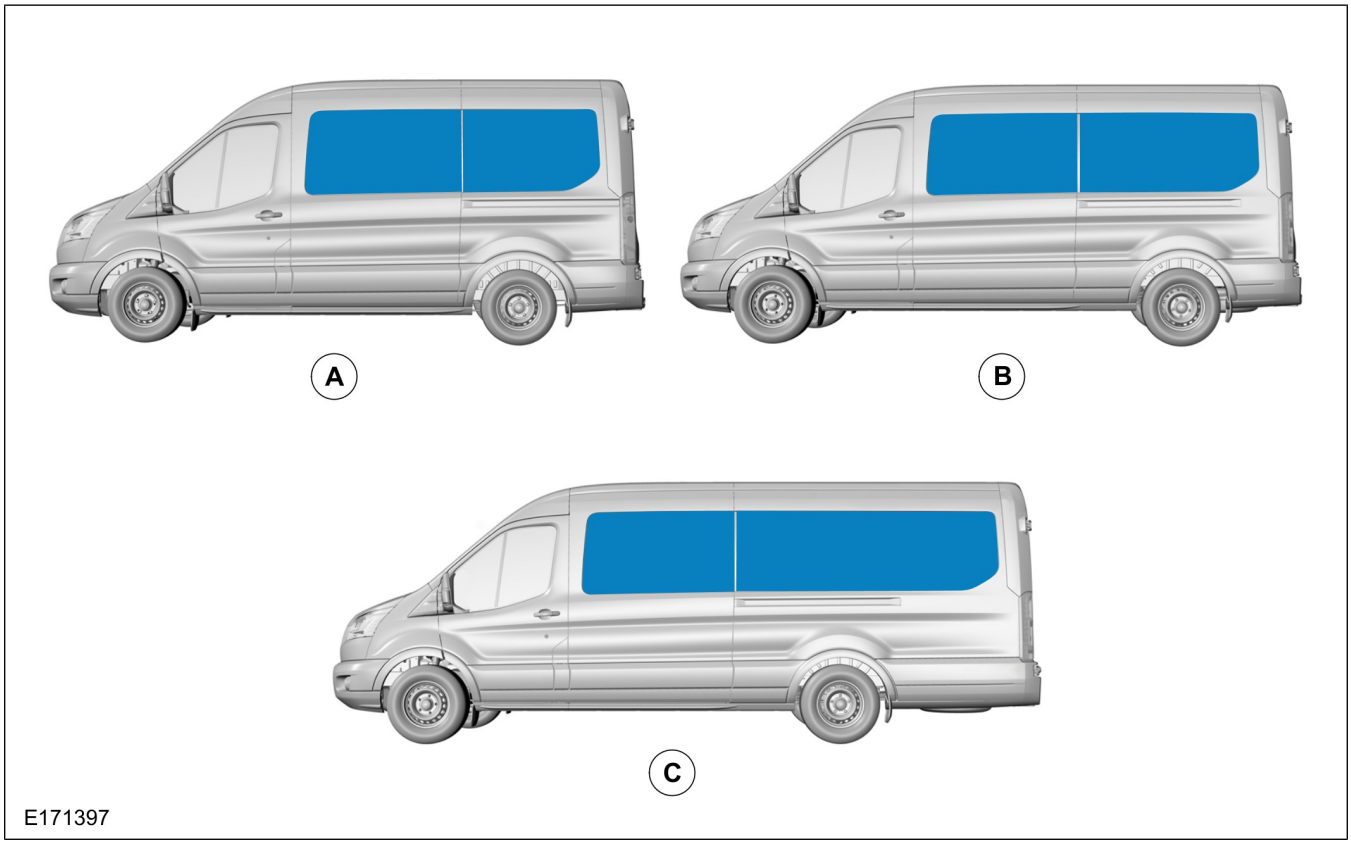
5.10.2 Rear Windows

For windows, it is recommended to specify the base vehicle as a Kombi or Bus body - however, when converting a van, the following should be adhered to:

- Cut the outer panel of the body side and door to within 1mm of the inner panel flange.
- Do not cut across panel joints or pillars.
- Use approved glass for installation according to legal requirements.

WARNING: For rear seat installation

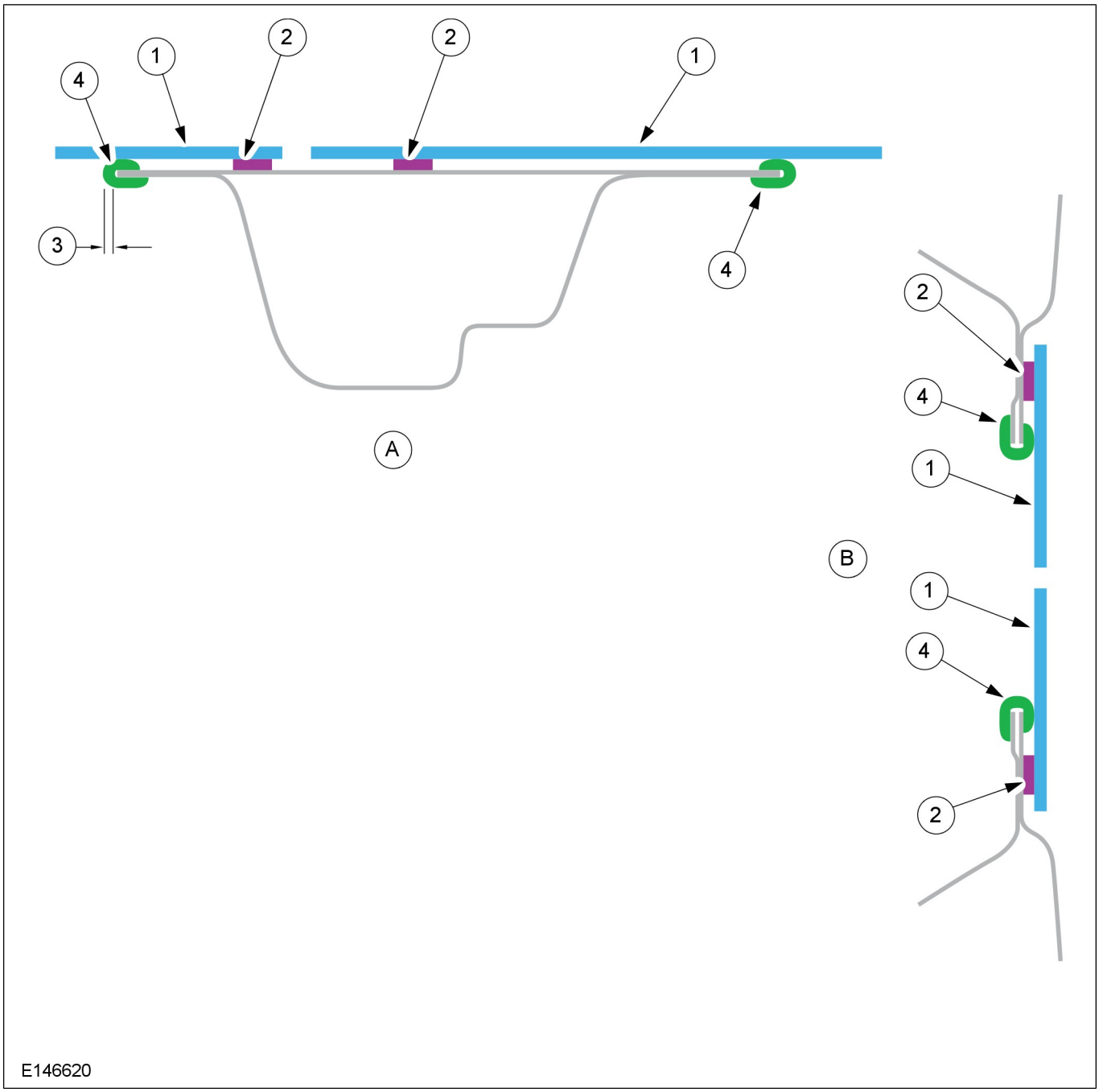
Refer to: 5.9 Seats (page 257).



For vehicle wheelbase and Roof height 'Vehicle Dimension Key' in this manual

Refer to: 1.13 Package and Ergonomics (page 29).

Section Through Typical Van Body Side for Window Engineering



E146620

Item	Description
A	Horizontal Section Through 'C' Pillar
B	Vertical Section Through Side Window (Non Side Load Door)
1	Glass
2	Adhesive
3	Cut within 0 and 1.5mm of inner body panel flange edge all around
4	Window trim strip

5.11 Airbag Supplemental Restraint System (SRS)

5.11.1 Air Bags

Front Air Bag Deployment Zones

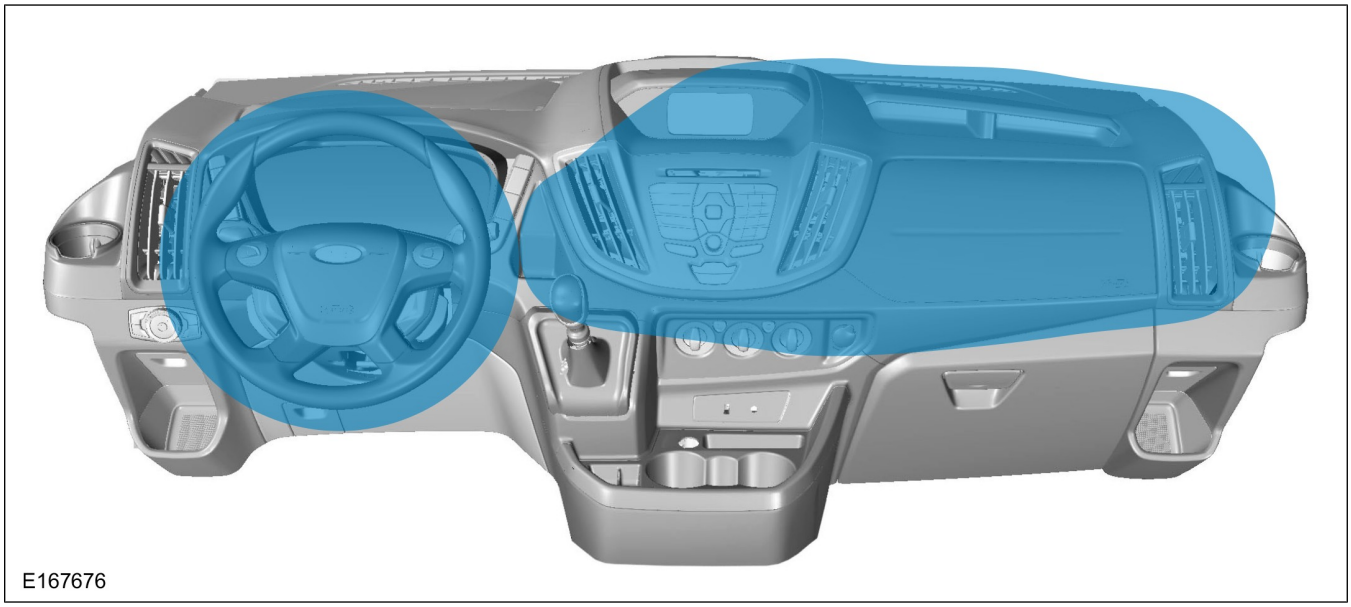
WARNINGS:

Do not place accessories in the deployment zone of the driver and passenger air bags as they may impair airbag deployment.

Do not place stickers or decals over the airbag covers as this may impair airbag deployment.

NOTE: Vehicles specified with a front passenger airbag are fitted with a deactivation switch located on the side of the Instrument Panel, on the passenger side. DO NOT remove or cover the deactivation switch as this could restrict access or function may be impaired.

NOTE: All M1 Vehicles are specified with passenger air bag as standard fitment. Passenger air bag includes the driver belt minder function.



E167676

Side and Curtain Air Bag Deployment Zones

WARNINGS:

Do not place accessories in the deployment zone of the side and curtain air bags as they may impair airbag deployment.

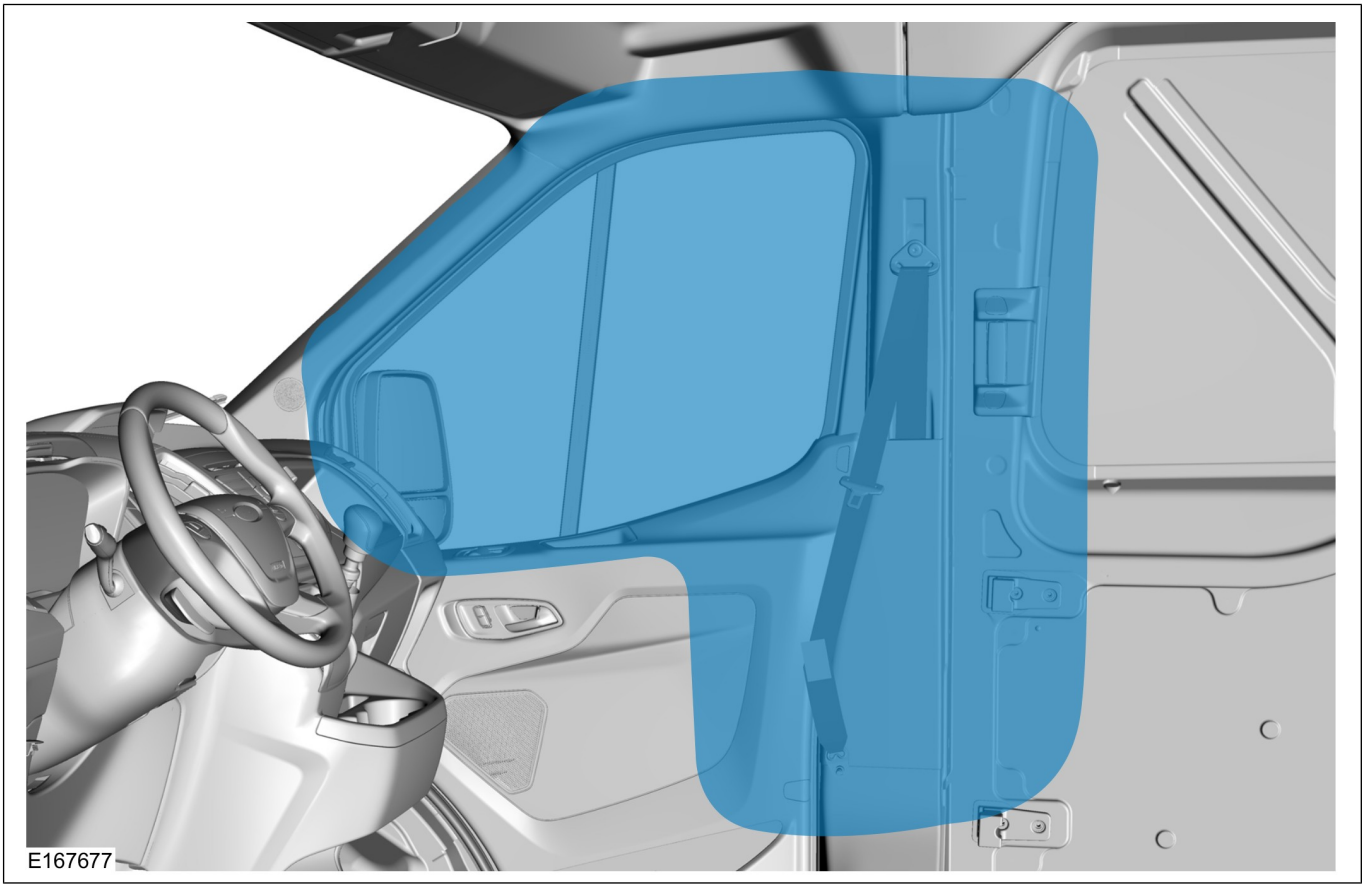
Do not place stickers or decals over the airbag covers as this may impair airbag deployment.

NOTE: It is recommended to specify a base vehicle without air bags if planning modifications in this area.

Side Air Bags (Seat Mounted): The side air bags on this vehicle have not been validated for use with swivelling front seats. Do not specify a base vehicle with side air bags if planning to retrofit a swivelling device on the front seats and/or an armrest on the outer side of the front seats; this may affect the function and/or deployment of the side air bags. Ensure any seat covers installed are designed to be used with side airbag equipped seats.

Curtain Air Bags: Extensive modifications to the roof and headlining may impair deployment of the curtain air bags. If roof or headlining is to be modified or replaced, do not specify curtain air bags on the base vehicle.

If access to the roof is required, to install roof mounted exterior accessories for example, ensure the unmodified headlining is refitted using the existing mounting points.


E167677

Restraints Control Module (RCM)

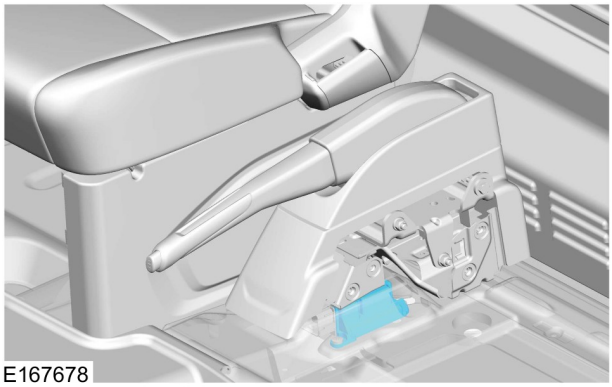
The RCM is located between the front seats , underneath the parking brake console, see figure E145413.

WARNINGS:

Modifications or reinforcements in the area of the RCM may affect the side airbag deployment timing and result in uncontrolled side air bag deployment.

The RCM device is protected by the parking brake and console to prevent damage from occupants when stepping past the seat to access the rear of the vehicle. The parking brake and console should be maintained in their fitted position to ensure protection for the RCM.

Restraints Control Module (RCM)


E167678

Front, Side and Door Sensors

The airbag sensor for the front air bags is located behind the front grille, see figure E167679.

The sensors for the side air bags are located at the bottom of the B-pillars, see figure E145412 and in the front door behind the speaker see figure E167680.

WARNINGS:

Modifications or reinforcements in the area of the sensors may affect the side air bags deployment timing and result in uncontrolled side air bag deployment.

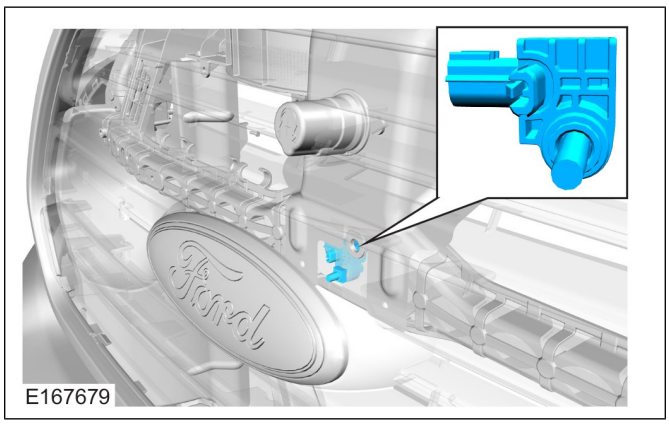
Drilling or grinding operations in these area are only permitted when battery cables are disconnected.

If the vehicle is specified with side and curtain airbags, ensure any accessories fitted to the doors are clear of the airbag deployment zones and that any holes created in the door trim, inner or outer sheet metal are sealed to retain the integrity of the door cavity. Failure to seal holes in the door trim or sheet metal may affect the sensitivity of the restraints system.

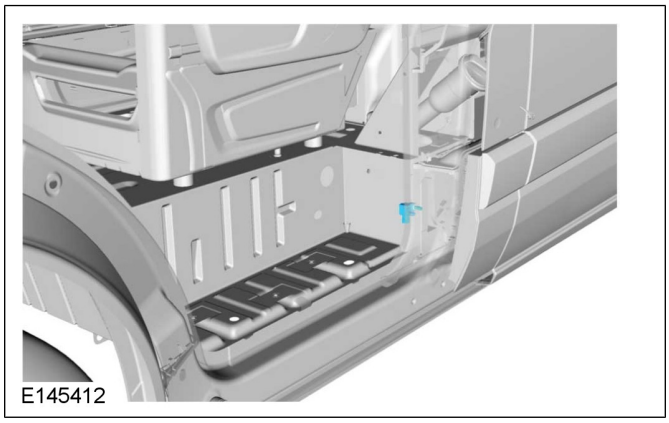
If the battery is disconnected

Refer to: 4.4 Battery and Cables (page 102).
Battery and Monitoring Sensor section for reconnecting battery.

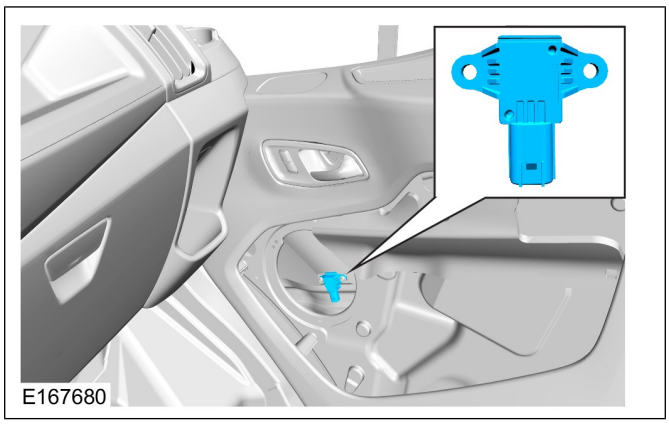
Front Sensor



Side Sensor



Door Sensor



5.12 Seatbelt Systems

5.12.1 Seat Belts

WARNING: Follow removal and installation procedures for the seat belt system to ensure correct function of the restraints system.

The removal and reinstallation of the seat belt, buckle or any component of the seat belt system should be avoided. However if removal and re-installation of the system is required during the conversion, follow the removal and installation guidelines of the seat belt system as described in the workshop manual. Please consult your local National Sales Company representative for further information.

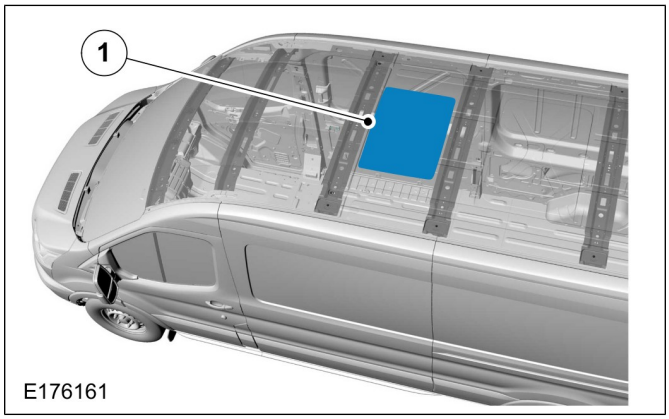
When removing the seat belt system, a seat belt webbing forked retainer should be applied to the webbing 200mm below the webbing button stop. This prevents a situation where all the webbing runs back into the retractor and the retractor becomes locked.

When reinstalling, fit the retractor to the body first and gently pull the webbing out of the retractor to allow fitment of the D loop. Then remove the forked retainer. If the retractor is locked, allow a small amount of webbing to reel back into the retractor to allow the webbing lock to release. Do not attempt to release the retractor by pulling on the webbing with significant force or by manually interfering with the locking mechanism.

5.12.2 Driver Belt-Minder

Driver belt-minder is a legal requirement for an M1 vehicle. A switch is provided in the driver's buckle to sense the seat belt wearing status of the driver. If an M1 vehicle is modified, this function must be retained.

5.13.1 Roof Ventilation



E176161

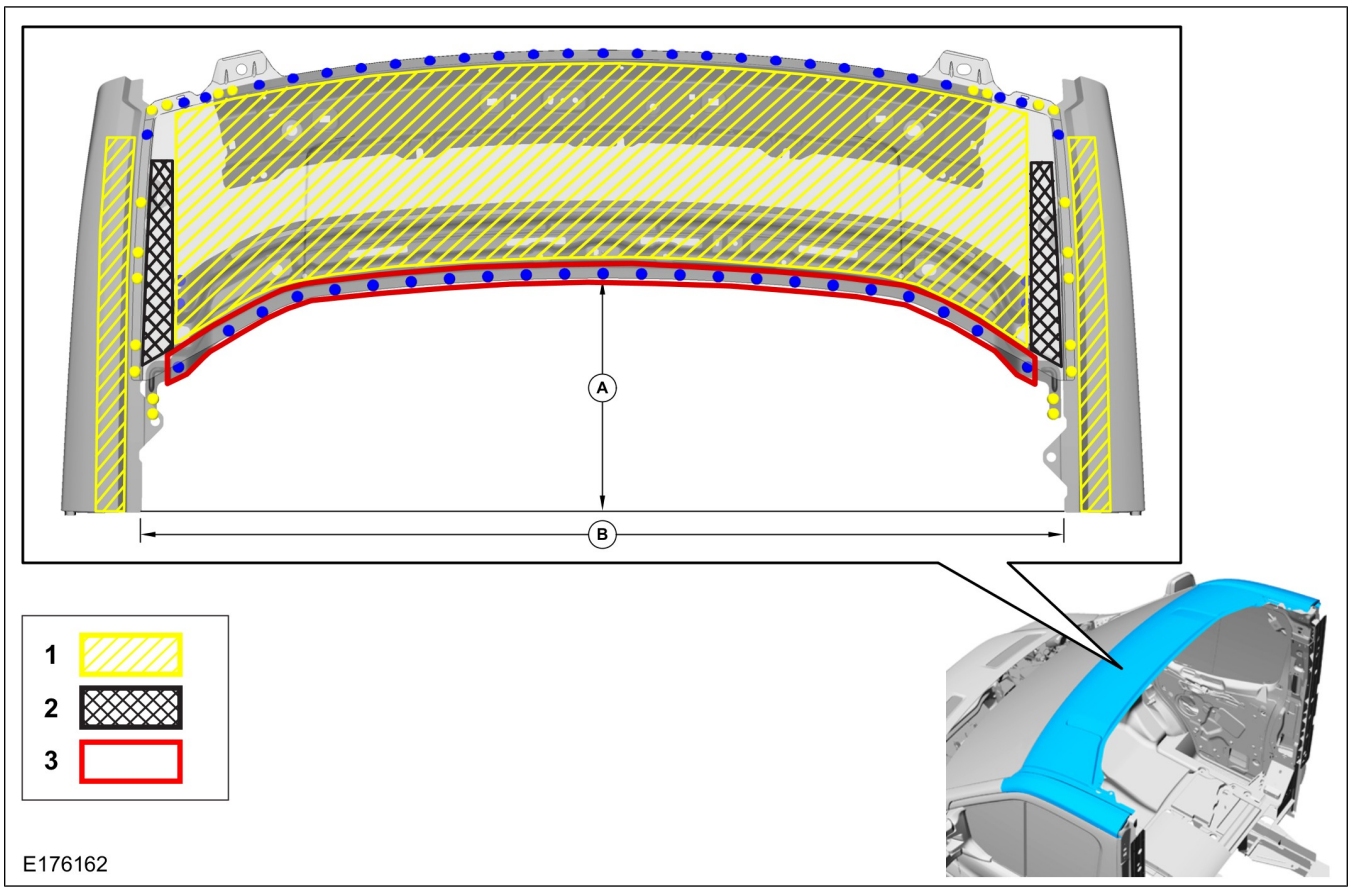
Item	Description
1	Local form in Roof Panel

General - Apertures must not cut through roof bows, see figure E176161. Ventilators must prevent direct entry of water and dust. A shut-off system should be available to prevent fume ingress. Interior and exterior projection legal requirements must be maintained.

Ventilation Units -The roof panel can support up to 1kg on an unsupported area of roof. Loads up to a maximum of 25kg must be distributed over the full length of the roof rails between the roof bows.

Air Conditioning Units -Units weighing more than 25kg must be internally supported on cross brace members distributing the load out to the roof rails.

5.13.2 Roof Cut Out - Camper Based Vehicles Only

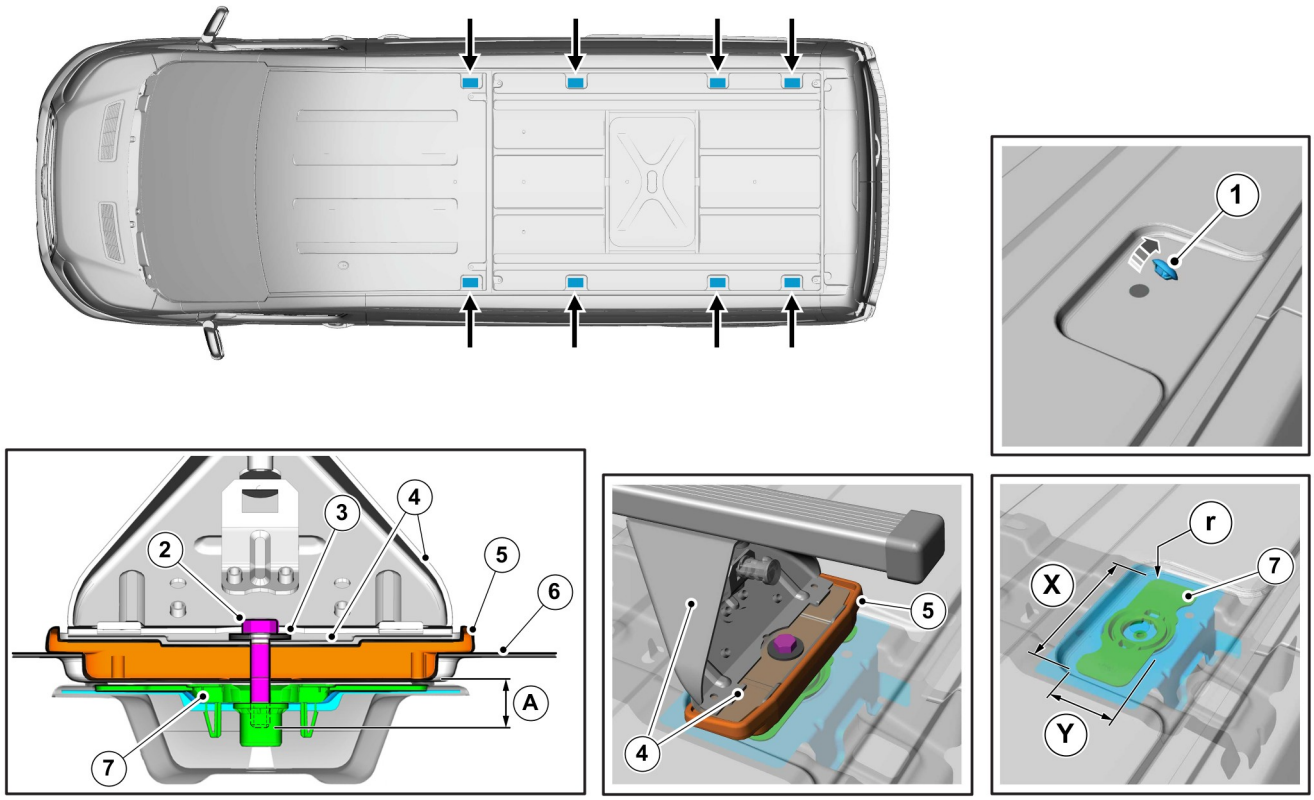


E176162

Item	Description
1	Rivet and self tapping screw area
2	Bolting area
3	Bolting area providing bolts are between blue spot welds
A, B	Maximum roof cut out standard (Transit Motorhome Chassis with roof and back panel removed Shown, for Camper Single Chassis Cab, the same fixing strategy applies).

5.13.3 Roof Racks and Load Carriers

Load Retaining Fixtures



E176163

Item	Description
1	Plug to avoid water ingress and corrosion
2	M8 Bolt
3	Seal
4	Roof Rack System
5	Seal
6	Roof Panel
7	Reinforcement
A	Maximum intrusion 16mm
X	130mm
Y	47mm
r	10mm

WARNING: Refer to the Owners Manual for information on Load Carrying and maximum roof loads.

NOTE: The number of load retaining fixtures vary depending on the vehicle.

Roof racks may be fitted to all Van, Bus and Kombi variants providing the following is satisfied:

- The load of a single attachment under worst case loading, must not exceed 31.75kg, as long as the total carried load does not exceed the maximum recommended weight, including the roof rack/attachments as stated in the Owner's Manual.
- The load is evenly distributed (converter to ensure owner's information book identifies this limitation).
- Ideally, the bearing surface of the roof rack attached should be the same as the reinforcement inside the roof, see figure E176163, item 7 and dimensions X,Y and r.

- Ensure sealing of surfaces, for example: with EPDM rubber material or equivalent and ensure sealing along the bolt for preventing water ingress into the interior of the vehicle, see figure E176163 items 3 and 5.
- The thread size is M8. The maximum intrusion of the M8 bolt into the roof is 16mm, see 'A' in figure E176163.
- Read and follow the manufacturer's instructions when fitting a roof rack.
- It is recommended that the rack leading edge should not be located forward of the rear edge of the driver's door, or "B" pillar.
- When removing the roof rack ensure holes are properly sealed with sealing plugs or equivalent water tight elements.

5.14 Corrosion Prevention

5.14.1 General

Avoid drilling into closed frame body members to avoid the risk of corrosion from swarf.

If drilling is required, however:

- Re-paint metal edges and protect against corrosion after cutting or drilling operations.
- Endeavor to remove all swarf from inside the side member and treat to prevent corrosion.
- Apply corrosion protection inside and outside of the chassis frame.

For Welding:

Refer to: 5.1 Body (page 214).

5.14.2 Repairing Damaged Paint

After cutting or reworking any sheet metal on the vehicle the damaged paint must be repaired.

Ensure all materials are compatible with the relevant Ford specifications and maintain the original performance where possible. For specifications consult the Vehicle Converter Advisory Service VCAS@ford.com

5.14.3 Under Body Protection and Material

WARNING: Do not over-coat or contaminate surfaces of components such as brakes or catalytic converters.

Ensure all materials are compatible with the relevant Ford specifications and maintain the original performance where possible.

Some proprietary products affect the original coatings. For specifications of corrosion protection materials, please consult your local National Sales Company representative or the Vehicle Converter Advisory Service VCAS@ford.com

5.14.4 Painting Road Wheels

WARNING: Do not paint wheel clamp surfaces in contact with other wheels, brake drum or disc, hub and holes or surface under wheel nuts. Any further treatment in these areas may affect the wheel clamp performance and the vehicle safety. Mask the wheel when changing the color or repairing paint.

5.14.5 Contact Corrosion

When using different materials with a different electrochemical potential, ensure that materials are isolated from each other to prevent contact corrosion caused by a potential difference.

Use appropriate isolation materials. Where possible, choose materials with low level of electrochemical potential difference.

5.15 Frame and Body Mounting

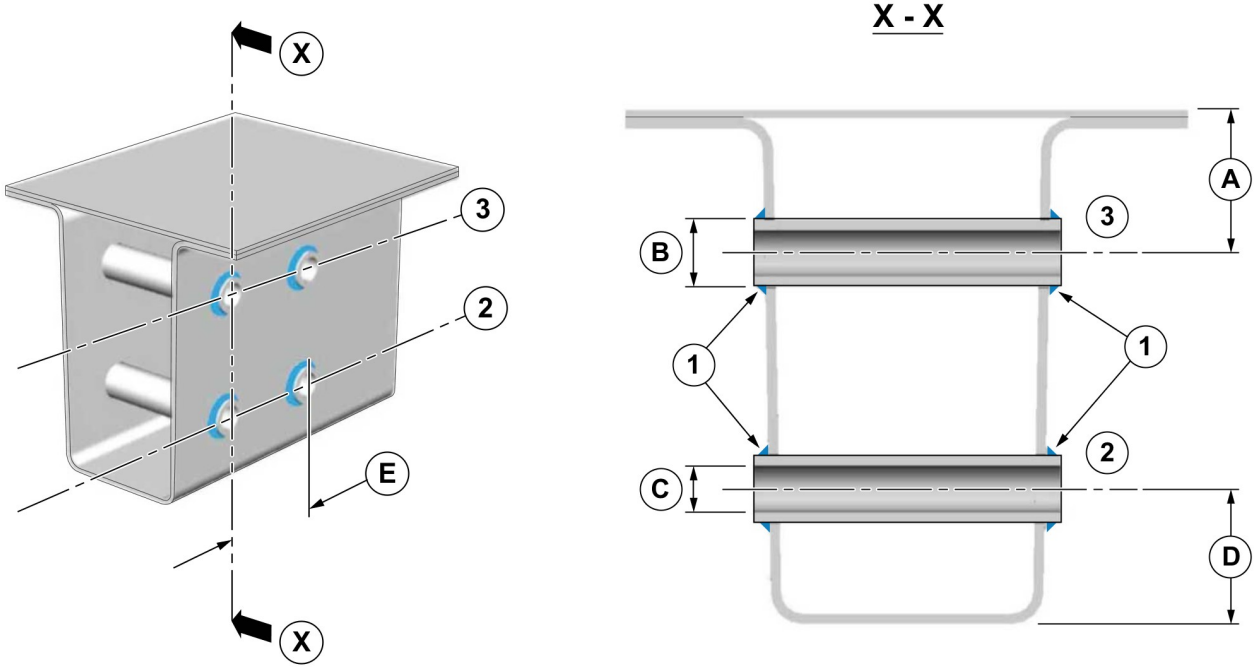
5.15.1 Mounting Points and Tubing

The holes on the frame are a result of the production process. They are not designed for fixing additional equipment. If additional fixings to the chassis frame are required please follow the recommendation given in figure E176204. This does not apply to areas of load applications such as spring fixings or damper fixings.

NOTE: After drilling, deburr and countersink all holes and remove chips from the frame. Follow corrosion prevention.

Refer to: 5.14 Corrosion Prevention (page 268).

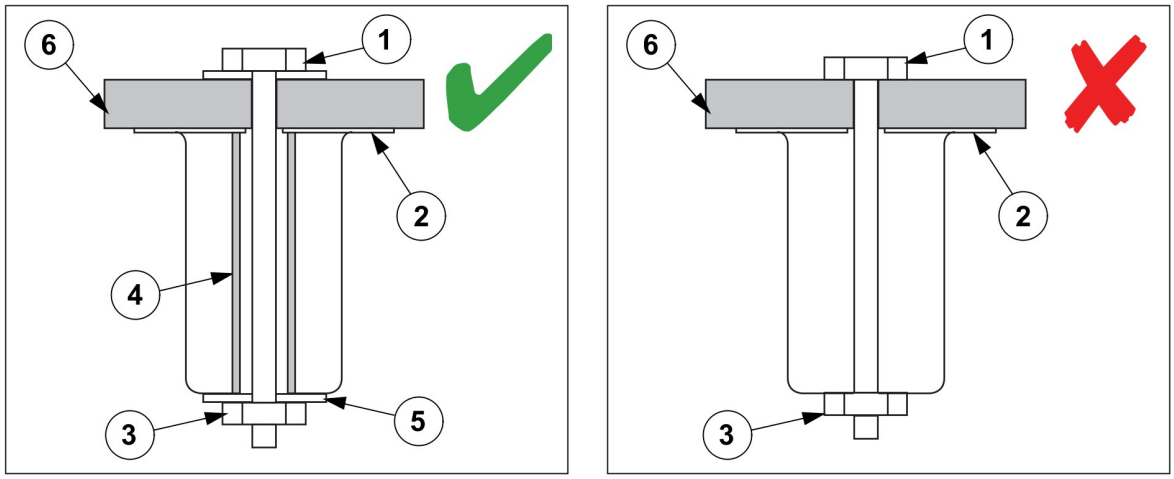
Frame Drilling and Tube Reinforcing



E176204

Item	Description	Item	Description
1	Full Penetration; Full diameter weld each side	B	Diameter 16.5mm maximum
2	Center line of holes/tubing	C	Diameter 11mm
3	Center line of holes/tubing	D	30mm to 35mm
A	30mm to 35mm	E	50mm minimum

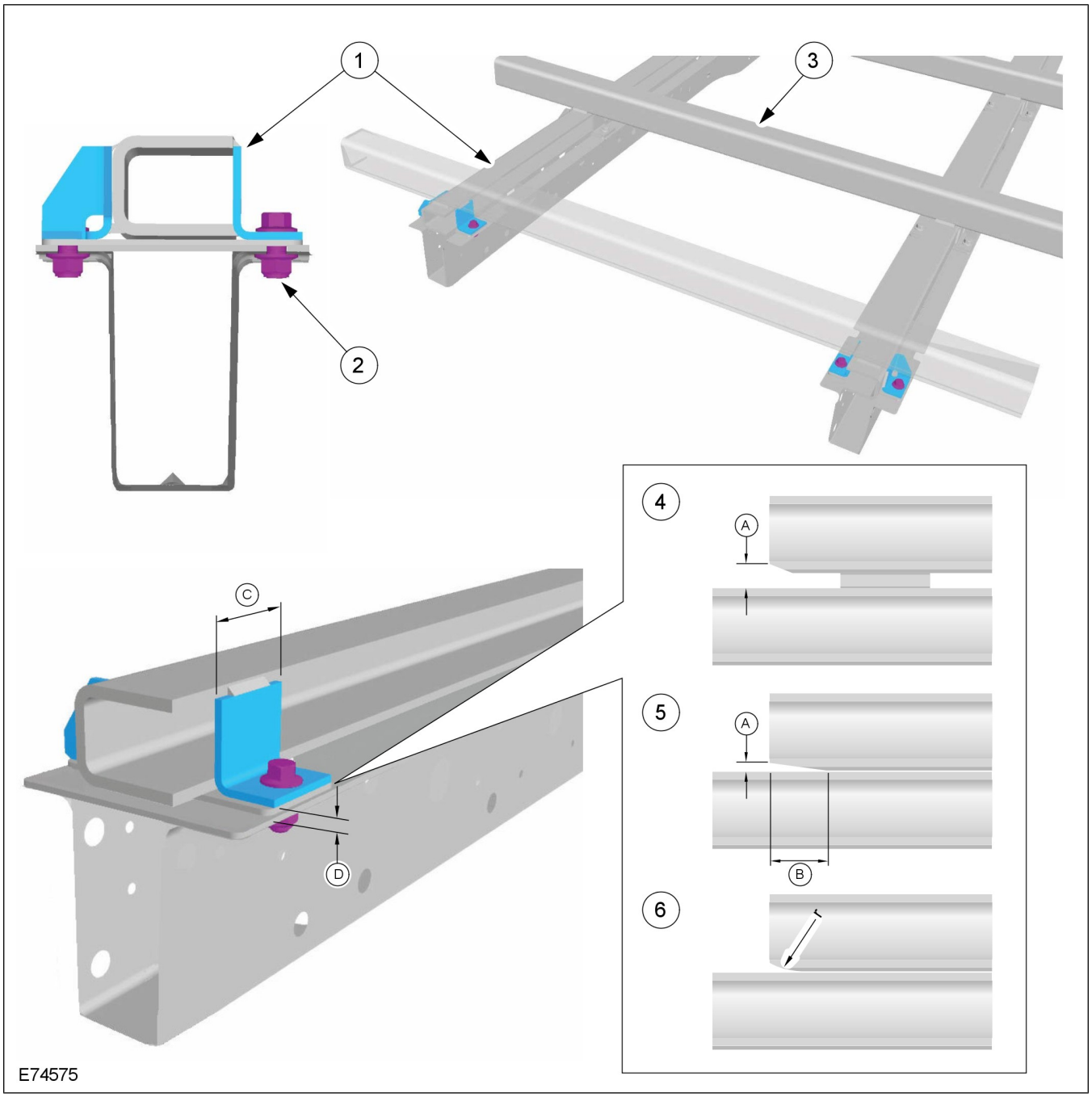
Recommended Frame Drilling and Tube Reinforcing



E196988

Item	Description	Item	Description
1	Screw	4	It is recommended to always use a tube
2	Longitudinal rail	5	It is recommended to always use washers. Size minimum equal to lower rail width.
3	Screw Nut	6	Floor - minimum thickness 37mm

Sub Frame for Low Floor or other Equipment - Chassis Cab



Item	Description
1	Continuous longitudinal float or body support member
2	Always use both sides of all chassis mounts
3	Cross members
4,5,6	Relief front end and longitudinal if there is a risk of stress concentration in chassis frame from longitudinal contact
A	5mm (minimum)
B	50mm (minimum)
C	50mm width for all brackets
D	Avoid longitudinal contact if possible which may create stress concentration
r	20mm (minimum)

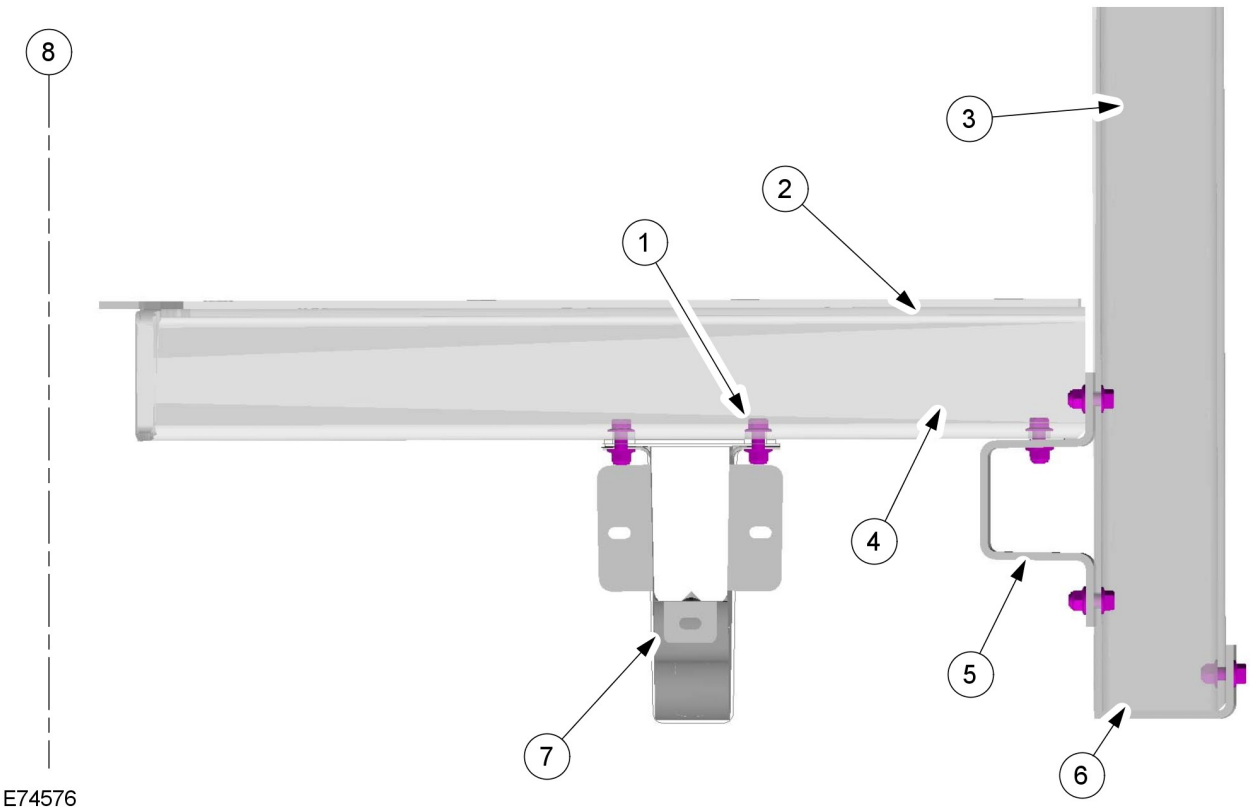
5.15.2 Self-Supporting Body Structure

Bodies and structures can be judged as self-supporting providing they maintain the following rules:

- Cross members are used at each chassis mounting point, please

  Refer to: 5.1 Body (page 214).
  - Chassis Frame Body Attachment figures E67667,E167668, 167669 and E167670 also E74576 and E176203 in this section.
- Each cross member has a suitably engineered connection to the body side wall (3) or to the continuous floor frame (5), shown in figure E74576.
- The body side wall or the continuous floor frame supports any overhang beyond the chassis frame, whether on standard frame or extended frame.

Typical Design Principle of a Self-Supporting Body Structure



E74576

Item	Description
1	Use all standard locations with 2x M10 fixings
2	Floor Panel
3	Body side frames
4	Floor cross members
5	Continuous floor U-profile frame
6	Longitudinal L-profile
7	Chassis frame rail of base vehicle
8	Vehicle center line of base vehicle

Alternatively, the self-supporting body structure can also be designed as shown in figure E74577. This concept is based on a self-supporting structure where the floor is mounted directly onto the top surface of the chassis frame.

Figure E74577 shows a generic vehicle cross section where the cross members and opposing out riggers are flush with the surface of the chassis frame side members.

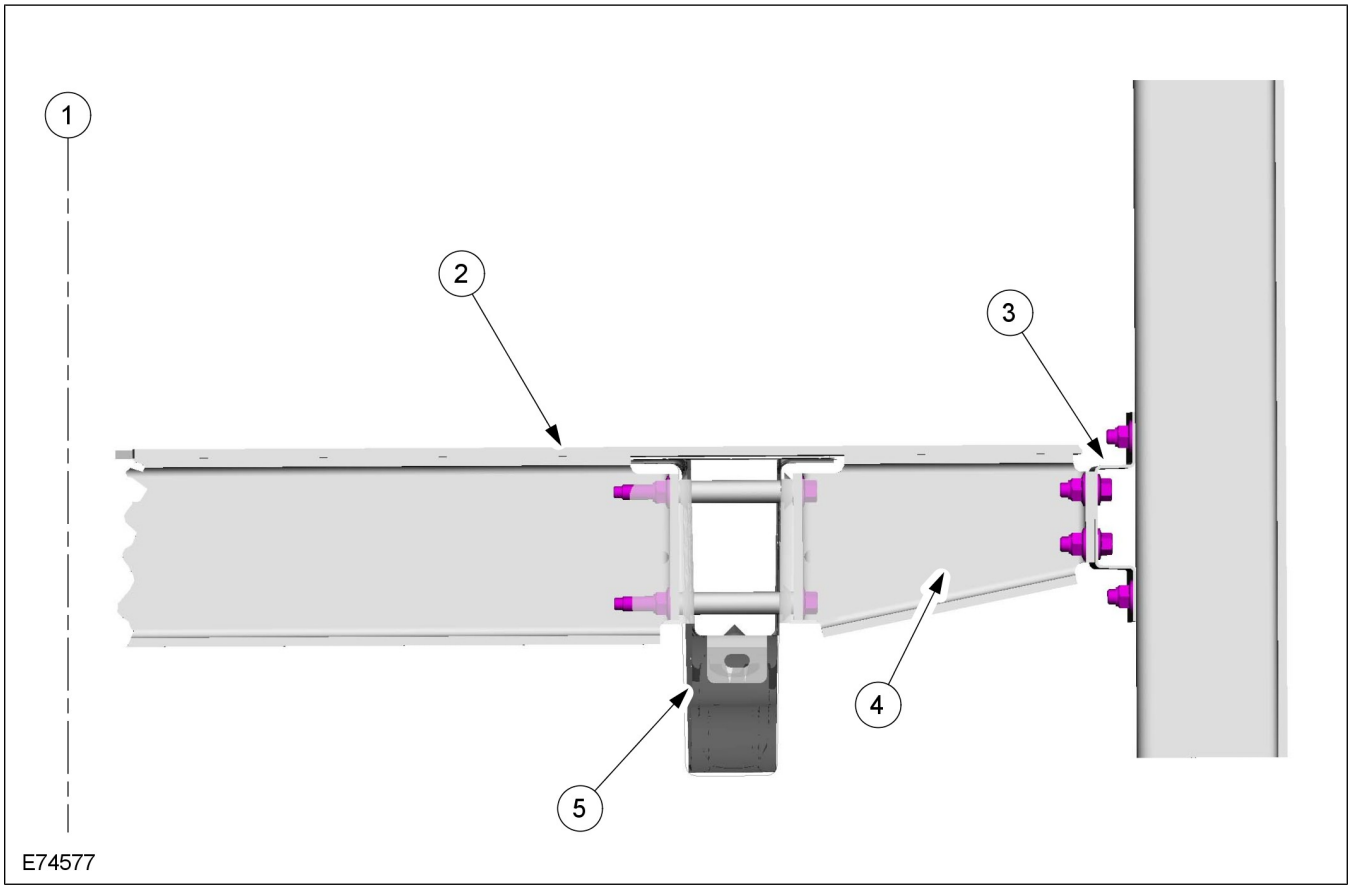
It is important to the overall function of the vehicle structure that the out riggers are each connected to a continuous longitudinal floor side frame or a structural body side structure assembly.

Low floor-re-work for guidance only:

- Engineer unique cross members and out-riggers spaced at approximately 600mm maximum pitch
- Out-rigger moment to be re-acted with cross-member between chassis frame with common through bolts where possible, see figure E74577 Low floor standard chassis frame.
- Drill frame and add spacer tubes, see frame drilling & tube reinforcing, see figure E176204.
- Out-rigger outboard ends should be attached to load bearing body side / floor edge frame or body side structure (including over wheel support).
- Structural wheel box should maintain longitudinal continuity with a rigid attachment to the floor edge frame or to the body side structure.
- Floor boards should be substantially attached to cross members and outriggers, but not to the chassis frame top surface.
- Low floor exhaust heat shields;

Refer to: 3.6 Exhaust System (page 71).

Low Floor Standard Chassis Frame



E74577

Item	Description
1	Vertical center line of vehicle
2	Floor panel
3	Continuous floor edge longitudinal
4	Outrigger
5	Low floor

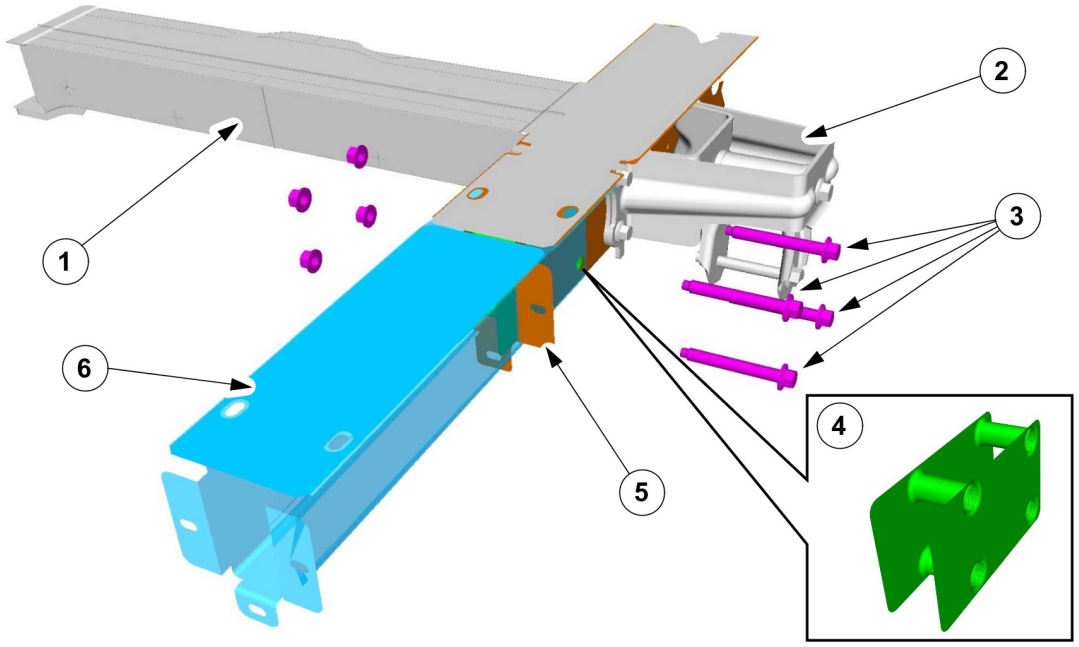
5.15.3 Extended Chassis Frame

General:

- Rear overhang extensions are available as Regular production Option.
- Bodies or equipment exceeding the standard extension length must be supported, please refer to figure E74575 low body longitudinal members or figure E74576 self-supporting body structures.

- It is the vehicle convertor's responsibility to mark up the Owner's Manual advising the available payload. Axel plated weights and maximum allowable axle mass as shown in this manual must not be exceeded.
- The vehicle should be planned for uniformly distributed loads.

5.15.4 Non Standard Rear Chassis Frame Extension



E176203

Item	Description
1	Cross member
2	Rear spring hanger
3	4x M10 bolts
4	Spacer tube assembly
5	Flanges removed
6	New flanges for under-run bar

Extensions longer than the standard Regular Production Option must comply with the following guidelines:

- The original rear cross member and or under-run bar or equivalent must be repositioned at the end of any altered extension to meet legislation, please refer to Figure E176203 Non Regular Production Option rear chassis frame extensions. Also see.

  Refer to: 1.16 Towing (page 43).
  figure E167538
- The standard fit under-run bar is bolted on as shown in figure E176203 and figure E167538 as mentioned in previous paragraph.
- The altered extension assembly must include a cross member adjacent to the end of the original chassis frame to replace the relocated under-run bar, see Figure E74577.
- Flat-beds and low bodies built onto Non Regular Production Option extensions must have continuous longitudinal members engineered by the Body Builder or equipment supplier, please refer to figure. E74577, to resolve the worst case moments at rear bump stop.
- Extensions should be secured to the chassis frame sandwiched under the rear spring shackle bracket utilizing the 4 bolts and 4 holes in the rear of the chassis frame, totaling 8 per vehicle, see figure E176203.

- The 4 rear most existing holes in the chassis frame must be sleeved with tubes to prevent chassis frame collapse, refer to figure E176203.
- The spacer tubes should, ideally, be part of a welded bracket and tube assembly to hold the tubes accurately in place, avoiding the need to weld the tubes in place, see figure E176203.
- Care must be taken when tightening the spring shackle bracket bolts and nuts to the correct torque. For Tightening torques

  Refer to: 1.14 (page 37).
- Extensions sleeved over the outside of the chassis frame will necessitate the removal of the under-run bar attachment flanges turned out at the chassis frame ends. The cut edges must be protected against corrosion.

  Refer to: 5.14 Corrosion Prevention (page 268).
- Drilling of the top flanges turned out is only permissible rearward of the spring hanger brackets, for continuity of the altered extension closing plate, if required. The diameter of the holes should be 6.0mm maximum.
- It is recommended that the altered extension has a similar closed section, material thickness and properties to the existing chassis frame.
- An equivalent open section for the extension assembly is at the vehicle converters discretion.
- Lightening holes in new extension and cross members are discretional.
- Do not weld original chassis frame except as specified when adding reinforcing tubes, please refer to figure E745171.
- Do not drill the top or bottom surface of the chassis frame, including the flanges turned out, except as recommended above for continuity of closure.
- Any alternative finish such as hot dip galvanizing is at the discretion of the Body Builder providing it does not have a detrimental effect on the original Ford product.

  Refer to: 5.14 Corrosion Prevention (page 268).

5.15.5 Frame Drilling and Tube Reinforcing

The chassis frame may be drilled and reinforcing spacer tubes may be welded in place, providing the following is applied:

- Adhere to all details shown in figure E148689.
- Locate and drill holes accurately, using a drill guide to ensure holes are square to frame vertical center line (allow for side member draft angle).
- Drill undersize and ream out to size.
- Endeavor to remove all swarf from inside side member, and treat to prevent corrosion.
- Fully weld each end of the tube and grind flat and square, in groups if applicable. Be aware of side member draft angle.
- Apply corrosion protection inside and outside of the chassis frame.

  Refer to: 5.14 Corrosion Prevention (page 268).
- Holes should be in groups of two, either vertically spaced at 30 to 35mm from chassis frame top and/or bottom surface, or horizontally at 50mm minimum pitch, 30 to 35mm from top and/or bottom chassis frame surface, please refer to figure E148689.
- Always use M10 bolts with grade 8.8 minimum.
- Do not position tubes at the medium chassis frame height, this may create “oil canning” of the deep section side walls.
- Where possible, the outrigger moments should be resolved by matching inner cross members between the chassis side members inline with the outriggers, please refer to figure E74577.
- A diameter of 16.5mm is the maximum allowable hole size in the chassis frame side wall, irrespective of the usage.

Avoid drilling into closed frame body members to avoid the risk of corrosion from swarf.

Refer to: 5.14 Corrosion Prevention (page 268).

Drilling and welding of frames and body structure have to be conducted following the guidelines. Please consult the Vehicle Converter Advisory Service VCAS@ford.com for details.

Refer to: 5.1 Body (page 214).
Welding.

5.15.6 Ancillary Equipment - Sub Frame Mounting

Typical sub-frames and longitudinal members for flatbed and low or drop-side bodies or equipment exceeding the standard or Regular Production Order frame length should adhere to the following guidelines:

- Flat-beds and low bodies mounted on integral longitudinal members, channel or box section metal – not wood, must use both sides of all frame mounting brackets, see figure E74575.
- Longitudinal members must be relieved at the front end if they are to contact the chassis frame top surface, to minimize stress concentrations, see figure E74575. However, it is preferable to mount the longitudinal onto the mounting brackets, with a clearance to the chassis frame top surface.
- Each set of brackets must use 2 x M10 bolts grade 8.8 minimum.
- The rear 2 sets of chassis frame mounting holes/locations should have a full bolt torque with 100% grip. The attachment to the remaining forward chassis frame holes / locations must be precisely located and retained, but allow some relative flexing between the sub-frame and chassis frame. For example, clamp control devices such as conical washer stacks or machine springs with self locking fasteners.
- Minimum floor heights will require wheel arch boxes to clear the rear tires, see Vehicle Data sheets for relevant tire jounce.

- Chassis frame, for example: clamp control devices such as conical washer stacks or machine springs with self locking fastenings.
- Minimum floor heights will require wheel arch boxes to clear the rear tires.

Pedestal mounted low or drop side bodies – (not illustrated)

For bodies or equipment not exceeding the standard or Regular Production Order chassis frame length.

For flat-beds and low bodies raised above the maximum “jounced” tire position to obtain an uninterrupted flat floor surface see vehicle data sheets.

- Fore and after longitudinal bracing must be added between the rear-most 2 cross members only
- All chassis frame mounting holes/locations must always be used.
- All chassis frame mounting bracket fastenings must have a full bolt torque with 100% friction grip.

5.15.7 Water Tank on Camper Vehicles

NOTE: It is recommended that a decal or label is fitted adjacent to the filler aperture identifying the correct fluid to be used, for example: 'Water only' for water tanks.

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